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# DSP ALGORITHMS FOR DIGITAL HEARING INSTRUMENTS

by

Erkan Onat

# A Thesis Submitted to the Faculty of Graduate Studies and Research through Electrical and Computer Engineering in Partial Fulfillment of the Requirements for the Degree of Master of Applied Science at the University of Windsor

Windsor, Ontario, Canada

2001

°2001 Erkan Onat



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#### **ABSTRACT**

A new digital filter bank design and a new compression algorithm that can improve the performance of hearing instruments located completely in the ear canal (CIC) are developed in the thesis. In order to assess state-of-the-art hearing instruments employing advanced signal processing techniques the DynamEQ-II analog hearing instrument developed by the Gennum Corporation was studied extensively. A sophisticated SIMULINK model, involving the use of audio files, was developed to evaluate the performance characteristics of the strategies and algorithms used in the DynamEQ-II. The RangeEar algorithm employed in the DigiFocus hearing instrument from the Oticon Company was also studied using SIMULINK in a similar manner. Two recommended improvements for a new hearing instrument are presented. The first improvement involves the use of an eight-band digital filter bank based on an interpolated finite impulse response (IFIR) prototype filter that has been optimized using delay elements to give a maximally flat overall magnitude response. The resulting group delay is a constant and less than the value where self-hearing and "lip reading" problems occur. The second improvement uses a new compression algorithm based on a model of the human auditory system. The new algorithm replaces the existing constant homomorphic multiplication algorithms with an acoustic signal intensity weighted multiplication. The resulting nonlinear compression ratio expands low level signals and compresses high level signals in such a manner so as to improve noise immunity and increase the intelligibility of the sound. The MIT hearing loss simulator was employed to evaluate the effectiveness of the new proposed filter bank and compression algorithm by analysis of and listening to actual test audio files.

To My Dear Parents

## Acknowledgements

I would like to express my deepest thanks and appreciation, for his continuous technical guidance, support and encouragement, to Dr. W. C. Miller. His wisdom was the light in this research.

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#### Chapter 1

#### INTRODUCTION

In this thesis research on DSP algorithms for CIC (completely in the canal) digital hearing instrument is carried out. The DSP algorithms covered are digital filterbanks and digital compression algorithms. Digital version of state of the art DynamEQ-II hybrid hearing aid is simulated. Current technology digital filterbank designs and compression algorithms are simulated and improved. Performances are compared with the aid of a hearing loss simulator.

The history of hearing instruments is tracked from 19<sup>th</sup> century on, but it had been known that Greeks used shells and Romans had bronze funnels as hearing instruments. In 1800 the first hearing instrument company, which was manufacturing tubes and trumpets as hearing instruments was established [1]. In mid 1890's the first patent for electrical hearing aid is filed but never reached to production. 1899 was the year for the first commercially manufactured hearing aid called Akoullalion [2], which was made of carbon. The first vacuum tube hearing aid, which was very heavy and worn on the body, was patented in 1921. It was consisting of microphone, earphone, amplifier and two batteries, which would last only a day. With the introduction of transistor technology after 1953 the size of the hearing aids got smaller and their capabilities were increased. In 1970 the first hybrid hearing aids, which had analog and digital circuitry were manufactured [2]. In 1988 many programmable hearing aids were introduced. They had

analog circuitry, which was programmed with computers digitally. In 1996 the first behind the ear 100% digital hearing instrument was manufactured.

#### 1.1 Hearing Instrument Technologies

As listed in the history of hearing instruments there has been a transition from analog technology to digital technology. This transition brought three major types of hearing instruments:

Analog Hearing Instruments: This type of hearing instruments is also called the conventional hearing instruments. They consist of the microphone, the amplifier unit, the loudspeaker and the battery. The circuitry used in these hearing instruments is totally analog. There are several drawbacks of using the analog technology: The high resolution in frequency domain achieved with digital technology can not be achieved. Analog hearing aids have up to two frequency channels [3]. They are amplifiers, whose electroacoustical performances are adjusted manually through trimmer potentiometers. They apply linear amplification.

Programmable Hearing Instruments: This type of hearing instruments is based on analog circuitry, where a memory module replaces the potentiometers. The memory module can be a RAM or EEPROM, which are accessed through an external microprocessor. They are basically analog hearing aids, whose control is improved through digital technology. Even if the patients hearing changes they can be reprogrammed instead of having to obtain a completely new instrument. Compression can be achieved through the sound-level dependent amplification [4].

Digital Hearing Instruments: They convert the analog signal received from the microphone to digital and process the signal totally in digital domain. As demonstrated in Fig. 1-1 the digital signal is processed with DSP algorithm and the output is converted again to analog signal, which drives the loudspeaker. In signal processing part the sound is splitted into multichannels, where the frequency shaping of the sound signal is done according to the patients audiogram. Nonlinear amplification parameters are set once and the algorithm adjusts itself according to the intensity level of the input sound. Besides compression algorithms speech enhancement algorithms are also used [5]. It allows better overall sound quality and compensation of loudness growth.

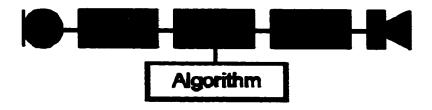


Fig. 1-1 Digital hearing instrument structure

#### 1.2 Hearing Instrument Types

Hearing instruments can be grouped according to their sizes into four categories: BTE (behind the ear), ITE (in the ear), ITC (in the canal) and CIC (completely in the canal). Their location on the ear is plotted in Fig. 1-2 [6].

BTE (Behind the ear): These hearing instruments rest behind the earlobe and connected to the ear by a custom earmold. Their location allows relaxation in their size constraint.

Therefore circuits allowing more gain can be used. It can be used for a wide range of hearing losses from mild to profound.

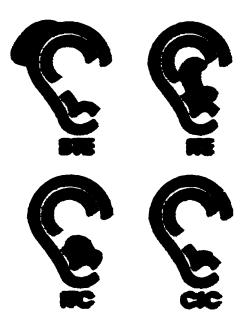


Fig. 1-2 Hearing instrument types

ITE (In the ear): They fit in the bowl of the ear and are visible in the ear. They are also powerful based on their size and can be used for hearing losses from mild to severe.

ITC (In the canal): This hearing instruments are located more in the canal, but still visible. They can be used for hearing losses from mild to moderate.

CIC (completely in the canal): They go very deep inside the ear canal and are almost invisible as shown in Fig. 1-3 [7]. Therefore they have more comfort and cosmetic value. Because of the closer proximity to the eardrum and the resonance characteristic of the ear canal, less power is required to provide equal amount of amplification. Other hearing aids have the 'occlusion effect', which means the sensation of talking in a barrel. This is

greatly reduced or eliminated with CIC hearing aid [8]. Another advantage is the reduced wind noise.

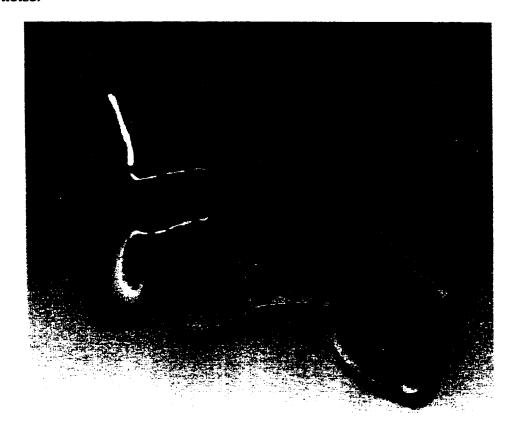


Fig. 1-3 CIC Hearing instrument placement

#### 1.3 Overview

The first chapter gives an introduction into thesis by explaining the hearing instrument history, technology and types. It points out that the research covers filterbank designs and compression algorithms for CIC digital hearing instruments, which are tested with hearing loss simulator.

Second chapter explains the anatomy of human hearing and relates the limitations of human hearing and characteristics of hearing losses with hearing instrument design constraints.

Gennum Corporation's DynamEQ-II hybrid hearing instrument characteristics are explained in third chapter. The research on its digital version simulation is explained and the limitations are pointed out.

Chapter four covers the research on digital filterbank design for hearing instruments.

Research on interpolated FIR filterbank design, modulated filterbank design, extension of QMF (Quadrature mirror filter) to multichannels and wavelet filterbank design are explained. Their suitability for hearing instruments is discussed.

Two state of the art compression algorithms are demonstrated in chapter five. Their Simulink implementations are explained and performances are evaluated using the hearing loss simulator. The preference is discussed.

Summary of the research and future research possibilities are given as the conclusion in chapter six.

### Chapter 2

#### **HUMAN HEARING**

In this chapter the mechanism of human hearing is explained. Important characteristics of human hearing for hearing instrument design are clarified. Different types of hearing losses and their effects are pointed out. Hearing instrument design constraints are discussed.

#### 2.1 The Ear Structure

As one of the most intricate and delicate mechanical structures in the human body, the human ear can be divided into three main parts: Outer, middle, and inner ear Fig. 2-1 [9]. In this section the working principles and characteristics of these parts are explained.

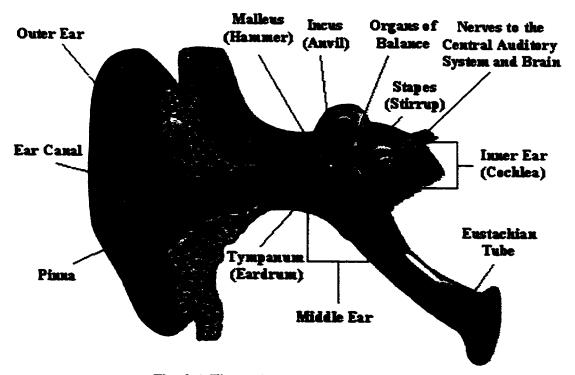


Fig. 2-1 The main parts of ear anatomy

#### 2.1.1 Outer and Middle Ear

The outer ear is composed of two parts, the pinna and the ear canal. The pinna of the outer ear serves as a horn collecting sound into the canal. In terms of amplification human pinna is relatively ineffective comparing to some animals pinna, which supplies an appreciable gain over certain frequency ranges [10]. However, this part of the ear helps in localizing the direction of the sound source. The time delay to each ear from sounds on the right or the left as well as sounds from the front and the back is enhanced by the pinna [11]. The ear canal is an approximately straight tube, about 0.7 cm in diameter and 2.5 cm long. At the resonance of the canal, which is about 3 kHz, the SPL at the drum is about 10 dB higher than at the entrance of the canal [10]. The resonance curve of the canal is quite broad. Therefore some gain is observed over the frequency range from 2 to 6 kHz.

Measurements have been done to obtain the average pressure transformation from the free field to the eardrum [14]. The data pool covers 100 subjects in five countries over a period of 40 years. The data is showing the average pressure transformation from the free field to the human eardrum in the horizontal plane as a function of frequency at 15° intervals in azimuth. That means the sound source is aligned with the eardrum in vertical axis and the measurement is performed at every 15° angle increment on horizontal axis with constant distance from the drum. 0° angle corresponds to facing the source. At f frequency and  $\theta$  degree the measurements are done both in the eardrum  $L_d(f,\theta)$  and at the same point when the subject is removed  $L_f(f,\theta)$ . The sound pressure transformation  $T_d(f,\theta)$  is given as:

$$T_d(f,\theta) = L_d(f,\theta) - L_f(f,\theta)$$
 (2-1)

These measurements give us the average frequency response of the outer ear with combination of the diffraction of sound waves by the head and shoulders. This total response is called as HRTF (Head related transfer function). Fig. 2-2 is showing the average HRTF in the range of 0° to 180°. Fig. 2-3 is the mesh plot of the total data, showing the change of the HRTF with respect to measurement frequency and angle. From Fig. 2-2 it is observed that the frequency ranges 2 kHz-6 kHz and 11 kHz-12 kHz are more emphasized by the HRTF. The maximum difference of emphasis at different frequencies is less than 16 dB. Fig. 2-3 shows us that this characteristic is consistent at different azimuth angles, while the magnitudes differ. The Matlab code of HRTF data plotting is given in Appendix I.

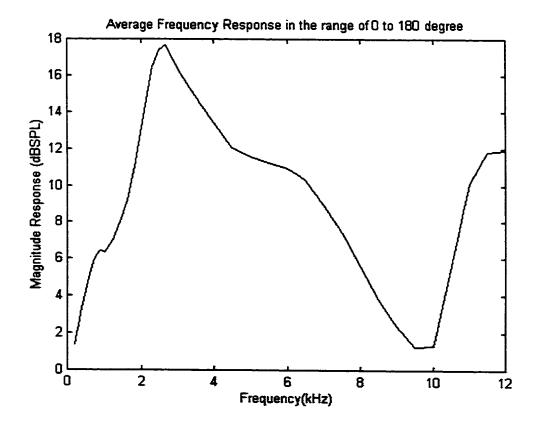


Fig. 2-2 The average HRTF in 0°-180° azimuth angle range

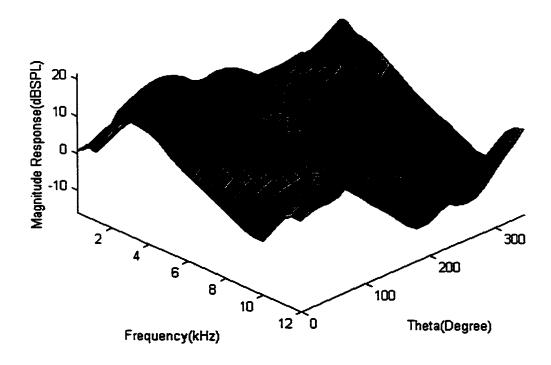


Fig. 2-3 Mesh plot of HRTF Measurements

The middle ear consists of the tympanic membrane or eardrum and a set of small bones called ossicles: the malleus (hammer), incus (anvil), and stapes (stirrup). The middle ear is connected to the throat through the Eustachian tube.

The middle ear has the duty of impedance matching. Both outer and middle ear is filled with air, whereas inner ear is filled with liquid. The air has low mechanical impedance, which means that it has low acoustic pressure and high particle velocity resulting from low density and high compressibility [13]. On the other hand liquid has high mechanical impedance. Because of the difference in mechanical impedance most of the sound is reflected at an air/liquid interface. The area difference between the eardrum and oval

window at cochlea is the first source of compensation. The eardrum has an approximate area of 60 mm<sup>2</sup>, while the oval window, which is transmitting the sound into the liquid, has an approximate area of 4 mm<sup>2</sup>. This difference in the area increases the sound wave pressure 15 times. The vibration of the eardrum is sensed by the hammer and through the action of other bones the sound pulse is amplified, which is the second source of compensation for the impedance difference.

The atmosphere exerts much more pressure on the eardrum than any other sound, and if there were no compensatory mechanism it would rapture. The Eustachian tube equalizes the atmospheric pressure on both sides of the eardrum. If this tube were open permanently we would not be able to hear anything, because it would be balancing also the sound pressure. Therefore it operates only during the action of swallowing [14].

The middle ear has also a safety mechanism for high intensity sounds. For high intensities, the muscles controlling the motion of the ossicles change their tension to reduce the amplitude of the motion of the stapes, thereby protecting the delicate mechanism of the inner ear. This process is called as *acoustic reflex* [10]. The weakness of the protection is the fact that it takes approximately 0.5 ms after the first perception of the loud sound to activate the reflex. Therefore it offers no protection for sudden impulsive sounds such as gunshots.

#### 2.1.2 Inner Ear

It consists of three parts: the vestibule (entrance chamber), the semicircular canals (organs of balance), and the cochlea. Middle ear is connected to inner ear through the vestibule at two openings, the oval window and the round window. Oval window is

sealed with stapes and its support and the round window is sealed with a thin membrane, so that there isn't any liquid leakage from the inner ear. Except these two openings the rest of the inner ear is surrounded by bone. The semicircular canals don't play any role in hearing but in balancing.

The cochlea is a very critical organ in our hearing. Its name is derived from a Greek word for snail. It has roughly circular cross section, making 2.5 turns and has an approximate length of 3.5 cm. The cross-sectional area decreases in irregular manner and the cochlea has a total volume of 0.05 cm<sup>3</sup>. The cochlea is partitioned into two channels: the upper gallery (scala vestibuli) and lower gallery (scala tympani). These two galleries are connected two each other at the apex of the cochlea through a small opening (helicotrema). On their other ends upper gallery is connected to oval window and the lower gallery is connected to the round window.

In Fig. 2-4 [10] a cross-section of one of the turns of the cochlea is given. Besides the two galleries there is an isolated part in cochlea, called the cochlea duck, where the auditory nerves are located. This part is isolated from the galleries by the two cells thick Reissner's membrane and Basilar membrane. The organ of corti, carrying the hair cells, is located on Basilar membrane. The bony ledge carries the auditory nerve and at the end of bony ledge the nerve fibers enter the basilar membrane. The tectorial membrane lies above the basilar membrane. It is attached at one end to the bony ledge and at the other end it projects into the cochlear liquid. The hairs from the hair cells in the organ of corti extend to the under surface of the tectorial membrane. The organ of corti has four rows of hair cells all along the cochlea. There are approximately 30000 hair cells, whose 3500 are located in the inner row, where there are less vulnerable to damage.

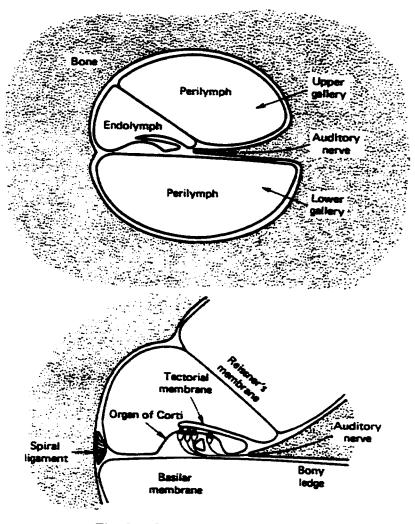


Fig. 2-4 Cross Section of Cochlea

The upper and lower gallery of the cochlea is filled with perilympatic fluid, whereas the cochlea duct is filled with endolympathic fluid. When the ear mechanism is excited by sound the stapes creates fluid disturbance through oval window. This disturbance travels down the upper gallery toward the apex of the cochlea, through the helicotrema, into the lower gallery, and back to the round window, which acts as a pressure-release termination. Since the tectorial membrane is attached to the bony ledge and the organ of corti is attached to the basilar membrane, the vibration difference between them flex the hairs, thereby exciting the nerve endings attached to the hair cells into producing electrical impulses. The basilar membrane is stiffest near the oval window and becomes

more flexible toward the opposite end. This decreasing stiffness makes the membrane resonate frequency selective through the cochlea. When a high frequency signal hits the cochlea, the basilar membrane resonates where it is stiff, resulting in the excitation of nerve cells close to the oval window. Fig. 2-5 shows the functional diagram of the human ear [13], and Fig. 2-6 [15] shows the approximate response positions of cochlea for different frequencies. This frequency dependent excitation pattern is called the place principal. The nerve cells encode the audio information by producing an action potential, which is an electrical impulse, in response to each cycle of the vibration. This works up to 500 Hz, which is the maximum rate that the neurons can produce action potentials. This problem is solved by human ear by allowing several nerves to take turns performing a single task. For example a 2 kHz tone can be represented by 5 cells alternately firing 400 times per second. This is called the volley principle [13].

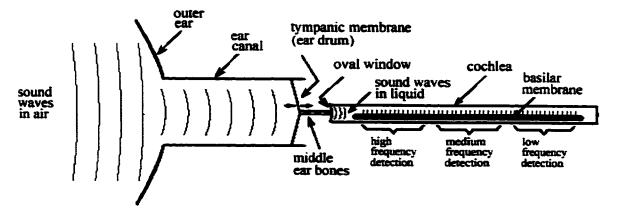


Fig. 2-5 Functional Diagram of Human Ear

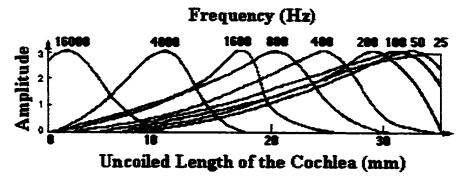


Fig. 2-6 Place Principle of Cochlea

Like the middle ear also the inner ear has a protection mechanism. The brain controls the sensitivity of the inner ear by returning signals through the Efferent Nerve Fibers. These fibers use the outer hair cells in order to protect the inner hair cells. The outer hair cells restrict or permit vibrations to reach to inner hair cells. This way the cochlea is protected in noisy environments and becomes more sensitive in quite environments. This feedback system is called the *Efferent System* [16].

#### 2.2 Limits of Human Hearing

The cooperation of the individual parts described in section 2.1 establishes our hearing. Both intensity and frequency ranges and loudness concept of human hearing are explained in this section.

#### 2.2.1 Dynamic Range

The dynamic range of human hearing is defined as the difference between the audible weakest sound and the upper comfortable level, where discomfort starts. The nominal threshold of hearing (P<sub>0</sub>) at 1 kHz is measured as 2·10<sup>-5</sup> Pa. In order to derive the intensity of this pressure, the acoustic resistance should be defined. The acoustic resistance 'r' varies with temperature because of its dependence on density of air 'p' and speed of sound 'c' according to Eq. (2-2). At 0 °C the acoustic resistance is 428 Rayls.

$$r = \rho \cdot c \tag{2-2}$$

whereas at room temperature it is reduced to 415 Rayls. To achieve a standard, the intensity threshold  $(I_0)$  is derived at room temperature:

$$I_0 = (P_0)^2 / r = (2 \cdot 10^{-5})^2 / 415 = 0.964 \cdot 10^{-12} = 10^{-12} Watts / m^2$$
 (2-3)

10<sup>-12</sup> Watts/m<sup>2</sup> is defined as the weakest audible sound intensity level at 1 kHz. The intensity or pressure of a sound signal is defined as the ratio of its value to these threshold values. The sound pressure level (SPL) and sound intensity level (IL) equations are:

$$SPL = 20 \cdot \log_{10}(P/P_0)$$
  $IL = 10 \cdot \log_{10}(I/I_0)$  (2-4)

The dynamic range of human hearing is accepted as from 0 dB SPL (2·10<sup>-5</sup> Pa) to 120 dB SPL (20 Pa). Over 120 dB SPL sound causes discomfort and damage in our ear. Table 2-1 shows some example sounds with their SPL and intensity values [13].

Watts / cm <sup>2</sup>	dBSPL	Example Sound
10 <sup>-2</sup>	140	Pain
10 <sup>-3</sup>	130	
10-4	120	Discomfort
10 <sup>-5</sup>	110	Jack hammers and rock concerts
10-6	100	
10 <sup>-7</sup>	90	OSHA limit for industrial noise
10 <sup>-8</sup>	80	
10-9	70	
10-10	60	Normal conversation
10-11	50	
10 <sup>-12</sup>	40	Weakest audible at 100 Hz
10 <sup>-13</sup>	30	
10 <sup>-14</sup>	20	Weakest audible at 10 kHz
10 <sup>-15</sup>	10	
10 <sup>-16</sup>	0	Weakest audible at 3 kHz
10 <sup>-17</sup>	-10	
10 <sup>-18</sup>	-20	

Table 2-1 Sound examples for dynamic range of human hearing

Table 2-1 shows us that human hearing is not only intensity dependant. The weakest audible sound intensity differs according to the frequency of that sound.

#### 2.2.2 Frequency Range

The frequency range of human hearing is generally accepted to be 20 Hz to 20 kHz. As shown in Fig. 2-6 human cochlea splits the sound signal approximately into octave bands. The term octave means a factor of two in frequency. Human hearing covers approximately 10 octaves. The bands and their characteristics are given in Table 2-2 [17]:

Octave	Frequency Range	Characteristics
l <sub>st</sub>	20-40 Hz	Low Bass - These frequencies add fullness, power and boom to sound. Lowest notes of bass, piano and tuba fall into this
2 <sup>nd</sup>	40-80 Hz	category.
3 <sup>rd</sup>	80-160 Hz	Upper Bass - These frequencies provide a balance in the
4 <sup>th</sup>	160-320 Hz	structure of sound. Without them, sound is thin. The lower tones of the cello, trombone and rhythm sections produce sounds in this range.
5 <sup>th</sup>	320-640 Hz	Midrange - Sounds get their intensity from this range of
6 <sup>th</sup>	640-1,280 Hz	frequencies. Fundamentals and lower harmonics of most sound sources fall into this category.
7 <sup>th</sup>	1,280-2,560 Hz	sound sources fair into this category.
8 <sup>th</sup>	2,560-5,120 Hz	Upper Midrange - Humans hear this range of frequencies best. 3,000-3,500 Hz contains information, which improves the intelligibility of speech and lyrics. If this band is incorrectly processed, sound becomes unpleasant.  Frequencies above 3,500 Hz give sound realism and clarity.  Listeners perceive sound in this section of the octave (and up to about 6,000 Hz in the 9 <sup>th</sup> octave) as being close. Thus, 3,500 - 6,000 Hz is known as the presence range.
9 <sup>th</sup>	5,120-10,240 Hz	Treble - Frequencies in this range give sound sparkle and
10 <sup>th</sup>	10,240-20,480 Hz	brilliance. Most humans do not hear much beyond 16,000 Hz.

Table 2-2 Octave bands of human hearing and their characteristics

As shown in Table 2-2 each octave gives different characteristics to the sound signal. Because of the logarithmic frequency distribution of human hearing, the bandwidths of octave bands are increasing along the frequency axis. This shows that different, but equal amount of audio information is located between 20 Hz - 40 Hz and 10 kHz - 20 kHz. Therefore if we omit the 10<sup>th</sup> octave of the sound signal, the signal will still carry 90% information.

The male speech lies between 100 Hz and 8 kHz, whereas the harmonics of female speech can reach up to 10 kHz. The frequency and dynamic ranges of speech and music are plotted in Fig. 2-7 [18]. The solid line shows the border of normal hearing. We observe that human speech can be totally extracted if the original signal is low-pass filtered up to 8 kHz. On the other hand music covers a wider frequency band than the speech does.

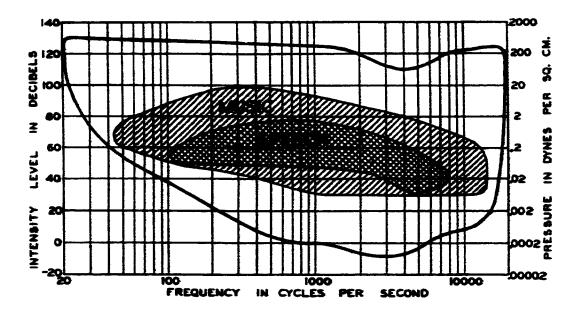


Fig. 2-7 Frequency and intensity ranges of speech and music

#### 2.2.3 Loudness

As the border of hearing in Fig. 2-7 shows, the loudness of an equal intensity sound can vary drastically at different frequencies. The loudness is a psychophysical quantity and it depends on intensity, frequency as well as our neural system. Therefore it can only be measured by a human listener. The most commonly used loudness data is the Fletcher & Munson curves [14]. The measurements are done in the age group of 18 to 25 years with normal hearing. As reference 1 kHz tone is taken and the listener is asked to bring the signal as loud as it was at 1 kHz throughout the frequency sweep. Each time the intensity of the 1 kHz sound is increased by 10 dB and the same measurements are performed through the whole dynamic range of hearing. The unit of perceived loudness is the "phon", which takes the SPL level of 1 kHz signal as reference. That means signals, which are on the same contour with a 10 dB SPL 1 kHz signal are at 10-phon loudness level. Fig. 2-8 shows Fletcher&Munson equal loudness contours [19].

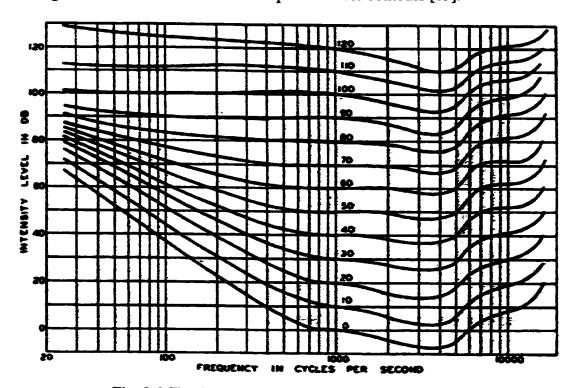


Fig. 2-8 Fletcher & Munson equal loudness contours

From Fig. 2-8 we observe the high sensitivity of human ear for signals between 1 kHz and 6 kHz. Listeners can detect sounds as low as 0 dB SPL at 1 kHz, but require almost 40 dB SPL at 100 Hz. Listeners can tell that two tones are different if their frequencies differ by more than about 0.3 % at 1 kHz. At 100 Hz this increases to 3 %.

## 2.3 Hearing Loss Types

The intricate structure of human ear can be damaged by different sources. The degrees of hearing losses and their effects are given in Table 2-3. Hearing Loss is generally separated into two categories: 'Conductive Hearing Loss', 'Sensorineural Hearing Loss'.

LOSS	CLASSIFICATION	EFFECTS	
0-15 dB SPL	Normal hearing	-	
16-25 dB SPL	Borderline normal (children)	-	
15-25 dB SPL	Slight	Minimal difficulty with soft speech	
25-40 dB SPL	Mild	Difficulty with soft speech	
40-45 dB SPL	Moderate	Frequent difficulty with normal speech	
46-70 dB SPL	Moderate-severe	evere Occasional difficulty with loud speech	
71-90 dB SPL	Severe	Frequent difficulty with loud speech	
>91	Profound	Near total loss of hearing	

Table 2-3 Hearing loss degrees and their effects

#### 2.3.1 Conductive Hearing Loss

Conductive hearing loss is caused by damage to, or a malfunction of the outer and middle ear. That means any hearing loss caused by a problem on the path up to inner ear is called the conductive hearing loss. Some of the disorders, which cause conductive hearing loss, can be listed as:

- -Wax: Wax can build up and block sound from passing through the auditory canal.
- -Otosclerosis: It causes immobilization of middle ear bones. It can be caused by deposits forming between, or dislocation of the ossicles.
- -Malformation: The malformation in the ear canal can cause hearing loss.
- -Rupture: The rupture of the ear drum, which can be caused by excessive air pressure or physical contact.
- -Otitis media: Middle ear infection that causes fluid formation on the middle ear lining.
- -Cholesteatoma: Tumor growth on eardrum.

The characteristics of the conductive hearing loss can be observed at an audiogram. The audiogram is extracted through presentation of pure tones into impaired persons each ears through earphones. The test is done at 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz and 8 kHz and the hearing loss at these frequencies are recorded. Some audiologists include 6 kHz too [20]. Besides the air conduction measurements also bone conduction audiogram is extracted by placing an oscillator behind the patients ear at 'mastoid process' and vibrating the bony structure of the skull, which brings the cochlea into vibration. This way the outer and middle ears are by-passed and the cochlea is tested for disorder. A typical conductive hearing loss audiogram is given in Fig. 2-9 [21].

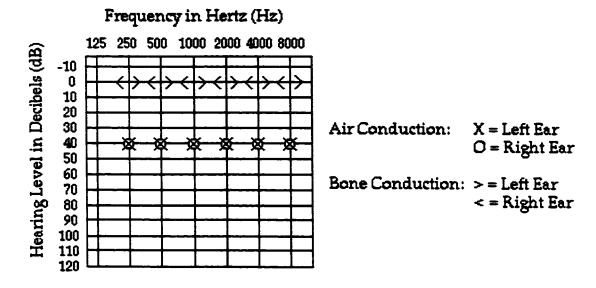


Fig. 2-9 Audiogram example for conductive hearing loss

The audiogram example for conductive hearing loss in Fig. 2-9 shows that, even though the air conduction screening shows a hearing loss, the bone conduction test doesn't show any impairment. It is because of the fact that the inner ear is functioning properly. Conductive hearing losses can be treatable either medically or surgically.

### 2.3.2 Sensorineural Hearing Loss

This type of hearing loss covers the disorder in the inner ear and in auditory neural system. Commonly the problem is the damage of the haircells inside the cochlea. The hearing can diminish gradually or suddenly as a trauma. The result is permanent hearing loss, which can not be cured with medicine or surgery. The need of hearing instruments is mainly for this type of hearing loss. Fig 2-10 shows a typical audiogram of sensorineural hearing loss, which shows an increasing loss at high frequencies. We observe that, both bone conduction and air conduction screening gives the same result.

## 2.3.2.1 Causes of sensorineural hearing loss and their characteristics

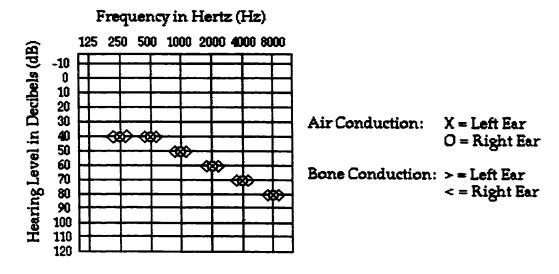


Fig. 2-10 Audiogram example for sensorineural hearing loss

Aging: All human beings suffer a loss of hearing as part of their aging process. This sensorineural hearing loss is not associated with environmental conditions, but the changes in body chemistry. Table 2-4 shows the effect of aging on both male and female hearing. We observe that aging has more effect on high frequencies than low frequencies.

	Frequency						
Age	500 Hz		2000 Hz		4000 Hz		
	Male (dB)	Female (dB)	Male (dB)	Female (dB)	Male (dB)	Female (dB)	
25	0	0	0	0	0	0	
30	0	2	0	2	3	3	
40	1	4	4	5	10	6	
50	3	7	10	9	19	13	
60	6	9	18	12	31	17	

Table 2-4 Sensorineural hearing loss with age

It also shows us that aging causes more hearing loss for male than for female [11].

Acoustic Trauma: Short duration sound of sufficient intensity, like gunshot or explosion, may result in an immediate, severe, and permanent hearing loss, which is termed acoustic trauma. Depending on the intensity of the sound the organ of corti can be torn apart.

Noise induced hearing loss: Repeated exposure to sound at moderate intensity can cause permanent threshold shift of hearing. It is typically seen in industry, where the work environment has high noise pollution. As the Fig. 2-11 shows this sensorineural hearing loss has a dip around 4 kHz. 250 workers had been exposed to sound levels of approximately 100 dB SPL [22]. It shows a combination of aging and noise effect.

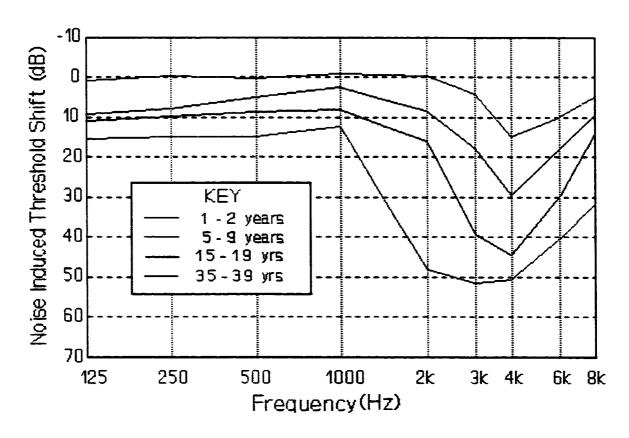


Fig. 2-11 Noise induced threshold shift

Ototoxicity: It is the ear poisoning caused by drugs or chemicals. Some antibiotics, anti-cancer drugs and excessive aspirin can cause this sensorineural loss. They damage the hair cells or the auditory nerves [23]. The hearing loss typically starts at high frequencies and progresses into speech understanding range. It shows a ski-slope high frequency loss as plotted in Fig. 2-12 [24].

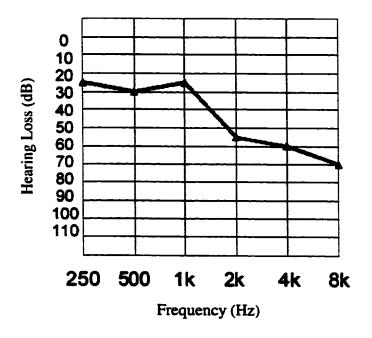


Fig. 2-12 Ototoxicity hearing loss

Meniere's Disease: It is caused by the change in fluid volume inside the cochlea. This effects the hair cells. An audiogram showing its effect is plotted in Fig. 2-13 [24]. The audiogram shows low frequency loss.

Injuries: Head injuries, which cause a reduced blood supply, can effect the cochlea.

Fever: High fevers for a prolonged time can harm inner ear structure.

Other diseases: Meningitis or tumor growth in auditory nerve can cause hearing loss.

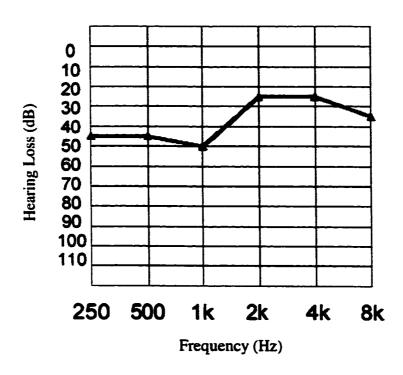


Fig. 2-13 Meniere's disease hearing loss

## 2.3.2.2 Dynamic range reduction and loudness growth

The sensorineural hearing loss shifts the hearing threshold level. On the other hand it doesn't effect the upper comfortable level of hearing. This reduces the dynamic range of hearing to a narrower range. This reduced dynamic range changes the loudness growth in the ear. That means in Fig. 2-8 even though the high sone contours aren't displaced the lower phon contours shift up and the contours get closer. Therefore the growth of perceived loudness with increasing sound intensity is abnormally rapid. This growth is shown for mid-frequency range in Fig. 2-14. The dashed line shows the loudness growth for impaired hearing and solid line shows the loudness growth for healthy hearing. As it can be seen after 100 dB SPL the loudness of the signal is equal to both the normal person and the hearing impaired person. The impaired person has a hearing loss of 40 dB, where the impaired loudness growth curve starts.

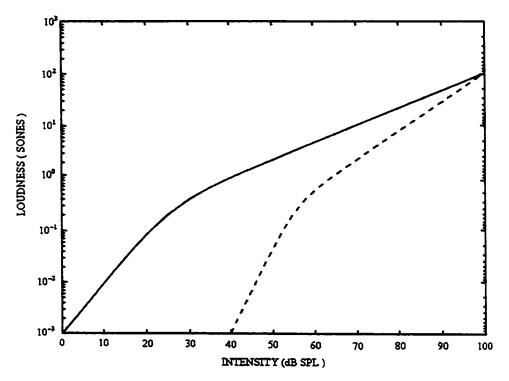


Fig. 2-14 Normal and impaired loudness growth

## 2.4 Discussion on hearing instrument design constraints

In previous sections the anatomy of human ear and its characteristics are clarified.

Different type of hearing losses and their signatures are pointed out. In this section the impact of these characteristics on hearing instrument design are pointed out.

Auditory canal compensation: It is shown that the outer and middle ears are the transmission parts of the human hearing. The resonance characteristic of the ear canal is important for hearing instrument design, because of the fact that the resonance frequencies lie in the frequency range of human speech, which is the target signal for hearing aid. By placing the microphone deeper in the ear canal, the natural amplification of the ear canal contributes to the general efficiency of the hearing instrument. Smaller instruments require less power than larger hearing instruments to treat the same degree of

hearing loss. Fig. 2-15 is comparing the relative gain contributed through hearing instrument and the ear canal [25]. This example shows the aid for a slight hearing loss. Using the resonance characteristics of the ear canal the gain difference between completely in the canal and in the ear hearing aids are compensated.

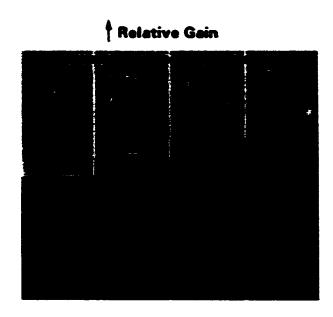


Fig. 2-15 Auditory canal compensation

Limits of amplification: Both middle ear and inner ear has protection mechanisms, but they don't protect against short time high intensity sounds. Therefore in hearing instrument design special care should be given to keep the sound signal in comfortable range of human hearing. That means the sound intensity shouldn't exceed 120 dB SPL.

Frequency resolution: 80% of the patients who are suffering from hearing loss has sensorineural loss, which can not be cured. Therefore hearing instrument designers are focused on this portion of hearing loss. As plotted and tabulated in section 2.3.2 sensorineural hearing loss can have different type of frequency characteristics. It is because of the fact that the cochlea is operating as a filterbank and if by any cause the

part of the organ of corti sensing a specific band is damaged, a narrowband hearing loss occurs. Therefore the hearing instrument should have a high frequency resolution in order to compensate properly. Considering that the bandwidth of a telephone line is between 200 Hz and 3.2 kHz, a frequency range up to 8 kHz would cover almost the whole speech components and most of the music components as demonstrated in Fig. 2-7. In terms of octave scale 90% of the sound information would be covered.

Compression: Because of the dynamic range reduction and rapid loudness growth linear amplification can not be applied to sound signals. It would amplify soft signals to audible range but loud signals to uncomfortable range. Therefore hearing instruments apply compressive amplification, which maps the sound signal into dynamic range of impaired person. It is demonstrated in Fig. 2-16 [26].

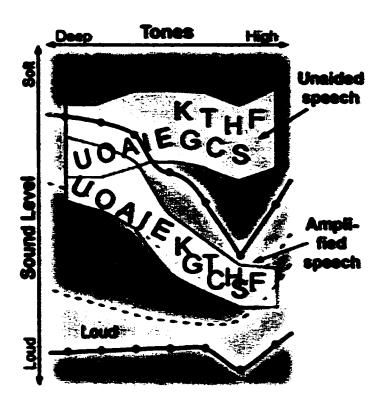


Fig. 2-16 Compressive amplification

Processing Delay: The time-difference between the sound entrance into microphone and sound exit from the loudspeaker is called the processing delay. As the bone conduction audiogram proves, we don't only hear through our ear canal. Even though our ear canal is totally blocked we can hear ourselves through the vibrations from our skull. There shouldn't be much time difference between the processed sound and original sound, so that we don't hear our echo. The processing delay or in other words group delay should be less than 10 ms and it should be fairly constant so that the original sound is not distorted.

**Power Consumption:** Another important point for hearing instrument design is the power consumption. The processing power should be kept as small as possible so that the battery life of the instrument is long. It is inconvenient to change the battery of the hearing instrument often.

# Chapter 3

# DYNAMEQ-II HEARING INSTRUMENT

This chapter covers the research on Gennum Corporation's DynamEQ-II hybrid WDRC (Wide dynamic range compressor) system. The digital simulator of the analog hearing instrument is created. The limitations of the hearing instrument are discussed.

## 3.1 Signal representation

As it is pointed out in first chapter the signal coming from the microphone has to be represented digitally. This representation is done by converting the analog electrical signal into digital electrical signal, which is represented by 1's and 0's. This process is called the quantization. A very important point is the word length used for the analog signals representation. It is because of the fact that the data word length determines the dynamic range of the representation. Table 3-1 shows the dynamic range of different audio applications and devices [27]. The importance of the dynamic range coverage is observed by comparing the quality difference of an AM radio and CD player, which is partly dependent on sampling frequency too. The performance limitations of the hearing instrument microphone determines the necessary data word length. The lower limit of the microphone, which is called the noise floor, is the point at which the incoming signal can not be distinguished from the internally generated noise of the device. For a typical microphone it occurs at 23 dB SPL [28]. The upper limit is where the device gets into

saturation, which is approximately 110 dB SPL. That means a dynamic range of 87 dB need to be represented.

Audio Device/Application	Dynamic Range		
AM Radio	48 dB		
Analog Broadcast TV	60 dB		
FM Radio	70 dB		
Analog Cassette Player	73 dB		
Video Camcorder	75 dB		
ADI Sound Port Codecs	80 dB		
16-bit Audio Converters	90 to 95 dB		
Digital Broadcast TV	85 dB		
Mini-Disk Player	90 dB		
CD Player	92 to 96 dB		
18-bit Audio Converters	104 dB		
Digital Audio Tape (DAT)	110 dB		
20-bit Audio Converters	110 dB		
24-bit Audio Converters	110 to 120 dB		

Table 3-1 Dynamic Range Comparisons

Adding each bit to the word length means adding two more stages to the data representation levels. That means there will be an increase of  $20 \cdot \log_{10}(2) \approx 6dB$  for Analog to digital converter (A/D). That shows why a 16 bit A/D covers 90 to 95 dB dynamic range as listed in the Table 3-1. It is shown that to achieve a high quality sound at least 16 bit representation is needed [28]. For simulations in Matlab 16 bit way sound files are used. It is consistent with the word length used in a real hearing instrument. The biggest magnitude '1' of the way data is considered as 110 dB SPL.

## 3.2 DynamEQ-II Specifications

The dynamic range compression system has the conceptual model shown in Fig. 3-1 [29] and the functional block diagram is given in Fig. 3-2 [30]. The signal is separated into two channels with the aid of Linkwitz-Reilly state-variable filters. The filter outputs are applied to compressors, which map the input signal into comfortable hearing range of the patient. The two channels are added together without causing any signal distortion. It is because of the identical phase responses of filters. Additional gain can be applied before the signal is sent to the receiver.

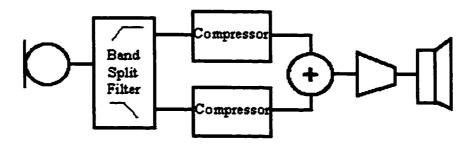


Fig. 3-1 DynamEQ-II system model

The Linkwitz-Reilly state-variable filter has tunable crossover frequency, which means that the cutoff frequency of the low-pass and high-pass filters can be shifted according to the crucial hearing loss frequency point.

#### 3.2.1 Twin average Detection

Hearing instruments apply level dependent amplification to achieve compression. AGC (Automatic Gain Control) systems differ the way they measure the intensity level of the input sound. There are two major types: Peak detectors and average detectors [31]. In

peak detector systems the gain of the system is adjusted according to the peaks of the signal being sensed. On the other hand the average detector

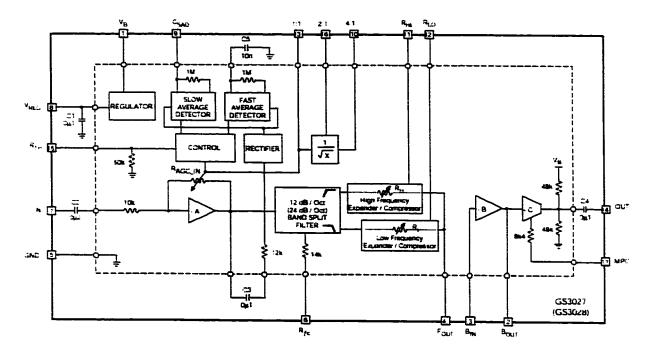


Fig. 3-2 DynamEQ-II functional block diagram

systems adjust their gains according to the average value of the input sound over a definite time. This average is sensed by a low-pass filter. DynamEQ-II has average detector system.

Another important point about level dependent amplification is how fast the system responds to the change in the sound intensity. As it is indicated in second chapter, human ear doesn't have a protection system for impulsive high intensity sound. Therefore the hearing instrument should respond very fast for high intensity changes in the signal. Otherwise the loud sound will be treated as a soft sound and it will be amplified to

uncomfortable levels. On the other hand the sound signal should hold its original envelope as much as possible so that the important speech clues are not lost [32].

This dilemma is solved in DynamEQ with twin average detection system. Two different averages of the sound signal are taken at the same time. The first low pass filter has an R-C time constant of 220 ms, which is the slow average detection. The other low pass filter has an R-C constant of 10 ms, which is the fast average detector. The fast average detector takes control, when its value exceeds the slow average detector by 6 dB. Otherwise the compression system is run by the value of the slow average detector [33]. The block diagram of these two detectors running the 2:1 compressor can be seen in Fig. 3-2 at left upper corner.

Attack and Release Times: Because of the dilemma of keeping the envelope characteristics and protecting against high intensity sounds a standard is defined for hearing instruments. This standard defines attack and release times, which show how quick the instrument reacts against a high intensity sound and how much time it takes for it to start applying a stable gain after an intensity reduction. The ANSI S3.22-1987 standard is as follows [33]:

The attack time is defined as the time between the abrupt increase from 55 to 80 dB and the point where the level has stabilized to within 2 dB of the steady value for the 80 dB input sound pressure level. The release time is defined as the interval between the abrupt drop from 80 to 55 dB SPL and the point where the signal has stabilized to within 2 dB of the steady state value for the 55 dB SPL input sound pressure level.

The theoretical envelope forms for DynamEQ system are given in Fig. 3-3. V<sub>FAD</sub> shows the voltage level at the output of the fast average detector and V<sub>SAD</sub> shows the voltage level at the output of the slow average detector. It is observed that the fast average detector quickly responses to the level change in the input sound signal and takes the control from the slow average detector. The peak at the edge of the transition from 55 dB SPL to 80 dB SPL shows the reaction time of the average detection system to the sudden sound intensity increase. When the sound intensity level drops from 80 dB SPL to 55 dB SPL the fast average detector shows again a quick response but this time the control is given to the slow average detector and it takes longer time to bring the output signal to the stable level. This is a desired response, because the gain is kept constant as much as possible, so that the important clues in the speech envelope are not changed.

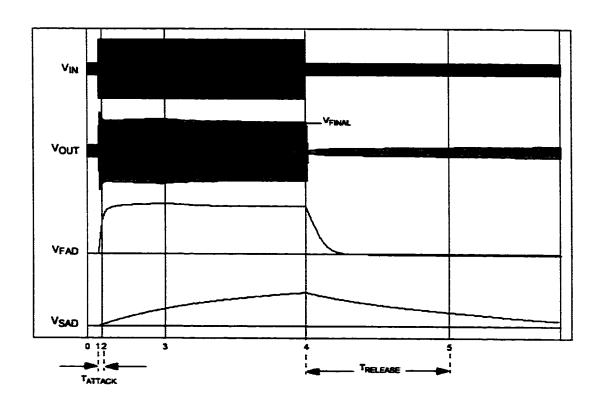


Fig. 3-3 Demonstration of attack and release times for DynamEQ-II

#### 3.2.2 Control Parameters

Besides the filter cutoff frequency adjustment DynamEQ-II has 5 control parameters.

These parameters and their effect on I/O curve are explained below.

Compression Ratio: Both in high and low frequency channels independent from each other, compression ratios can be adjusted. The ratios can be between 1:1 and 1:4. The compression is applied to the sound between lower threshold level and upper threshold level, which is set as 95 dB SPL. The structure has a two-step compression adjustment. The first step is 2:1 compression before filtering and the second step is expanding or compression according to the desired overall compression ratio. These two blocks are synchronized. R<sub>HI</sub> and R<sub>LO</sub> are the resistors adjusting the compression ratios at high and low frequency channels. The effects of these two control parameters on I/O curve are plotted in Fig. 3-4 [29]. For this example the lower threshold level is set as 40 dB SPL.

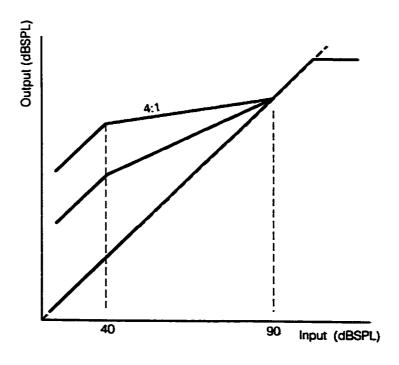


Fig. 3-4 Compression ratio effect on I/O curve

Lower threshold Control: This parameter is adjusted through R<sub>TH</sub> resistor. It determines the lower threshold level of the I/O curve. Sound signals below this level are amplified linearly and the sound signals between this level and 95 dB SPL are amplified according to the compression ratio settings. The sound signals below this threshold are not fed into compressive amplification so that the low noise signals are not amplified and mask the important sound part. The effect of this control parameter, when all the other parameters are kept constant is plotted in Fig. 3-5 [29].

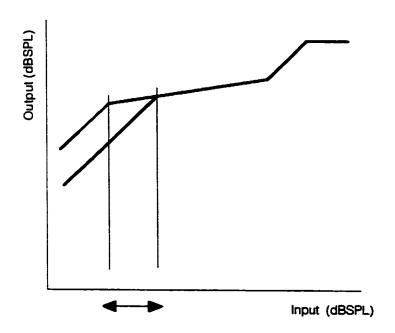


Fig. 3-5 Lower threshold effect on I/O curve

MPO Control: MPO (Maximum Power Output) adjusts the maximum output power of the instrument through  $R_{MPO}$ . It determines the ending point of the linear amplification above the upper threshold. Above MPO level the signals are pulled to this value. The effect of this control parameter is plotted in Fig. 3-6 [29].

Gain Control: This control applies gain to all signals below MPO level. It is a useful control parameter for patients who have both conductive and sensorineural hearing

loss. As indicated in second chapter conductive hearing loss has uniform frequency response and doesn't cause loudness growth, because of the fact that it doesn't effect the hair cells. It can be compensated by linear amplification. The effect of gain control on I/O curve of the system is plotted in Fig. 3-7.

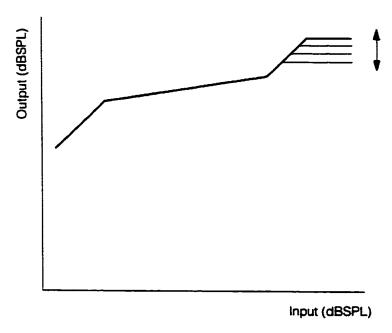


Fig. 3-6 MPO effect on I/O curve

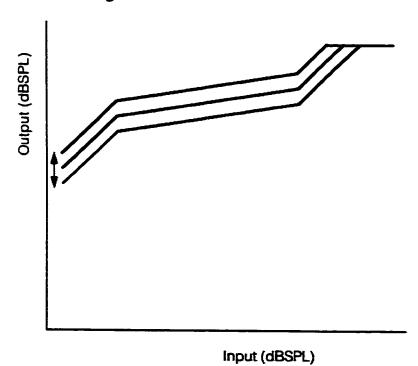


Fig. 3-7 Gain effect on I/O curve

#### 5.5 DynameQ-11 Digital System Simulator

The analog DynamEQ-II dynamic range compression system is simulated digitally in Matlab's Simulink environment. The simulation is based on the specifications given in chapter 3.2. The overall view of the simulator is given in Fig. 3-8. The elements of the simulator and their specifications are explained below.

## 3.3.1 Simulator architecture

The simulator has the same system model given in Fig. 3-1. The 16-bit input sound data is spitted into two bands, where compressive amplification is applied. The simulator can be divided into three parts: Filters, average detectors and gain control units. The operations of these parts are explained below.

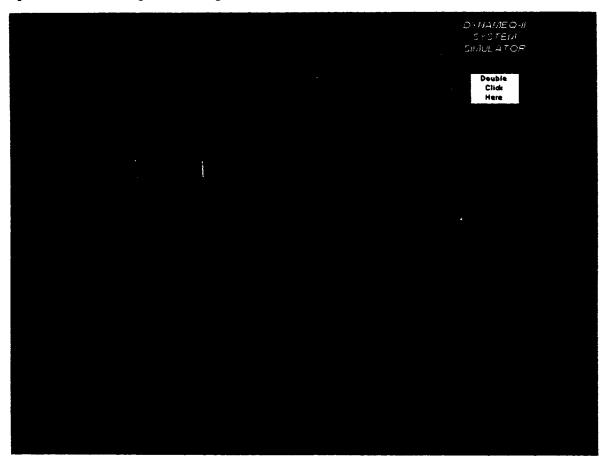


Fig. 3-8 DynamEQ-II digital system simulator

The input sound signal is separated into low frequency and high frequency Filters: channels by the aid of the low pass and high pass filters. In digital filter design for hearing instruments the stop band attenuation should preferably cover the dynamic range of the input sound signal so that severe hearing losses can be compensated. On the other hand the limitations of the hearing instrument should also be taken into consideration. The phase response of the filters should be as linear as possible or identically nonlinear as it is the case in analog DynamEQ-II system. The phase linearity is necessary because of the fact that alternating group delay at different frequencies will cause distortion at the final output sound signal. The group delay should be less than 10 ms because of the selfhearing problem. In VLSI systems, multiplication is the most power consuming unit. Therefore the filters should be implemented with minimum number of multipliers. There is a trade-off between the filter attenuation and order of the filter, which determines the length of the group delay and number of arithmetic units. For this design, where there are only two channels, the dynamic range of the input signal can be covered without exceeding the group delay limitation.

Half-band filters are used to separate the input sound signal. A half-band filter is a symmetric finite-duration impulse response (FIR) digital filter, whose impulse response (h<sub>n</sub>) has the following property:

$$h_{2,p} = 0 \quad \text{for} \quad p \neq 0$$
 (3.1)

It means that almost half of the coefficients of a half-band filter are zero except p=0, which corresponds to the mid coefficient of an even order filter. For a  $N=4\cdot M-1$  length filter it takes M+1 multiplications and  $2\cdot M$  additions to compute each output.

These numbers are  $2 \cdot M$  multiplications and  $4 \cdot M - 2$  additions for an ordinary FIR filter. The constraint given in Eq. 3.1 requires the following relationship [34]:

$$H(e^{j \cdot w}) + H(e^{j \cdot (x - w)} = 2 \cdot h_0$$
 (3.2)

In this addition the first term is the frequency response of the low pass filter. The second term is the frequency response of the complementary high pass filter, which is the reversed and shifted by  $\pi$  response of the low pass filter. In order to get unity gain from this summation  $h_0$  should be 0.5. This gives us the final form of the constraint required for an even order low pass filter in order to achieve total unity gain with its complement:

$$h(n) = \begin{cases} 0 & n = odd \neq (N-1)/2 \\ 0.5 & n = (N-1)/2 \end{cases}$$
 (3.3)

This low pass filter automatically satisfies the following conditions [34]:

$$f_p + f_s = 0.5 \; ; \; \delta_p = \delta_s \tag{3.4}$$

 $f_p$  is the normalized passband cutoff frequency whereas  $f_s$  is the normalized stopband cutoff frequency.  $\delta_p$  is the maximum passband error, whereas  $\delta_s$  is the maximum stopband error. The low pass filter can be designed by McClellan-Parks algorithm, which is also known as remez algorithm [35]. The algorithm gives a half band lowpass filter when the conditions given in Eq. 3.4 are applied. The high pass filter can be extracted from the odd length (N) even order (N-1) low pass filter by a simple subtraction written both in frequency and time domain as follows:

$$H_h(z) = z^{-(N-1)/2} - H_l(z)$$
;  $y_h(n) = y_l(n - (N-1)/2) - y(n)$  (3.5)

An example of a half band low pass filter and its complement is given below:

$$h_t = [0 \ 0.2929 \ 0.5 \ 0.2929 \ 0] ; h_h = [0 \ -0.2929 \ 0.5 \ -0.2929 \ 0]$$
 (3.6)

The summation of these two impulse responses gives: [0 0 1 0 0], which is nothing but the shift of the input signal by 2 samples. This proofs us that the perfect reconstruction is achieved with a half-band low pass filter and its complement high pass filter.

In simulator a 96<sup>th</sup> order half band low pass filter is used. The magnitude and phase responses of the low pass filter and its complement, which is the high pass filter, are given in Fig. 3-9 and Fig. 3-10. The filters have 99 dB stop band attenuation and 0.0001 dB pass band ripple, which satisfies Eq. 3.4. At a sampling frequency of 16 kHz the cutoff frequencies are at 3.5 kHz and 4.5 kHz. The overlap of the filter responses is covering a range of 1 kHz. If the -3dB points of low pass and high pass filters are taken into consideration the overlap is 180 Hz.

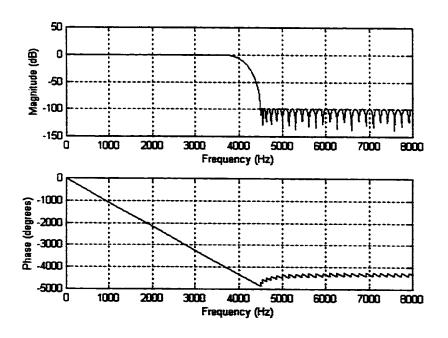


Fig. 3-9 Frequency response of the simulator low pass filter

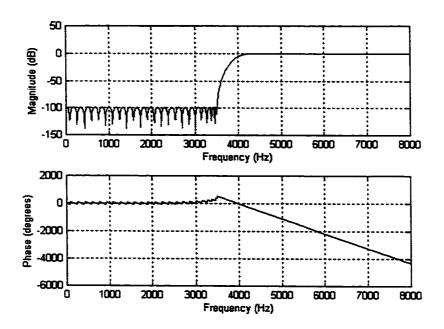


Fig. 3-10 Frequency response of simulator high pass filter

The group delay of the filters are 48 samples, which corresponds to 3ms delay at 16 kHz sampling frequency. The total magnitude response is unity gain, because of the half band characteristics explained above. If a buffer of 10 dB is left for noise floor, 90 dB gain can be applied in each channel

Average Detectors: The twin average detection system is implemented. The analog DynamEQ-II utilizes RC circuits with time constants of 220 ms and 10 ms. These are lowpass filters monitoring a window of 220 ms and 10 ms and taking the averages in these windows. The digital counterpart of these systems are moving average detectors, which are digital lowpass filters. With 16 kHz sampling frequency, to take the average of 220 ms window 3520-tap and to take the average of 10 ms window 160-tap digital filters are needed. The outputs of the taps (delay elements) will be added together and divided to 3520 and 160. The frequency responses of these two filters are given in Fig. 3-11 and

Fig. 3-12. The slow average detector has a lower cutoff frequency and higher stopband attenuation than fast average detector. The same frequency response is obtained with a simpler structure given in Fig. 3-13. Instead of making 3520 additions at each cycle the structure adds the weighted new sample into average and subtracts the weighted sample, which is leaving the window from the average.

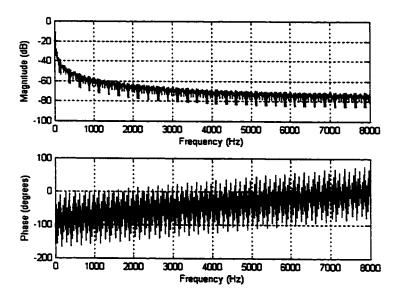


Fig. 3-11 Frequency response of slow average detector

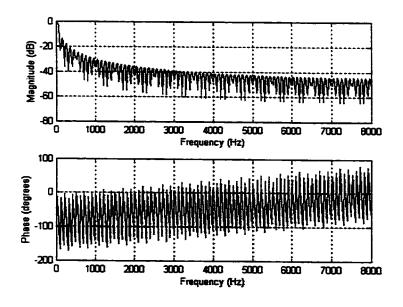


Fig. 3-12 Frequency response of fast average detector



Fig. 3-13 Average detector structure in DynamEO-II simulator

The average is stored in a memory element and the input signal is delayed 220 ms in order to subtract it from the average when that specific sample is leaving the window. The cost of this structure is one division and two additions at one cycle.

The average detectors monitor the average intensity of the sound signal because of the fact that the squared signal is fed into the detectors. After the average detection the signals should be converted into dB scale, so that the gain control unit can apply the control parameters. In dB conversion special attention should be given to zero valued samples, since the logarithm of zero gives minus infinity. The dB converter structure is given in Fig. 3-14. The intensity level is determined with the function:

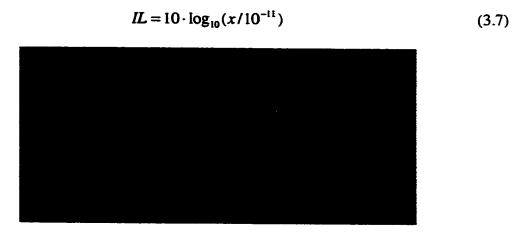


Fig. 3-14 dB converter in simulator

Gain Control Unit: The gain control unit takes the output from slow and fast average detectors and applies the four control parameters to achieve the gain response characteristics of the DynamEQ-II. The gain control block is given in Fig. 3-15. In order to achieve the same I/O curve with DynamEQ-II several relational and logical operations are applied. The effects of compression ratio, threshold, MPO and gain control parameters on gain control blocks I/O curve are simulated. Fig. 3-16 shows the effect of

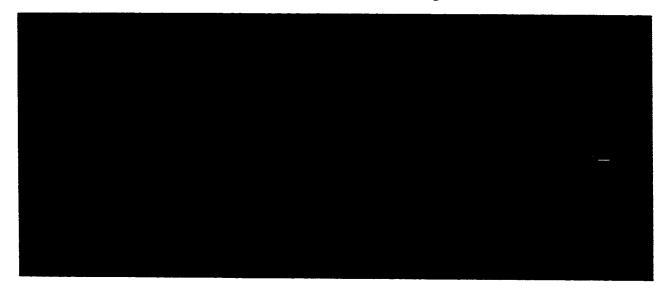


Fig. 3-15 Gain control block of DynamEQ-II simulator

compression ratio parameter. The same effect given in section 3.2.2 is achieved. In simulation the lower threshold is kept constant at 20 dBSPL, the gain is kept at zero and MPO is kept at 100 dBSPL. The compression ratio is increased from 1:1 to 4:1 and the change is plotted. The same shifting effect is achieved. Lower threshold change is simulated by keeping the compression ratio at 2:1, the gain at zero and MPO at 100 dBSPL. Fig. 3-17 shows the same characteristics observed in section 3.2.2. The threshold level is increased from 20 dBSPL to 80 dBSPL with 20 dB increments. The effect of gain is also simulated. This time the lower threshold level is kept constant at 20 dBSPL, compression ratio is kept constant at 2:1 and MPO is kept at 100 dBSPL. The gain is

effect in section 3.2.2. It is plotted in Fig. 3-18. Finally the MPO change is simulated. The threshold is kept constant at 20 dBSPL, the gain is kept constant at 0 dB and the compression is kept constant at 2:1. The MPO is decreased from 100 dBSPL to 80 dBSPL by a decrease of 5 dB. The same characteristic is achieved and plotted in Fig. 3-19.

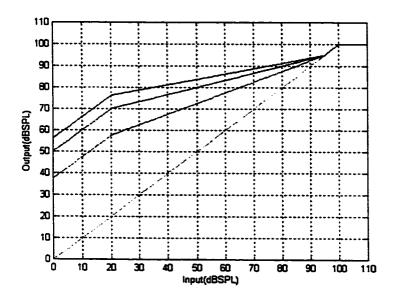


Fig. 3-16 Simulated compression ratio change effect on I/O

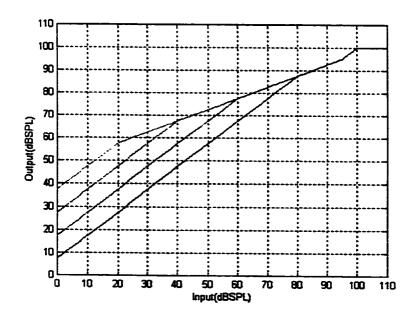


Fig. 3-17 Simulated lower threshold change effect on I/O

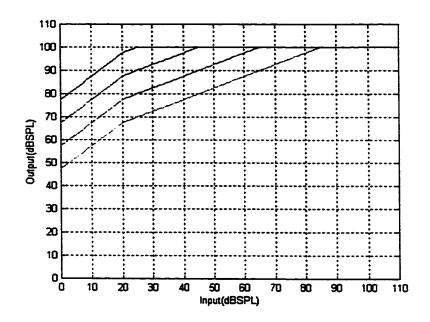


Fig. 3-18 Simulated gain change effect on I/O

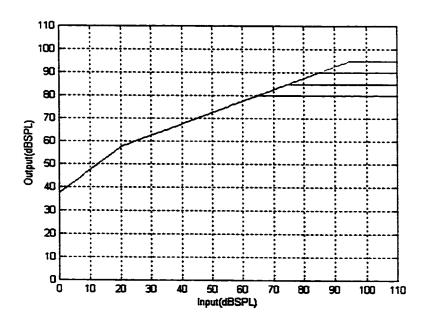


Fig. 3-19 Simulated MPO change effect on I/O

The gain control unit determines the gain characteristic according to the parameters, whose characteristics are simulated above, and multiplies the original signal in each

channel with the necessary gain. The processed signals in two bands are added together and the final form of the output sound signal is achieved.

#### 3.3.2 Attack and Release times of the simulator

As explained in section 3.2.1 attack and release times are important parameters for hearing instruments. They show the behavior of the device in time domain. Using the ANSI S3.22-1987 standard the attack and release time characteristics of the simulator are extracted. A sinusoidal signal at 2.5 kHz jumping from 55 dBSPL level to 80 dBSPL level is fed into gain control unit. The test signal is plotted in Fig. 3-20. It is showing the magnitude of the input signal. When its square is taken and the dB level is extracted, we observe that some signal go below 0 dB SPL. This is because of the fact that Simulink utilizes floating-point arithmetic. Even if a 16-bit signal is fed into system, when we take the square the signal starts getting represented with floating point. With 16-bit representation the part of the signal below 10 dBSPL would be represented as 10 dBSPL. The intensity level of this test signal is plotted in Fig. 3-21.

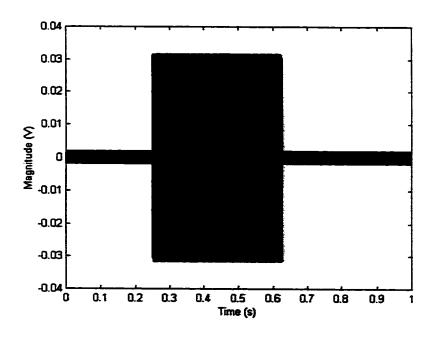


Fig. 3-20 Magnitude of the input test signal

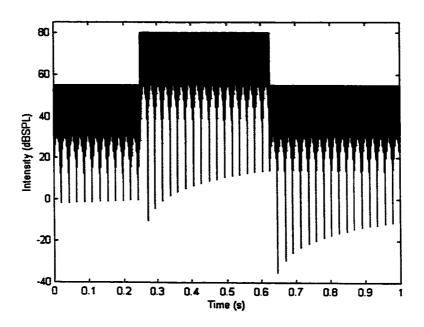


Fig. 3-21 Intensity level of input test signal

The test signal is fed into simulator, whose threshold variable is 30 dBSPL, compression ratio is 1.5:1, gain is 0 dB and MPO is 110 dBSPL. The steady state output signal values for these control parameters are 79.4 dBSPL and 96 dBSPL respectively. In first simulation the gain unit switches the control over fast average detector as soon as it is higher than slow moving average by 6 dB. And it gives the control back to slow average as soon as fast average falls below the slow average plus 6 dB border. This uncorrelated control mechanism brings an additional peak at the transition from 55 dBSPL to 80 dBSPL as plotted in Fig. 3-22. When the fast average falls below the slow average plus 6 dB border the slow average detector takes the control but at that time its value is not equal to fast average detector and this causes discontinuity in the gain. This discontinuity deviates the signal from its final stable point and causes a longer attack time. The attack time for this simulation is 53.6 ms. When we check the characteristic of the fast average detector filter, we see that the filter operates over a window of 10 ms. The attack time is

more than 5 folds bigger than what it is suppose to be. The release time is 218 ms, which is a normal value comparing with the slow average detection window length of 220 ms. This attack time problem is solved by changing the control algorithm. Both the slow moving average (V<sub>s</sub>) and fast moving average (V<sub>f</sub>) are taken into consideration in determining the control average (V<sub>c</sub>), if the fast moving average is bigger than slow moving average. The weighting parameter 'w' determines the effect of slow moving average when the fast moving average is bigger than the slow moving average. The response of the simulator to the test signal with gain control unit modified according to the Eq. 3.8 is plotted in Fig. 3-23.

$$V_{c} = \frac{(V_{f} - V_{s}) \cdot V_{f} + w \cdot V_{s}}{(V_{f} - V_{s}) + w}$$
(3.8)

The control parameters are kept the same as the previous simulation. The weighting parameter is set to 6. It can be seen that the additional peak at the attack time is eliminated. The attack time is 6.4 ms and the release time is the same as before, 0.22 second.

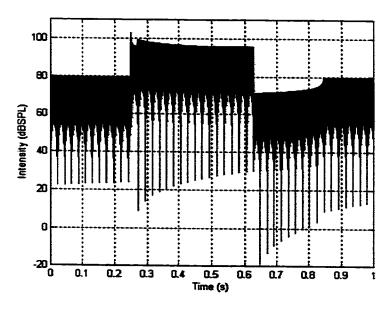


Fig. 3-22 Simulator response to test signal

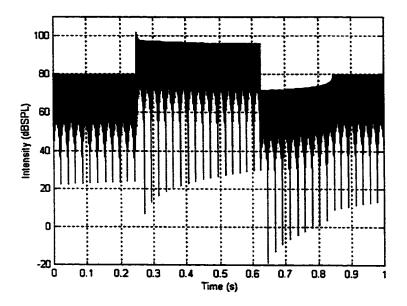


Fig. 3-23 Modified simulator response to test signal

Comparing the Figures 3-21 and 3-23 we observe that the signal, whose main energy lies between 20 dBSPL and 80 dBSPL is mapped to a signal, which lies between 40 dBSPL and 95 dBSPL. Because of the relaxed release time response the lower level of the main lobe of the mapped signal is shifted from 50 dBSPL range to 40 dBSPL range. Therefore the effect of 1.5:1 compression can not be observed well.

## 3.3.3 DynamEQ-II simulator response to speech signal

For hearing instruments the target signal is the speech. The response of the DynamEQ-II simulator to a speech signal is observed. The simulator is run for a hearing loss of 25 dB at frequencies higher than 4 kHz and no loss for frequencies lower than 4 kHz. The input signal is a female speech: 'A lion was awaken from its sleep'. The time domain waveform of the input signal is given in Fig. 3-24. The histogram showing the intensity levels of the input signal is given in Fig. 3-25. It is observed that most of the energy of the signal is lying between 50 dBSPL and 85 dBSPL, which is a typical range for speech.

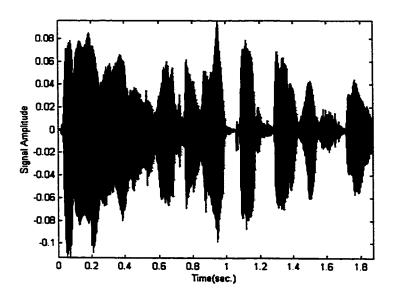


Fig. 3-24 Input speech waveform

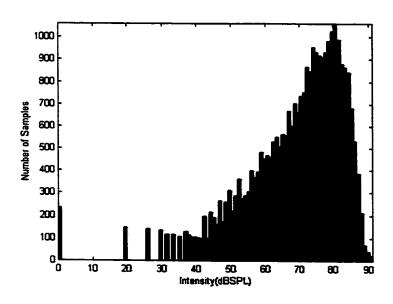


Fig. 3-25 Histogram of the intensity levels of input speech

Since there isn't any loss at low frequencies the gain control unit in low-channel keeps the signal as it is. At high channel the I/O response is adjusted for the compensation of hearing loss of 25 dB. This is achieved by applying 2:1 compression ratio starting from the threshold of 40 dBSPL. The gain parameter is kept zero and MPO is set to 110

dBSPL. The high channel I/O curve is plotted in Fig. 3-26. The signal is mapped to 25-110 dBSPL range and special care is given not to emphasize the input signals below 40 dBSPL.

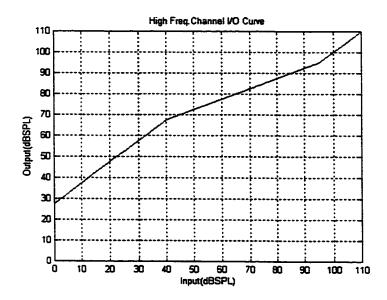


Fig. 3-26 High channel I/O curve for speech simulation

The output waveform of the simulator is plotted in Fig. 3-27. We observe amplitude increase and slight changes in waveform envelope.

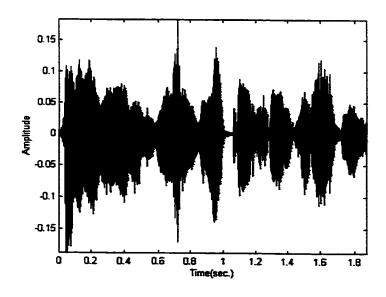


Fig. 3-27 Simulator output waveform

The histogram of the intensity levels at the simulator output is given in Fig. 3-28. The upper limit of the intensity level is kept almost the same, but there are more samples lying close to upper limit. The important point is that this histogram is showing the total response of the low channel and high channel. Since the signal in the low channel is kept as it is we can't make healthy observation in time domain.

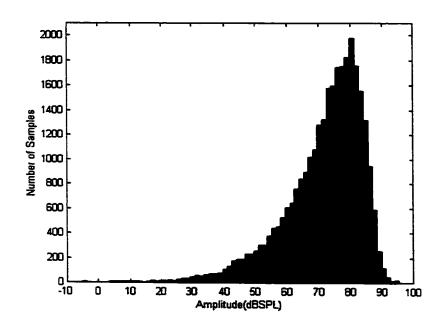


Fig. 3-28 Simulator output histogram

The spectrum of the input speech and output speech are plotted and the effect of the hearing instrument is observed. Fig. 3-29 shows the spectrum of the input signal. It is observed that most of the energy of the input signal is lying up to 3.5 kHz range. For healthy hearing the low intensity level of the signal above this frequency range is enough to extract the information out of it. Fig. 3-30 shows the spectrum of the output signal. The response of the hearing instrument can be observed very well. The part of the signal over 4 kHz is emphasized for impaired hearing, but the rest is kept as it is.

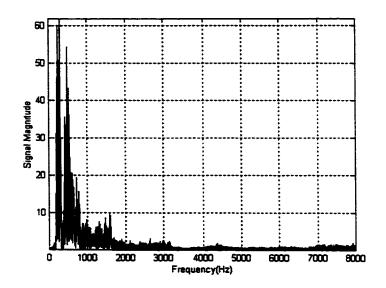


Fig. 3-29 Spectrum of input sound signal

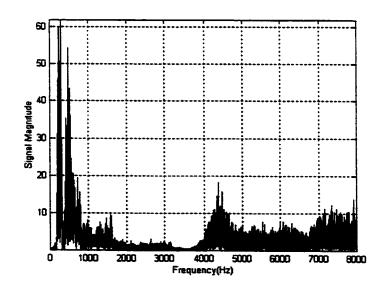


Fig. 3-30 Spectrum of simulator output

# 3.4 Discussion

In this chapter the state of the art analog hearing instrument DynamEQ-II is simulated using digital signal processing structures. Except the frequency shift property of the hearing instrument, the rest of its characteristics are simulated successfully. The response

of the instrument to speech signal for the high frequency hearing loss of 25 dB case is demonstrated.

The success of the instrument is subjective. As indicated in second chapter the perception of loudness is psychophysical. Even though research on generating a performance metric has been done [37] [38], a standard metric can not be defined. Therefore to evaluate the performance of the hearing instruments field tests are performed, where patients with variety kind of hearing losses wear the instruments in daily life.

To evaluate the performance of the hearing instruments in Simulink environment research on hearing loss simulators is done.

An important disadvantage of the DynamEQ-II system is the poor frequency resolution. The moving cutoff frequency doesn't give enough flexibility to compensate some hearing losses, like the notch type noise induced hearing loss given in Fig. 2-11 or Meniere's disease hearing loss given in Fig. 2-13. If the cutoff were set at the frequency where the notch starts, than the high frequency levels, which don't show much hearing loss, would be overemphasized by the instrument.

Therefore research on digital filter bank structures suitable for hearing instruments is carried out.

# Chapter 4

# DIGITAL FILTER BANK DESIGN FOR HEARING INSTRUMENTS

Research on digital filter banks, which can fulfill the requirements of a hearing instrument, is carried out. This chapter covers four different types of filter bank designs: Interpolated FIR (IFIR), QMF (quadrature mirror filter bank), DFT modulated and wavelet filter banks. The improvements achieved in state of the art designs are pointed out. The performances, limitations and suitability for hearing instruments of these filter banks are discussed.

## **4.1 Design Constraints**

Filter bank is one of the core parts of the digital hearing instrument. Its performance determines the frequency resolution of the instrument and the gain limits in each frequency band. Therefore extended research is carried out on this topic. Most of the constraints listed at the end of the second chapter for the hearing instrument design are also the constraints for the digital filter bank design. The impacts of these constraints on digital filter bank design are explained in this section.

Frequency Range: It is shown in 2<sup>nd</sup> chapter that the frequency range of human hearing is from 20 Hz to 20 kHz. Because of the octave band characteristic of the human

hearing, good quality sound can still be achieved with half the frequency range coverage. In filter bank designs 16 kHz is taken as sampling frequency. Because of the fact that spectrum coverage of a system is half of its sampling frequency [39], up to 8 kHz of the input sound signal is taken. This will cover the first nine octaves in Table 2.2.

Number of Channels: Another important constraint is the frequency resolution. The monitoring of the hearing loss is done through audiogram, which takes measurements at eight different frequencies. Therefore 8 channels is an acceptable resolution for hearing instruments. More resolution at lower frequencies is preferable because of the octave characteristic of human hearing.

Stopband Attenuation: The stopband attenuation in each channel determines the gain range of the hearing instrument. It is preferable to get as much attenuation as possible. The order of the filter is proportional to stopband and passband attenuation [40]. When the order of the filter increases, the group delay and implementation cost increases too. Therefore the tradeoff between these parameters should be well adjusted to achieve optimum design.

Group Delay: The group delay of the filter bank should be as constant as possible, so that there won't be any destruction in sound signal. If the group delay is kept too high, than the impaired person starts hearing himself or the visual image and aural image don't map on each other. Some publications recommend a group delay less than 5 ms [41] and some recommend group delay less than 12.5 ms [42]. Therefore in our filter bank designs we tried to keep the group delay as small as possible and 10 ms is determined as the border.

For a filter with frequency response  $H(e^{j\cdot wT})$  the phase  $\tau_p$  and group delay  $\tau_g$  are defined as [43]:

$$\phi(w) = \arg H(e^{j \cdot w T}) \quad \tau_p = -\frac{\phi(w)}{w} \quad \tau_g = -\frac{d\phi(w)}{dw}$$
 (4.1)

Since group delay is the derivative of the phase, constant group delay implies linear phase. Infinite impulse response filters (IIR) can achieve high stopband attenuation with fewer coefficients than finite impulse response filters (FIR) [44]. But they suffer in phase response. Their nonlinear phase response causes deviations in group delay. For audio applications the nonlinearity in phase might be acceptable, if the group delay deviations are minor. FIR filters can be designed with symmetrical coefficients, which assure the linear phase response and constant group delay [44].

Power Consumption: The power consumption is one of the most important constraints in filter bank design for hearing instruments. To achieve long battery life the circuitry inside the instrument should consume minimum power. The most power consuming arithmetic unit in binary VLSI implementation is multiplication [44]. Therefore the number of multiplication should be kept as small as possible. Besides the multiplication per unit time (MPU), addition per unit time (APU) is another important parameter to estimate the power consumption of the filter bank design [44].

Size: The research on filter bank designs is for CIC model hearing instruments. Therefore the size of the filter bank structure should be kept as small as possible. This implies the use of minimum number of digital elements in filter bank structure, which also effects the power consumption.

## 4.2 IFIR Filter Bank Design

This filter bank design method employs linear phase interpolated FIR filters and their complement. Properties of these filters and filter bank design procedure are explained in this chapter. Research on improving the overall magnitude response of the filter bank is demonstrated.

## 4.2.1. Interpolated Finite Impulse Response (IFIR) Filters

This technique enables the implementation of computationally efficient FIR filters. Instead of designing a very high order FIR filter, which satisfies the desired ripple and cutoff frequency specifications, the frequency response is achieved by cascading two or more FIR filters [45]. The basic idea is to implement the filter as a cascade of two FIR sections, where one section generates the sparse set of impulse response values with every L<sup>th</sup> sample being nonzero, and the other section performs the unwanted passband suppression. These two sections can be defined as prefilter and image suppressor. The block diagram is given in Fig. 4-1.



Fig. 4-1 Block diagram of IFIR technique

The technique is called the interpolated FIR, because of the fact that the image processor block is applying an interpolation scheme to the impulse response samples of the prefilter. This interpolation extracts the desired narrow band filter. The interpolation is

not applied to the input data, but the filter coefficients. Therefore it is more convenient to call the second block in Fig. 4-1 as 'image suppressor' instead of 'interpolator' [44].

The first step in the design process is to determine the constraints of the narrow band filter. As a design example the stopband, passband cutoff frequencies and stopband, passband ripples at 16 kHz sampling frequency are set as:

$$f_p = 250Hz$$
  $f_s = 750Hz$   $\delta_p = \delta_s = 0.01$  (4.2)

The direct design of the FIR filter using the McClellan-Park algorithm [35] requires an order of 62. The magnitude response is given in Fig. 4-2.

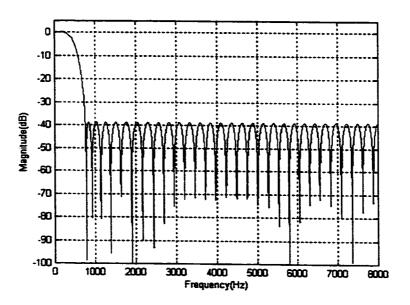


Fig. 4-2 Lowpass filter magnitude designed in one step

The same filter response can be achieved by employing the IFIR technique. The first step is to determine the L, which is the relaxation factor. L is taken as 8 for this example. Using the McClellan-Park algorithm a low pass model filter is designed, whose cutoff frequencies are L times bigger than the desired filters:

$$f_p = 2000Hz$$
  $f_s = 6000Hz$   $\delta_p = \delta_s = 0.01$  (4.3)

This filter is  $6^{th}$  order. Its design constraints satisfy the conditions of a half band filter, which are given in Eq.3.4. Therefore  $h_M(n)$  has only four nonzero coefficients, besides the middle coefficient, which is 0.5. Its magnitude response is given in Fig. 4-3.

$$h_{M}(n) = [-0.0506 \ 0.0 \ 0.2951 \ 0.5 \ 0.2951 \ 0.0 \ -0.0506]$$
 (4.4)

The next step is to zero pad this impulse response with L-1 samples. That means seven zero valued samples are inserted between each sample according to the following equation:

$$h_{MS}(n) = \begin{cases} h_{M}(n/L) & n = iL, i = 0, \pm 1, \pm 2, \dots \\ 0 & otherwise \end{cases}$$
 (4.5)

The magnitude response of  $h_{MS}(n)$  is given in Fig. 4-4. We observe that the first lobe in this magnitude response obeys the constraints of the desired narrow band lowpass filter. Therefore if the rest of the images are suppressed, the desired filter will be obtained.

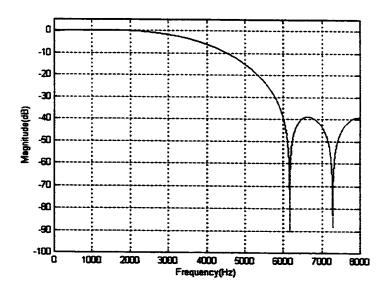


Fig. 4-3 Model filter magnitude response

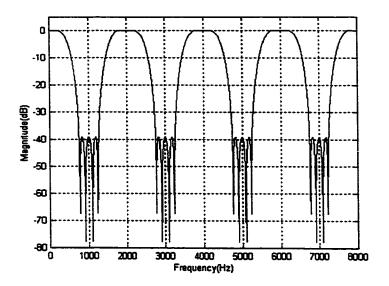


Fig. 4-4 Zero padded model filter magnitude response

The image suppression can be done in one step by a higher cutoff frequency lowpass filter or by cascade of couple FIR filters. Using cascade of three FIR filters as image suppressor the final magnitude response in Fig. 4-5 is obtained. It satisfies the design constraints given in Eq. 4.2.

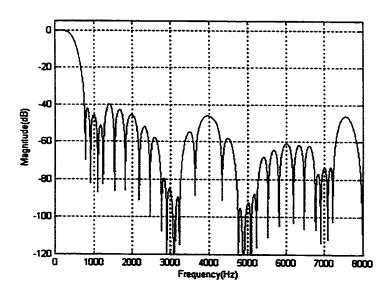


Fig. 4-5 Magnitude response after image suppression

Using its symmetry the cost of direct design can be reduced to 32 multiplications and 64 additions [35]. On the other hand the total cost of IFIR structure can be reduced to 11 multiplications and 14 additions. There is a remarkable saving in computation.

#### 4.2.2 Filter Bank Structure

The example given in previous section was describing the process of extracting the first passband of the filter bank. Each lobe in Fig. 4-4 is a passband of the filter bank and can be extracted using different type of FIR filters as image suppressors. The magnitude response given in Fig. 4-4 doesn't cover the whole spectrum. The complement of this zero padded half band filter is taken with the subtraction given in Eq. 3.5. Even though the zero padded filter is not a half band filter anymore, the coefficients, which are nonzero, are still the coefficients of a half band filter. Therefore the complement of this filter can be taken and the sum of these two filters is unity. The complement of the filter in Fig. 4-4 is plotted in Fig. 4-6.

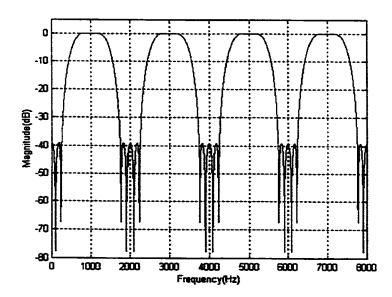


Fig. 4-6 Complement of zero padded model filter

The total 8-band filter bank structure is given in Fig. 4-7. The upper most lobe of the filter in Fig. 4-4 is left out as transition band. Only the first four lobes of this filter and the four lobes of the filter in Fig. 4-6 are taken into filter bank. Each pathway in the structure establishes a channel of the filter bank. The magnitude responses at each point of the structure are also plotted in Fig. 4-7. Each block represents the filter and its complement. For example the block  $H_1(z)$  has the response of this filter and its complement response is also achieved with the subtraction given in Eq. 3.5. Since only zero padded half band filters are employed throughout the structure, the complement of each filter can be taken.

The symmetry properties of the coefficients in the structure are given in Eq. 4.6 [41]. Every symmetric coefficient in a filters impulse response brings one multiplication. Therefore the filter bank can be implemented with 27 multiplications. 8 of them are the multiplication with 0.5, which can be implemented as a shift register in the hardware [46]. The total number of additions is 45. The cost of the total filter bank is less than the direct design of its first band given in Fig. 4.2.

$$h_{1}(0) = h_{1}(48), h_{1}(16) = h_{1}(32), h_{1}(24) = 0.5$$

$$h_{2}(0) = h_{2}(24), h_{2}(8) = h_{2}(16), h_{2}(12) = 0.5$$

$$h_{3}(0) = h_{3}(28), h_{3}(4) = h_{3}(24),$$

$$h_{3}(8) = h_{3}(20), h_{3}(12) = h_{3}(16), h_{3}(14) = 0.5$$

$$h_{4}(0) = h_{4}(12), h_{4}(4) = h_{4}(8), h_{4}(6) = 0.5$$

$$h_{5}(0) = h_{5}(10), h_{5}(2) = h_{5}(8), h_{5}(4) = h_{5}(6), h_{5}(5) = 0.5$$

$$h_{6}(0) = h_{6}(6), h_{6}(2) = h_{6}(4), h_{6}(5) = 0.5$$

$$h_{7}(0) = h_{7}(30), h_{7}(6) = h_{7}(24), h_{7}(12) = h_{7}(18), h_{7}(15) = 0.5$$

$$h_{8}(0) = h_{8}(2), h_{8}(1) = 0.5$$

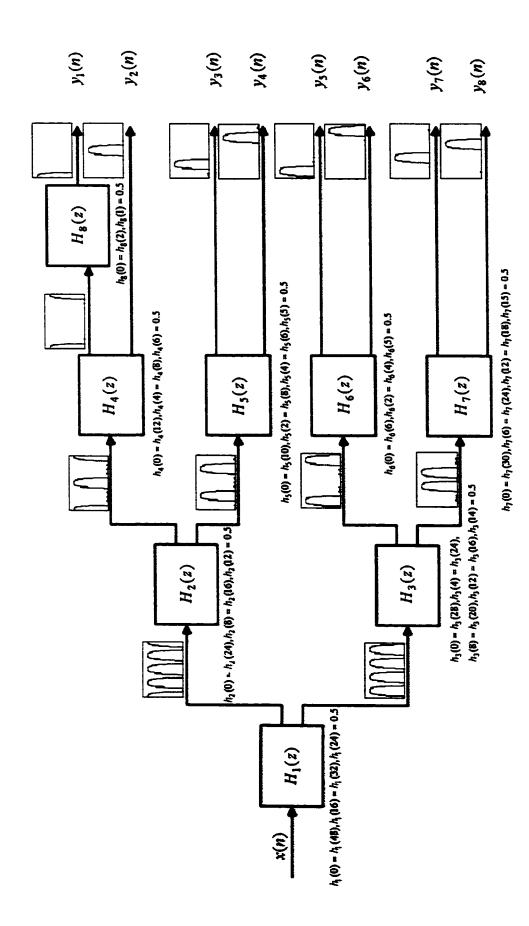


Fig. 4-7 IFIR Filter Bank Structure

The magnitude response of each passband is given in Fig. 4-8. The stopband attenuation of the filter bank, or noise floor of the filter bank is 38 dB and passband ripples deviate between 0.2 dB and -0.3 dB. The lower and upper passband and stopband cutoff frequencies of the channel responses are listed in Table 4-1.

Channels	Low. Stopband	Low. Passband	Up. Stopband	Up. Stopband
	Cutoff Freq.(Hz)	Cutoff Freq.(Hz)	Cutoff Freq.(Hz)	Cutoff Freq.(Hz)
1 <sup>st</sup>	-	-	280	745
2 <sup>nd</sup>	250	720	1300	1745
3 <sup>rd</sup>	1260	1710	2300	2740
4 <sup>th</sup>	2260	2700	3290	3745
5 <sup>th</sup>	3255	3715	4285	4745
6 <sup>th</sup>	4255	4715	5300	5745
7 <sup>th</sup>	5260	5700	6290	6745
8 <sup>th</sup>	6255	6700	7280	7750

Table 4-1 Cutoff frequencies of IFIR filter channel responses

It is observed that the main lobe of the first passband is 280 Hz wide. The rest of the channels have an approximate width of 580 Hz. It is a uniform filter bank except the first passband, which is half the width of the rest.

Only the phase response of the first passband is plotted in Fig. 4-9. As it can be seen it is linear. The rest of the channels have linear phase responses too.

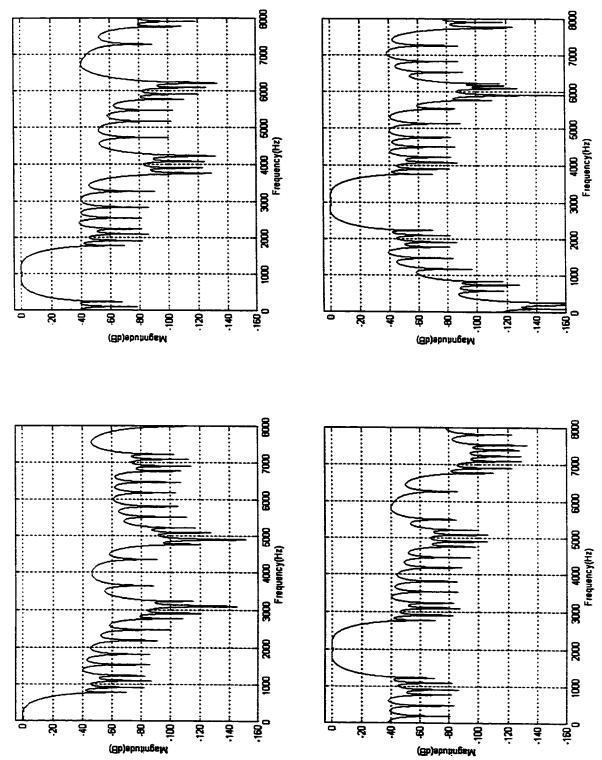


Fig. 4-8 Magnitude responses of pass bands

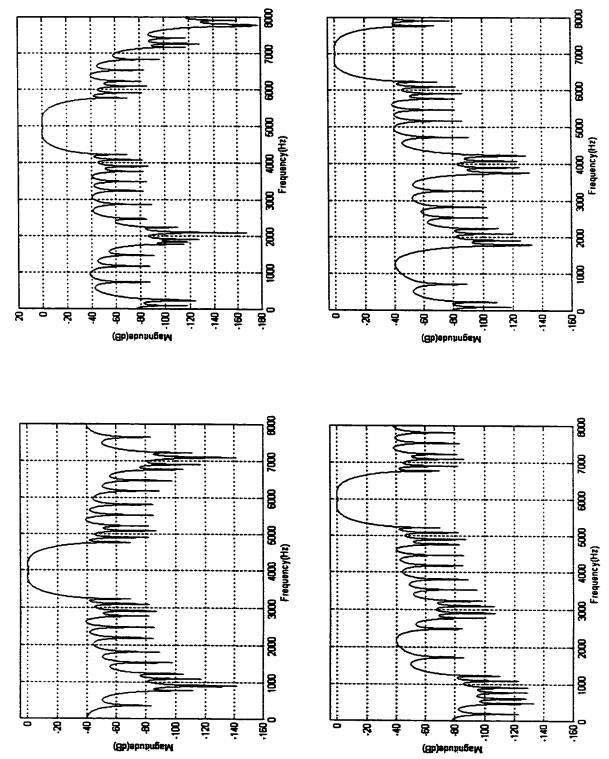


Fig. 4-8 Magnitude responses of pass bands

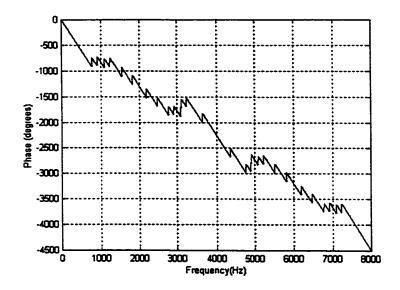


Fig. 4-9 Phase response of first passband

The linear phase response of the passbands brings constant group delay. The group delay of the filter bank is 53 samples, which corresponds to 3.3 ms at 16 kHz sampling.

## 4.2.3 Optimization of delay characteristics of the filter bank

The total response of the filter bank is plotted in Fig. 4-10. Even though only complementary filters have been used in filter bank structure, the total response deviates from unity gain. It is because of the mismatch of phase characteristics of individual passbands. This destructive effect can be eliminated by the addition of delay elements to shorter channels [47]. The delay characteristics of the channels are given in Fig. 4-11. There are six shorter channels in the structures. Delay elements can be added to these paths without altering the magnitude responses of channels and changing the group delay of the filter bank. The problem is to find the optimum numbers of delay elements, which will be added to each channel, to obtain maximally flat frequency response.

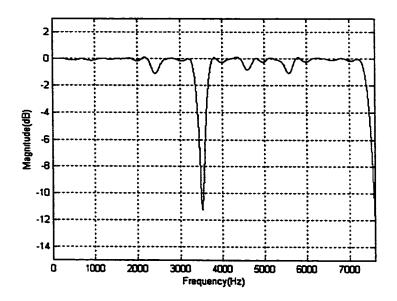


Fig. 4-10 Total magnitude response of the filter bank

We observe ripple in the range of -11.4 dB to +0.1 dB. This will drastically alter the input signal.

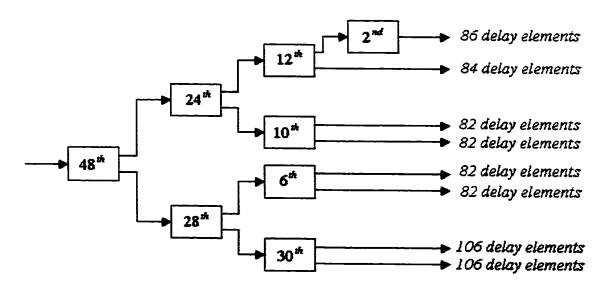


Fig. 4-11 The delay characteristics of filter bank channels

The addition of delay elements is handled as an integer programming problem with six variables and six constraints [48]. The variables are the number of extra delay elements,

which will be added to the channels and constraints are the delay differences between the longest path of the structure and the shorter channels. The group delay shouldn't be increased with these extra delay elements.

The addition of delay elements in the channel mainly effects the channels own passband. Therefore the optimization can be divided into six different optimization problems. The effect on the overall magnitude response at the end of each optimization process is plotted in Fig. 4-12.

The optimum result is plotted in Fig. 4-13 again. It is observed that the ripple is reduced to the range of +0.1 dB to -0.1 dB. The Matlab code of optimization process is given in Appendix II.

In Fig. 4-13 we can observe that the overall magnitude response doesn't cover a range up to 8 kHz. It is because of the fact that the upper most lobe of the filter bank is left out as transition band.

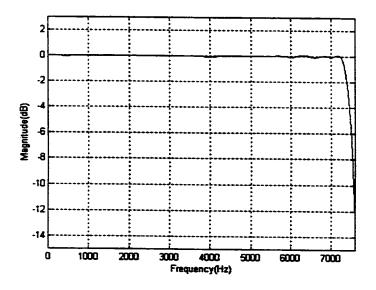


Fig. 4-13 Maximally flat overall magnitude response

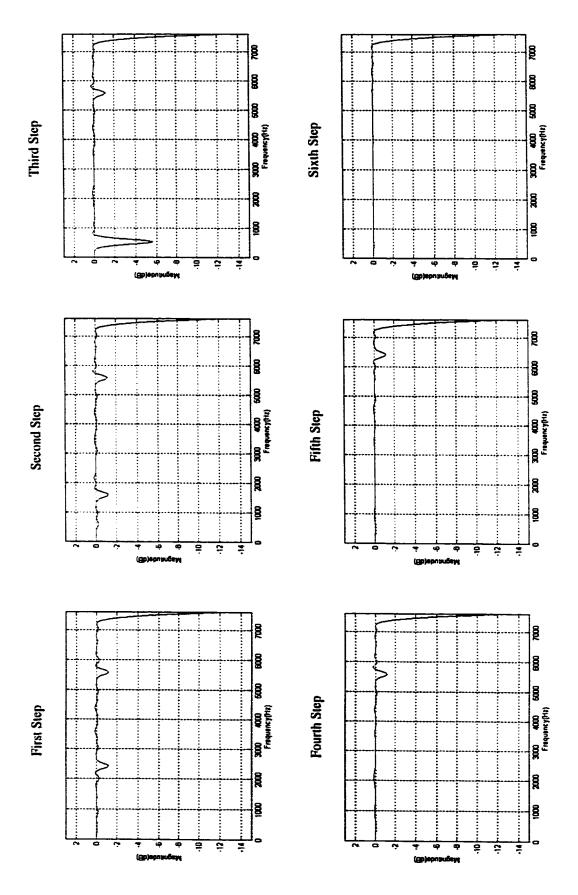


Fig. 4-12 Optimization Process of delay elements

#### 4.2.4 The applicable gain for filter bank structure

The IFIR filter bank has a noise level of 38 dB. This noise level doesn't mean that 38 dB of gain can be applied to a signal in the channel. The effect of gain increase in first channel of the filter bank is given in Fig. 4-14. The gain is increased from 0 dB to 35 dB by an increment of 5 dB and the effect of 38 dB gain is examined last. The responses are plotted all together. The impact on other channels is below 1 dB up to a gain of 25 dB. At 30 dB of gain it becomes 2 dB, at 35 dB of gain it becomes 5 dB and at 38 dB of gain it becomes 9 dB. It is observed that after 30 dB the increase of the gain in the channel brings additional increase of the gain in some adjacent bands.

The effect of gain increase is also observed in 5<sup>th</sup> channel and 7<sup>th</sup> channel. The overall magnitude response of the system with the gain increase in 5<sup>th</sup> channel is plotted in Fig. 4-15. The impact of channel 7 is plotted in Fig. 4-16. The same increase used for first channel is applied to these two channels.

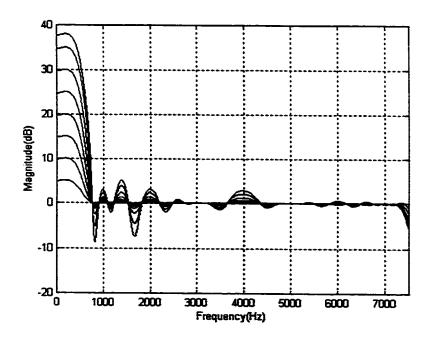


Fig. 4-14 The effect of 1st channel gain increase on overall response

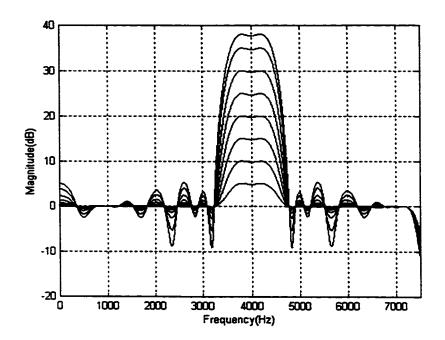


Fig. 4-15 The effect of 5<sup>th</sup> channel gain increase on overall response

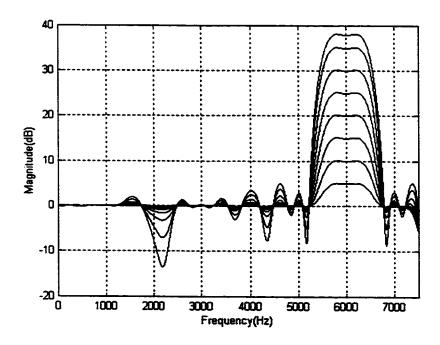


Fig. 4-16 The effect of 7<sup>th</sup> channel gain increase on overall response

Almost the same characteristics observed for the first passband is observed for the 5<sup>th</sup> and 7<sup>th</sup>. It shows that we have to leave some noise buffer between the upper gain of the filter

bank and noise floor. This buffer should 8 dB for this filter bank design. 30 dB of gain effects the other bands 2 dB, which is an acceptable value.

#### 4.2.5 IFIR Filter bank with -60 dB noise level

In section 4.2.4 it is shown that a filter bank with lower noise level than -38 dB is needed to compensate moderate level hearing loss. Therefore the design constraints of the filters are increased to 60 dB stopband attenuation. The structure of the filter bank is the same as in Fig. 4-7. The only difference is the increase in the order of filters to achieve higher stopband and passband ripples. In Fig. 4-17 all pass bands of the filter bank are plotted together. The passband ripples are between -0.02 dB and +0.02 dB. The noise floor is at -59 dB. It is shown in previous sections that the noise floor together is more important than the individual stopband characteristics. The effects of the individual stopband characteristics are observed best in gain increase effect on overall magnitude response. Therefore the passband magnitude responses are not plotted one by one.

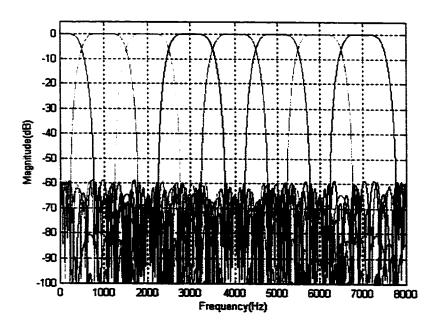


Fig. 4-17 Magnitude responses of 60 dB IFIR design pass bands

The lower and upper passband and stopband cutoff frequencies of the channel responses are listed in Table 4-2.

Channels	Low. Stopband	Low. Passband	Up. Stopband	Up. Stopband
	Cutoff Freq.(Hz)	Cutoff Freq.(Hz)	Cutoff Freq.(Hz)	Cutoff Freq.(Hz)
l st	-	-	240	765
2 <sup>nd</sup>	240	755	1245	1760
3 <sup>rd</sup>	1240	1760	2250	2760
4 <sup>th</sup>	2240	2750	3250	3760
5 <sup>th</sup>	3240	3760	4240	4760
6 <sup>th</sup>	4240	4750	5245	5760
7 <sup>th</sup>	5240	5750	6250	6760
8 <sup>th</sup>	6240	6750	7250	7760

Table 4-2 Cutoff frequencies of 60 dB IFIR filter bank

The width of the first pass band is 240 Hz and the rest is between 480 and 500 Hz. Comparing to Table 4-1, this design has more uniform response. On the other hand the width of the transition bands has been increased to 500 Hz. The difference between the Passband and stopband cutoff frequencies was approximately 450 Hz for the first design. This slight increase can bring more impact of the gain increase in the passband on the adjacent bands.

Total magnitude response of the filter bank is plotted in Fig. 4-18. Deviation from unity gain is in the range of +0.04 dB to -11.4 dB.

The same optimization process for overall magnitude response improvement is applied on this design too. The maximally flat overall magnitude response is plotted in Fig. 4-19. The ripples are reduced to the range +0.01 dB to -0.01 dB.

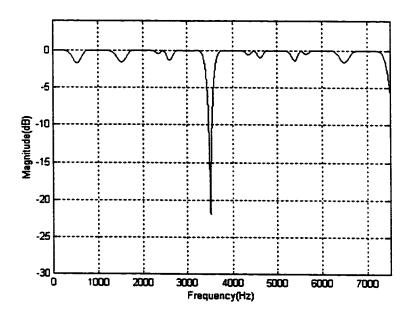


Fig. 4-18 Overall magnitude response of 60 dB IFIR design

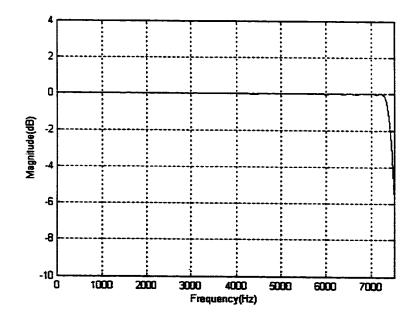


Fig. 4-19 Maximally flat overall magnitude response for 60 dB IFIR design

The effect of gain increase in the 7<sup>th</sup> channel is plotted in Fig. 4-20. In previous section we have seen that the gain increase response of different pass bands in IFIR structure are almost the same. Therefore only one channel is examined. The gain is increased by 5 dB up to 55 dB and the response for 59 dB gain is also plotted. We observe that for 59 dB gain the effect on the adjacent band becomes almost 20 dB. 55 dB gain brings a deviation of 7 dB in adjacent band. The influence of 50 dB gain on the adjacent band is below 3 dB, which is an acceptable value.

The buffer level between the noise level and gain should be again around 9 dB. Therefore gain up to 50 dB can be applied in this filter bank structure. It is enough to compensate moderate level hearing loss.

The cost of the 60 dB design is 42 multiplication and 75 additions. The additions also cover the cost of extracting the complementary filters. The group delay is increased to 103 samples, which corresponds to 6.4 ms at 16 kHz sampling frequency. It is below the 10 ms maximum group delay border.

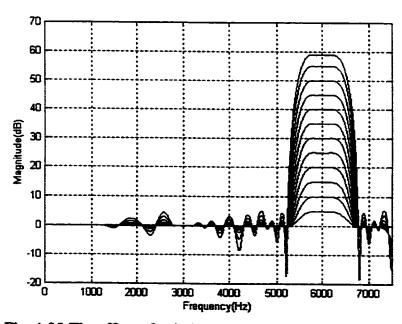


Fig. 4-20 The effect of gain increase on 60 dB IFIR filter bank

### 4.3 QMF (Quadrature Mirror Filter) Bank Design

QMF is a multirate filter bank. A multirate filter bank is constructed from two parts: The analysis filter bank and the synthesis filter bank. The analysis filter bank filters the single input signal into multiple outputs and downsamples (subsamples) them by a factor N. The synthesis filter bank upsamples the signals by N and generates a single output by eliminating the aliasing [49].

The block diagram of a QMF bank is given in Fig. 4-21. It is a two-band filter bank structure, where  $H_0$  and  $H_1$  are analysis filters and  $G_0$  and  $G_1$  are synthesis filters. The upper limit of downsampling in a multirate filter bank is its number of channels [50]. Therefore a QMF bank can downsample only by 2.

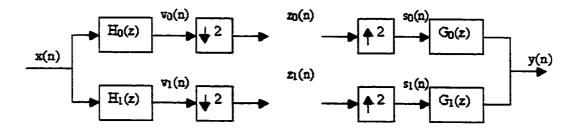


Fig. 4-21 Block diagram of QMF bank

The design difficulty is to reconstruct the input signal at the filter bank output without distortion. That means y(n) should be equal to x(n). The multirate filter banks are used in subband coding and transmultiplexing for telecommunications [49]. In these applications the aim is to reduce the number of samples in channels. There isn't much gain applied on signal.

In Fig. 4-21  $H_0(z)$ ,  $G_0(z)$  are low pass filters and  $H_1(z)$ ,  $G_1(z)$  are high pass filters. The operation of the filter bank can be described as follows: x(n) is separated into its low frequency  $v_0(n)$  and high frequency  $v_1(n)$  components. These signals are downsampled by 2, which has the effect of widening the frequency content of the signals by two [51].  $z_0(n)$  and  $z_1(n)$  are upsampled by a factor of two, which shrinks the frequency content of the signal back to its original range, but adds an additional image of the signal into spectrum. These images are suppressed by  $G_0(z)$  in first channel and  $G_1(z)$  in second channel. An impulse is fed into system and responses of the system at different points are given in Fig. 4-22.

The effect of downsampling is expressed in time domain, frequency domain and z domain as [50]:

$$z_{k}[n] = v_{k}[R \cdot n] \; ; \; Z_{k}(e^{j \cdot w}) = \frac{1}{R} \cdot \sum_{r=0}^{R-1} V_{k}(e^{j(\frac{w}{R} \cdot \frac{2\pi \cdot r}{R})}) \; ; \; Z_{k}(z) = \frac{1}{R} \cdot \sum_{r=0}^{R-1} V_{k}(W_{R}^{r} \cdot z^{\frac{1}{R}})$$
 (4.6)

R is the downsampling ratio and  $W_R^r = e^{-j\frac{2\pi r}{R}}$ . For two channel QMF bank R=2 and  $W_2^1 = -1$ . Therefore  $Z_k(z)$  is written for k=0,1 as:

$$Z_{k}(z) = \frac{1}{2} \cdot \left[ H_{k}(z^{\frac{1}{2}}) \cdot X(z^{\frac{1}{2}}) + H_{k}(-z^{\frac{1}{2}}) \cdot X(-z) \right]$$
 (4.7)

The effect of upsampling is defined in time domain, frequency domain and z-domain as:

$$s_{k}(n) = \begin{cases} z_{k}(n/R) & n = 0, \pm R, \pm 2 \cdot R, \dots \\ 0 & otherwise \end{cases} ; S_{k}(e^{j \cdot w}) = Z_{k}(e^{j \cdot R \cdot w}) ; S_{k}(z) = Z_{k}(z^{R})$$
 (4.8)

Therefore  $S_k(z)$  is defined for k=0,1 as:

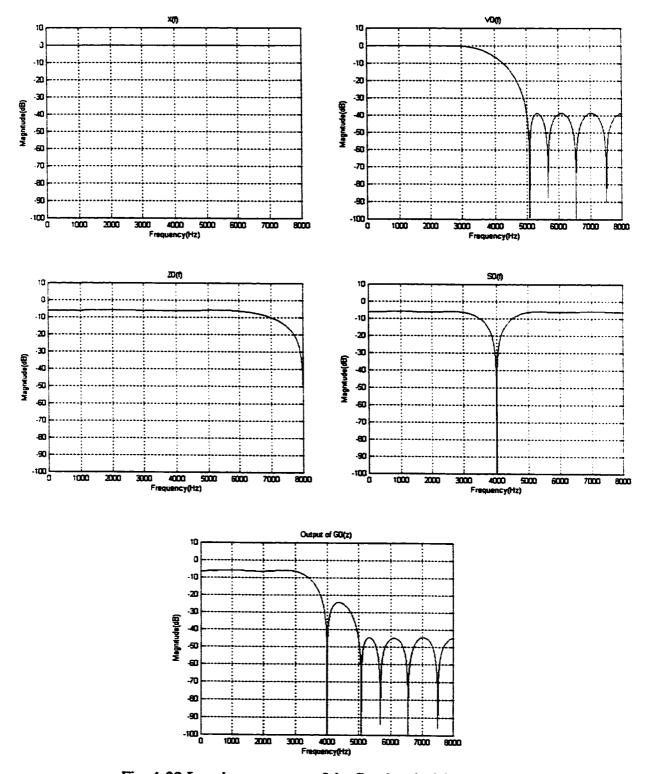


Fig. 4-22 Impulse responses of the first band of QMF bank

$$S_{k}(z) = \frac{1}{2} \cdot (H_{k}(z) \cdot X(z) + H_{k}(-z) \cdot X(-z))$$
 (4.9)

After the synthesis filters the total response of QMF bank is written as:

$$Y(z) = \frac{1}{2} \cdot G_0(z) \cdot [H_0(z) \cdot X(z) + H_0(-z) \cdot X(-z)]$$

$$+ \frac{1}{2} \cdot G_1(z) \cdot [H_1(z) \cdot X(z) + H_1(-z) \cdot X(-z)]$$
(4.10)

In order to achieve perfect reconstruction Y(z) should satisfy the following equation:

$$Y(z) = z^{-N} \cdot X(z) \tag{4.11}$$

N is an arbitrary integer. That means the output should be a delayed version of the input.

The transfer function of the filter bank can be written in matrix form as follows:

$$Y(z) = \frac{1}{2} \cdot [X(z) \quad X(-z)] \cdot \begin{bmatrix} H_0(z) & H_1(z) \\ H_0(-z) & H_1(-z) \end{bmatrix} \cdot \begin{bmatrix} G_0(z) \\ G_1(z) \end{bmatrix}$$
(4.12)

The matrix with H(z) is called alias cancellation matrix (AC Matrix). It has the analysis filter bank coefficients. The synthesis filter bank can be extracted from the defined analysis filter bank using the following equation [50]:

$$\begin{bmatrix} H_0(z) & H_1(z) \\ H_0(-z) & H_1(-z) \end{bmatrix} \cdot \begin{bmatrix} G_0(z) \\ G_1(z) \end{bmatrix} = \begin{bmatrix} T(z) \\ 0 \end{bmatrix}$$

$$\tag{4.13}$$

T(z) is the transfer function of the system. The zero term on the right side of the equation is to remove the aliasing. In order to achieve perfect reconstruction T(z) should satisfy Eq. 4.11, which means that it should be a delay. The synthesis filters can be written in terms of analysis filters and system transfer function as follows:

$$\begin{bmatrix} G_0(z) \\ G_1(z) \end{bmatrix} = \frac{1}{H_0(z) \cdot H_1(-z) - H_0(-z) \cdot H_1(z)} \cdot \begin{bmatrix} H_1(-z) & -H_1(z) \\ -H_0(-z) & H_0(z) \end{bmatrix} \cdot \begin{bmatrix} T(z) \\ 0 \end{bmatrix} (4.14)$$

In order to achieve an FIR solution for G(z)'s, the first term on the right hand side of the equation, which is the determinant of the AC matrix should be a constant delay.

The first solution to this problem was the quadrature mirror filter, which was defined with the relationships below:

$$H_1(z) = H_0(-z) \; ; \; G_0(z) = H_0(z) \; ; \; G_1(z) = -H_0(-z)$$
 (4.15)

When these equations are put into equation 4.13, it is seen that the zero aliasing condition is satisfied and the system transfer function T(z) becomes:

$$T(z) = H_0(z) \cdot H_1(-z) - H_0(-z) \cdot H_1(z) \tag{4.16}$$

This transfer function can be made close to a delay, but optimization is needed.

Another solution is obtained from the observation that  $H_0(z) \cdot H_1(-z)$  is a lowpass filter and  $H_0(-z) \cdot H_1(z)$  is its complementary highpass filter [50]. It means that they are half band filters and their summation gives unit response. A half band low pass filter can be designed and through spectral factorization two lowpass filters can be extracted from this filter [52]. The half band filter is spectrally factorized such that  $H_1(-z) = H_0(z^{-1})$ . Through the following equations the filter bank can be built:

$$G_0(z) = H_0(z^{-1}) ; G_1(z) = H_0(-z) ; H_1(z) = H_0(-z^{-1})$$
 (4.17)

They automatically satisfy both the alias cancellation and transfer function constraints.

The Barnwell coefficients for 40 dB stopband attenuation filter bank is used to built the QMF bank [50]. The effect of gain increase in first channel is plotted in Fig. 4-23. The gain is increased by 5 dB up to 40 dB.

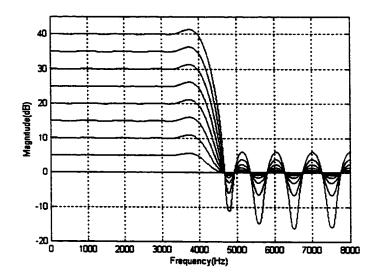


Fig. 4-23 Gain increase effect on QMF banks overall response It is observed that the gain should be kept below 35 dB for the QMF bank.

Our research is on 8-band filter bank, why did we explain a QMF bank? It is because of the fact that using the structure in Fig. 4-24, a QMF bank can be extended to an eight-band filter bank [53]. The analysis and synthesis filters are the same as the lowpass and highpass filters used in QMF bank. The signal is downsampled by 2 at each additional level in analysis filter bank. Between the analysis and synthesis filter bank the signal is downsampled by 8. At synthesis filter bank it is upsampled back to its original rate.

The signal processing is done between analysis and synthesis filter banks. The overall magnitude response of the filter bank gives unity response, since the same QMF properties are extended. But the impulse response of the system with gain applied between the analysis and synthesis filter banks doesn't show the uniformity plotted for

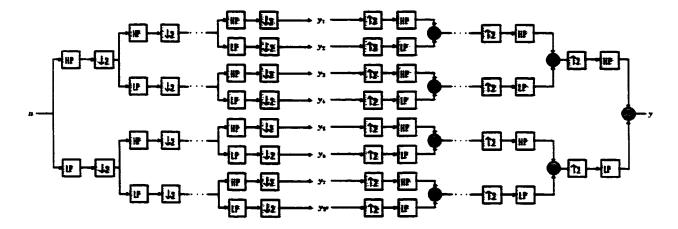


Fig. 4-24 The block diagram of extended QMF bank

the QMF bank in Fig. 4-23. 30 dB gain is applied to each channel, while the other channels are kept at 0 dB gain. The 8 different impulse responses of the filter bank are plotted together in Fig. 4-25. The individual channel magnitude responses have too much overlap.

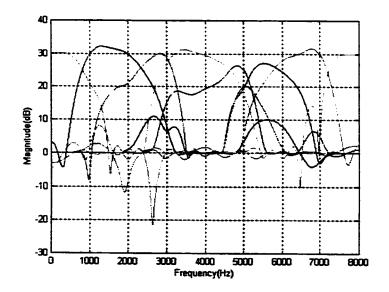


Fig. 4-25 Passbands of extended QMF bank

The filter bank is useful for subband coding, which doesn't apply much gain. The suitability of the filter bank for digital hearing aid is examined and the poor passband responses are demonstrated.

#### 4.4 Wavelet filter bank

The theory and specifications of wavelets need another thesis to cover. The important points of the wavelet theory for filter bank design are pointed out and the generation of filter bank using wavelets is explained.

Wavelets are introduced in 1980's as an alternative to Fourier transform. Wavelets are localized waves. Instead of oscillating forever they drop to zero.

The operation of wavelet transform can be described in discrete time as expression of input x(n) in the wavelet basis as a set of coefficients  $y_k(n)$  [54]. We can look at it as band pass filtering an input signal to obtain the coefficients. The coefficients are actually the signals in each channel and the filter coefficients  $h_k(n)$  are the basis of the wavelet transform. The discrete wavelet transform can be expressed as [44]:

$$y_{k}(n) = \sum_{m=-\infty}^{\infty} x(m) \cdot h_{k}(2^{k+1} \cdot n - m) \quad , 0 \le k \le M - 2$$

$$y_{M-1}(n) = \sum_{m=-\infty}^{\infty} x(m) \cdot h_{M-1}(2^{M-1} \cdot n - m)$$
(4.18)

This equation can be implemented by using the dyadic analysis filter bank given in Fig. 4-26. It is providing octave band response. In this implementation M = 6 and  $h_k$ 's are cascade of two basis coefficients of an orthogonal wavelet set. This two coefficients give one decomposition low pass filter LP (z) and one decomposition high pass filter HP (z).

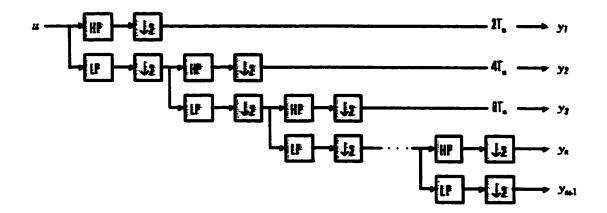


Fig. 4-26 Dyadic analysis filter bank

For example  $H_0(z) = HP(z^2)$  and  $H_1(z) = HP(z^2) \cdot LP(z^4)$ . The rest of  $H_k(z)$  is obtained by cascading the decomposition filters and downsamplers. The inverse discrete wavelet transform can be expressed as in Eq. (4-19) [44]:

$$x(n) = \sum_{k=0}^{M-2} \sum_{m=-\infty}^{\infty} y_k(m) \cdot g_k(n - 2^{k+1} \cdot m) + \sum_{m=-\infty}^{\infty} y_{M-1}(m) \cdot g_{M-1}(n - 2^{M-1} \cdot m)$$
 (4.19)

The tree-structured dyadic synthesis filter bank, given in Fig. 4-27, can be employed to perform the inverse wavelet transform. Reconstruction low pass and high pass filters are cascaded to implement the Eq. 4.19. As it was in the case of analysis part there are only two different filters. The four filters in this structure are the basis of the wavelet transform. These analysis and synthesis filter bank structures can be extended to 8 channels.

The wavelet families in Matlab are tested in eight-band filter bank structure for hearing instruments. The wavelets simulated in this tree structure filter bank are: Haar,

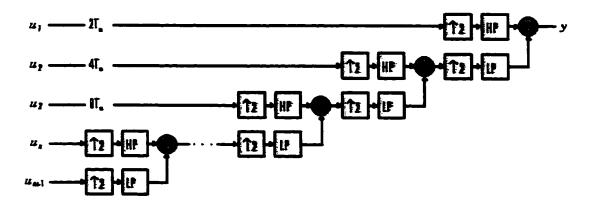


Fig. 4-27 Dyadic synthesis filter bank structure

Daubechies, Symlets, Coiflets, Meyer, Discrete Meyer, Gaussian, Mexican hat, Morlet and Shannon. The channel gain tests are applied to the systems in Simulink environment with the configuration given in Fig. 4-28. The most reasonable magnitude response is obtained from Discrete Meyer wavelet. The magnitude responses of the channels are plotted together in Fig. 4-29.

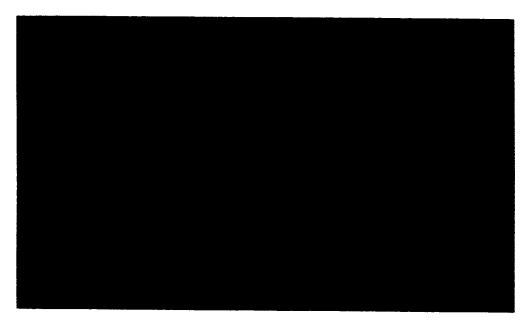


Fig. 4-28 Dyadic filter bank structure in simulink for wavelet gain test

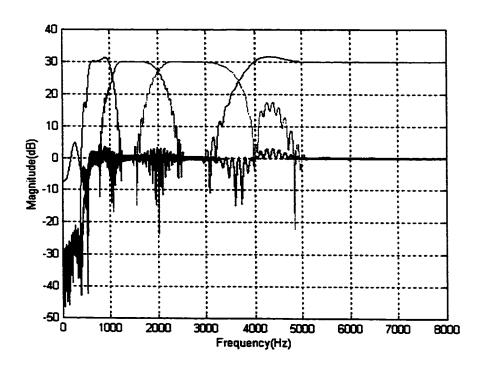


Fig. 4-29 Dyadic discrete meyer wavelet filter bank magnitude responses

A dyadic filter bank divides the spectrum into octave bands, which means it assigns half of the spectrum to the upper most channel and continues with the division of two of the rest. That means for this design the pass band frequencies are suppose to be: 8 kHz-4 kHz; 4 kHz-2 kHz; 2 kHz-1 kHz; 1 kHz-500 Hz; 500 Hz-250 Hz; 250 Hz-125 Hz; 125 Hz-72.5 Hz; 72.5 Hz-36.25 Hz. That means it is suppose to cover the spectrum of hearing up to 8 kHz. In Fig. 4-29 the gain in each channel is increased to 30 dB, while the rest is kept constant. We observe that the upper four channels satisfy the frequency expectations. The lower four channels disappear in the spectrum. This disappearance is because of the characteristic of the overall magnitude response plotted in Fig. 4-30. For low frequencies the response reaches to -40 dB. This characteristic is seen for all wavelet bases. The loss in low frequencies can be compensated but fluctuations in higher

frequencies will remain. Besides the problem in magnitude responses the phase response is extremely nonlinear and the group delay deviates from 500 samples to 2500 samples. which will delay the input up to 160 ms at 16 kHz sampling. Unfortunately this will have severe impact on sound.

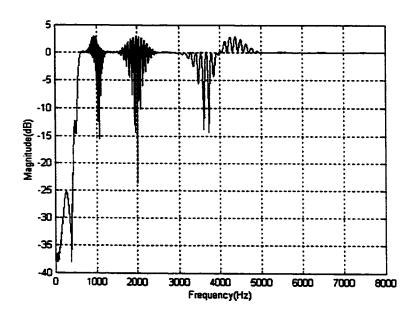


Fig. 4-30 Overall Magnitude response of discrete meyer wavelet filter bank

## 4.5 DFT Modulated Filter Bank

In previous sections the spectrum of the sound is divided into pass bands through tree structured filter banks. In section 4.2 the data rate is kept as it is and in following sections the data rate is reduced to obtain a reduced cost of processing in channels.

In this section a prototype filter is modulated with the aid of DFT and the signal is separated into bands with these modulated filters. The data rate is reduced with the aid of

analysis filter bank and the signal is recovered at its original rate through synthesis filter bank.

## 4.5.1 DFT Modulation Theory

The block diagram of a multirate filter bank can be given as in Fig. 4-31. In this block diagram H(z)'s are the analysis filters and G(z)'s are the synthesis filters. The analysis bank eliminates aliasing and the synthesis bank eliminates imaging, which are caused by the downsampling and upsampling by M. In this structure the filter designs can be independent to each other or they can be achieved from one prototype filter through complex modulation by multiplying the filter coefficients with  $W_K^{-k \cdot n}$ , which is defined in Eq. 4.20. 'k' is the band number and 'n' is the coefficient number, both starting from '0'.

$$W_K = e^{-j \cdot 2 \cdot \pi / K}$$
 and  $W_K^{-k \cdot n} = e^{j \cdot 2 \cdot \pi \cdot k \cdot n / K}$  (4.20)

'K' in Eq. 4.20 is the total number of channels in the filter bank structure. The effect of this modulation is demonstrated in Fig. 4-32. A low pass filter is modulated for K=16 and k=2.

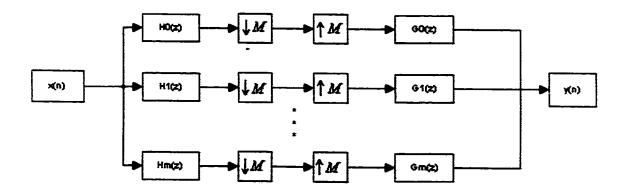


Fig. 4-31 Multirate filter bank block diagram

It is observed that the filter's magnitude response is shifted and it becomes a bandpass filter, which can be used as an analysis filter for the third channel of an eight-band filter.

We achieve the same result if we modulate the input signal instead of the filter. That means the spectrum of the input signal is shifted, while the filter response is kept the same. From mathematical point of view the input signal is multiplied with the term in Eq. 4.20 no matter whether it is placed in filter coefficients or on signal path.

Since the modulation is complex we end up with complex samples after the analysis filter bank. In order to retrieve real samples, in synthesis filter bank demodulation should be applied. That means the prototype filter should be shifted to the opposite direction of analysis filters in frequency domain. The band pass filters are achieved by multiplying with  $W_k^{kn}$ .

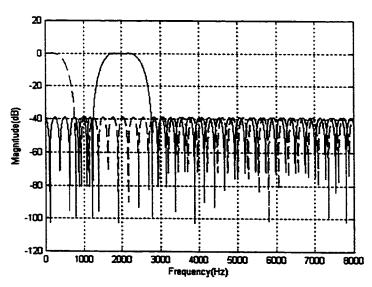


Fig. 4-32 Complex modulation of a FIR filter

The block diagram of a modulated filter bank is given in Fig. 4-33. It is observed that the filters h(n) and f(n) are repeated in each channel [55]. The implementation of modulated

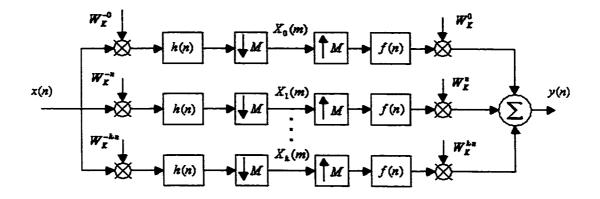


Fig. 4-33 Modulated filter bank structure

filter bank in this structure would be too inefficient. The same modulated filter bank can be implemented in polyphase structure.

**Polyphase Representation:** The polyphase representation of a transfer function is the separation of its coefficients in terms of their number. For example a filter with impulse response h(n) can be defined as the addition of odd numbered and even numbered coefficients as follows [44]:

$$H(z) = \sum_{n=-\infty}^{\infty} h(2 \cdot n) \cdot z^{-2 \cdot n} + z^{-1} \cdot \sum_{n=-\infty}^{\infty} h(2 \cdot n + 1) \cdot z^{-2 \cdot n}$$
 (4.21)

This separation can be performed for an integer K as follows:

$$H(z) = \sum_{l=0}^{K-1} z^{-l} \cdot E_l(z^K)$$
 (4.22)

This representation has a special meaning because of the noble identities plotted in Fig. 4-34. The proof of these identities can be found in [44].

Fig. 4-34 Noble identities

The analysis filter h(n) and synthesis filter f(n) in Fig.4-33 can be represented in polyphase form for K=16:

$$H(z) = \sum_{l=0}^{15} z^{-l} \cdot H_l(z^{16}) \quad F(z) = \sum_{l=0}^{15} z^{-l} \cdot F_l(z^{16})$$
 (4.23)

Using the noble identities in Fig. 4-34, the polyphase components can be replaced with downsamplers and upsamplers. The modulation can be taken after the analysis and before the synthesis filters. The final form of the DFT modulated filter bank is given in Fig. 4-35. A mathematical proof of the identity of the analysis part of Fig. 4-33 with the analysis part of Fig.4-35 can be done for critically sampled case (M=K) as follows:

$$p_{k}(n) = h(n) \cdot W_{M}^{-k \cdot n}, q_{k}(n) = f(n) \cdot W_{M}^{k \cdot n}$$

$$X_{k}(m) = \sum_{n=0}^{L-1} h_{k}(n) \cdot x(m \cdot M - n) = \sum_{n=0}^{L-1} h(n) \cdot W_{M}^{-k \cdot n} \cdot x(m \cdot M - n)$$
(4.24)

In Eq. 4.24  $h_k(n)$  are analysis filters and  $q_k(n)$  are synthesis filters. L is the length of the analysis filter.  $X_k(m)$  are the channel signals. In final expression of  $X_k(m)$  in Eq. 4-24 the substitutions  $n = i \cdot M + j$  and  $L = M \cdot L_p$  are made:

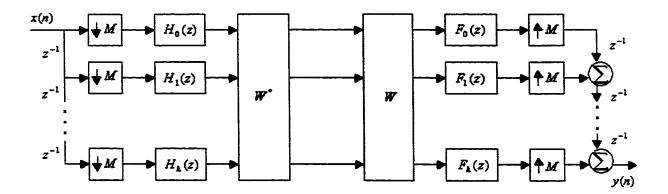


Fig. 4-35 DFT filter bank block diagram

$$X_{k}(m) = \sum_{j=0}^{M-1} \sum_{i=0}^{L_{p}-1} h(i \cdot M + j) \cdot W_{M}^{-k \cdot (i \cdot M + j)} \cdot x(m \cdot M - i \cdot M - j)$$

$$= \sum_{j=0}^{M-1} W_{M}^{-k \cdot j} \sum_{i=0}^{L_{p}-1} h(i \cdot M + j) \cdot x(m \cdot M - i \cdot M - j)$$

$$= \sum_{j=0}^{M-1} W_{M}^{-k \cdot j} \sum_{i=0}^{L_{p}-1} h_{j}(i) \cdot x_{j}(m-i)$$
(4.25)

The final expression in Eq. 4.25 is IDFT of the convolution of the polyphase components of the analysis filter with polyphase components of input signal, which are basically delayed versions of the input signal [56]. It exactly describes the operation of the DFT filter bank in Fig. 4-34. The only difference from the normal IDFT is that the prefactor 1/M is omitted.

### 4.5.2 M-Band Filters

An M-Band noncausal filter is defined as having the following property [57]:

$$\begin{cases} h(M \cdot p) = 0 & p \neq 0 \\ h(0) = \frac{1}{M} & p = 0 \end{cases}$$
 (4.26)

It is an extension of half band filters, which satisfy Eq. 3.3. The half band filters can be designed successively by Remez algorithm but the design of M-band filters with this algorithm doesn't totally satisfy the conditions in 4.26. Therefore another design method called 'Eigenfilter' method is used.

#### 4.5.3 Eigenfilter Design Method

It is a least-squares FIR filter design method. Its difference from other methods is that both frequency and time domain constraints can be put on filter design. For an even order linear phase filter the frequency response can be written as:

$$H_0(e^{j \cdot w}) = \sum_{n=0}^{M} b_n \cdot \cos(n \cdot w)$$
 (4.27)

Coefficients 'b' can be written in vector form:

$$b = [b_0 \ b_1 \ b_{M \ 1} \ b_M]^t \tag{4.28}$$

An error matrix 'P' for the design of an even order filter can be constructed with a weighting variable 'a' for passband and stopband attenuation [58]:

$$P(n,m) = \frac{(1-\alpha)}{\pi} \cdot \int_{0}^{w_{p}} (1-\cos(n \cdot w) \cdot (1-\cos(m \cdot w) \cdot dw) + \frac{\alpha}{\pi} \cdot \int_{w_{p}}^{\pi} \cos(n \cdot w) \cdot \cos(m \cdot w) \cdot dw$$
(4.29)

The total error of the filter design is given by:

$$E = b^t \cdot P \cdot b \tag{4.30}$$

The smallest eigenvalue of the matrix P is found and the eigenvector of this eigenvalue gives the b vector, which has least squares minimum error for the design parameters.

The time constraints can be imposed to the method by keeping the rows and columns of the P matrix according to the desired value of the corresponding coefficient. That means to obtain a filter, whose 5<sup>th</sup> coefficient is zero the 5<sup>th</sup> column and row of the matrix is deleted. This allows us to design M-band filters. The design method is written in Matlab and the code is given in Appendix III. A more detailed explanation of the method can be found in [58].

#### 4.5.4 Perfect reconstruction for DFT filter bank

The perfect reconstruction condition for critical subsampling (M=K) of the DFT filter bank is [56]:

$$H_k(z) \cdot F_{M-1-k}(z) = \frac{z^{-N}}{M}$$
 (4.31)

In this equation N is an arbitrary integer. That means polyphase components of analysis filter bank and synthesis filter bank, whose delay sum gives M-1, are matched together and their cascade should give a delay. It is very difficult to design two filters forcing with these constraints.

M-band filters obtain the property:

$$\sum_{k=0}^{M-1} H(z \cdot W^k) = 1 \tag{4.32}$$

That means the summation of the modulated filters from an M-band filter will give unity. If the analysis and synthesis filters are designed as M-band filters and their convolution also gives an M-band filter, than perfect reconstruction is obtained in the filter bank [44].

This property is used in the design of the DFT filter bank, which is explained in following section.

#### 4.5.5 DFT Filter Bank simulation

An 8-band filter bank is designed employing two 16-band filters. The filterbank modulates the filters 16 times, but since only 8 of these bands lie in positive frequency region, the filter bank is called 8-band filter bank. The rest of the bands are necessary for reconstruction of the original signal. The simulator is written in Matlab's Simulink environment. The simulator is shown in Fig. 4-36.

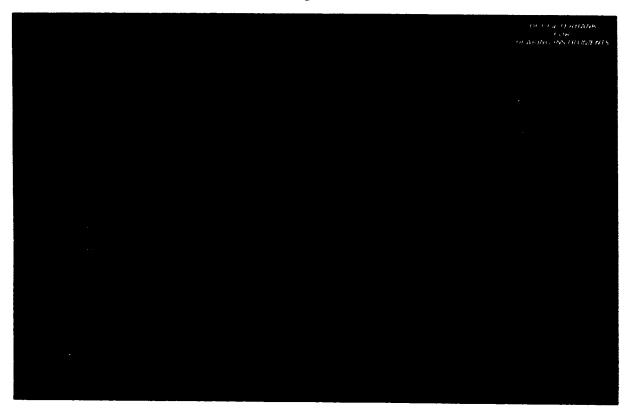


Fig. 4-36 DFT Filter bank simulator in Simulink

The simulator has the same structure shown in Fig. 4-35. The analysis low pass filter is represented in polyphase form. The outputs of the polyphase elements are fed into IDFT block. Between IDFT and DFT gain is applied to the signal. This is the region where all

the signal processing should take place. After demodulation of the input signal with DFT the signal is fed into polyphase components of the synthesis filter. The outputs are delayed and summed up and the final output signal is obtained.

Using the eigenfilter design method a 16-band linear phase FIR filter is designed. The magnitude response of this filter is plotted in Fig. 4-37. It is a 64th order filter.

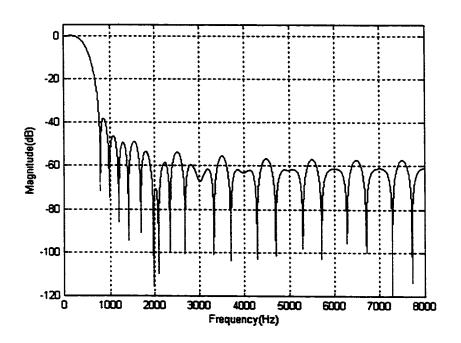


Fig. 4-37 Magnitude response of the analysis filter

This filter is used as analysis filter in the filter bank. It has a pass band cutoff frequency of 240 Hz, pass band ripple of 0.1 dB, stopband cutoff frequency of 760 Hz. It doesn't have an equripple characteristic in the stopband. The stopband attenuation deviates from 40 dB to 57 dB.

Because of the high gain deviations in digital hearing aids, with critical sampling the aliasing and imaging can not be eliminated totally. Therefore the signal is oversampled

by 2. That means instead of downsampling by 16, the signal is downsampled by 8 at analysis part and upsampled by 8 back to its original rate at synthesis part [59].

This relaxation allows us to design an 8-band filter in the synthesis part. This filter is extracted from the analysis filter by decimating the coefficients by 2. The magnitude response of the synthesis filter is plotted in Fig. 4-38. Because of the oversampling this frequency response is sharp enough to suppress the images of upsampling. The ripples of the filter are the same as analysis part. The passband cutoff frequencies are double of the analysis filter.

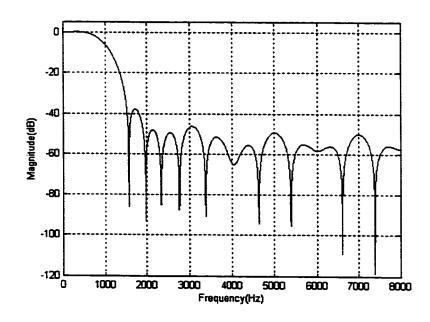


Fig. 4-38 Magnitude response of synthesis filter

These filters have the property that their middle coefficient is an integer multiple of 16 away from the first coefficient. In Eq. 4.32 the real coefficient of W, which is '1', should be multiplied with the middle coefficient of the M-band filter. Therefore the DFT and IDFT matrices should be shifted so that the polyphase element including the middle coefficient is fed to the path of the first row of W. Even though for this design the shift is

not necessary, the DFT and IDFT are directly implemented in the simulation. Instead of using the radix-2 algorithm the DFT coefficients are directly multiplied with the input signals.

The performance of the filter bank is tested using the gain increase method in pass bands. Since the filter bank is uniform and the characteristics of pass bands are exactly the same as the first band, the increase is applied only on the first channel of the structure. The gain is increased by 5 dB up to 40 dB and the response of the filter bank is plotted in Fig. 4-39.

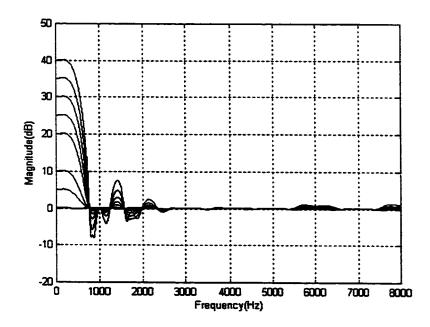


Fig. 4-39 The effect of gain increase on DFT filter bank overall magnitude response

Almost the same response as in IFIR filter bank is achieved. The effect on adjacent bands passes 3 dB after 30 dB gain. Therefore 30 dB gain should be the limit of the filter bank.

The overall magnitude response of the filter bank with no gain is plotted in Fig. 4-40. The ripple is in the range of -0.2 dB to +0.2 dB, which can be accepted as perfect reconstruction.

The total cost of the filter bank is determined by the cost of the analysis and synthesis filters and by the cost of the DFT and IDFT processes. They are tabulated below:

	Filters	IDFT+DFT	Total Cost
Multiplication	92	128	220 (28 MPU)
Addition	62	256	318 (40 APU)

Table 4-3 DFT filter bank implementation cost

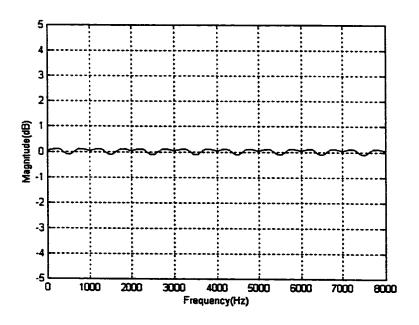


Fig. 4-40 Overall magnitude response of the DFT filter bank

Both analysis and synthesis filters are linear phase as stated at their design process. Since in filter bank structure they are divided into their polyphase components, the linear phase property is partly lost. Fig. 4-41 shows the group delay of the filter bank at zero gain. It deviates between 45 samples and 48 samples. This much deviation is acceptable. When the gain is applied to the channels the deviation in group delay increases too. Fig. 4-42 shows the group delay of the system, when 30 dB gain is applied to the first channel.

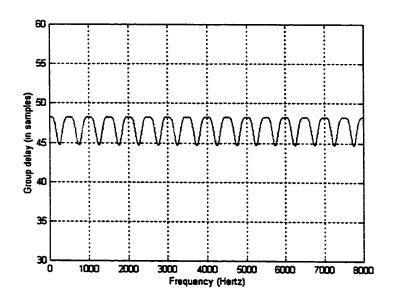


Fig. 4-41 Group delay of the DFT filter bank with no gain

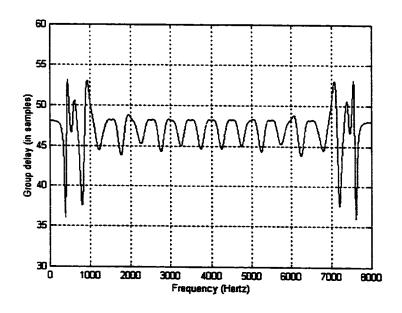


Fig. 4-42 Group delay of the DFT filter bank at 30 dB gain in first channel

There is a wider fluctuation of group delay between 36 samples and 53 samples. This will distort the sound signal.

### 4.6 Discussion

In this chapter research on digital filter banks is covered. Four different types of digital filter banks are designed and their performances are demonstrated.

The magnitude responses of extended QMF bank and wavelet filter bank don't meat our frequency resolution criteria. In wavelet filter bank even the perfect reconstruction can not be achieved.

The IFIR and DFT modulated filter banks show similar magnitude responses. The cost of these two filter banks is almost the same in terms of MPU (Multiplication per unit time) and APU (Addition per unit time). IFIR has 27 MPU and 45 APU. On the other hand DFT filter bank has 28 MPU and 40 APU. Even though the MPU and APU numbers are close to each other, in DFT filter bank we need to have 220 multipliers and 318 adders in the hardware. Not all of them operate at the same time but their locations are independent to each other. Therefore IFIR filter bank takes less space than DFT filter bank.

Another important drawback of the DFT filter bank is the fact that it doesn't have constant group delay. It causes distortion in the sound signal and the quality of the sound is degraded.

Because of the high gain need for the compensation of the moderate to severe hearing loss, 60 dB IFIR filter bank design is proposed as the optimum solution for the digital hearing instrument. Its processing delay is 6.4 ms at 16 kHz, which will allow 3.6 ms processing delay after the filter bank.

The quantization effects on 60 dB IFIR filter bank are examined. It is observed that 12-bit quantization causes increase in the noise floor. Therefore 16- bit quantization should be used.

# Chapter 5

# COMPRESSION ALGORITHMS AND PERFORMANCE EVALUATION

This chapter covers two state of the art digital compression algorithms, improvements achieved in them and the evaluation of their performances using a hearing loss simulator based on dynamic expansion. The compression algorithms are RangeEar and Homomorphic Multiplicative AGC (Automatic Gain Control). In order to make a healthy comparison the algorithms are simulated with the same filter bank. The choice of the previous chapter, which is the 8-band 60 dB IFIR filter bank, is employed in simulations.

# 5.1 RangeEar Compression Algorithm

The algorithm is separated into two parts. The first part is the frequency shaping of the input signal according to the audiogram. That means threshold level increase is compensated through amplification. The second part is the two-channel, wide dynamic range compression [60]. The block diagram of the system is given in Fig. 5-1.

# 5.1.1 RangeEar System Specifications

RangeEar employs 7-band IFIR filter bank with 40 dB stopband attenuation [61]. In filter bank design the second passband is divided into two passbands. On the other hand the two upper most passbands of the 8-band IFIR filter bank design in 4<sup>th</sup> chapter is left out

of the structure. At 17 kHz the width of the channels are listed in Fig. 5-1. The filter bank is designed in Matlab and the passbands are plotted in Fig. 5-2 at 17 kHz sampling frequency.

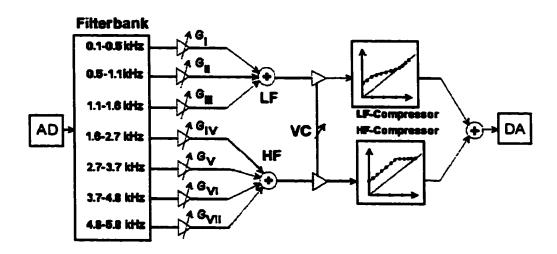


Fig. 5-1 RangeEar system block diagram

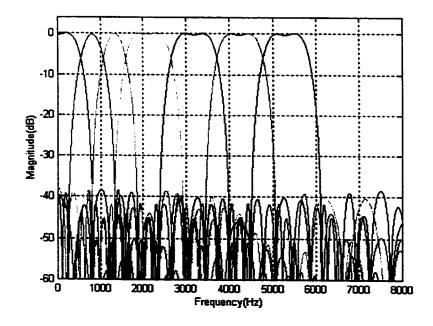


Fig. 5-2 Magnitude responses of RangeEar filter bank

After the division of signals into bands, frequency shaping is applied in each channel. The three lower channels are summed up and fed into low channel compressor. The rest four bands are summed up and fed into high channel compressor. Before the compressors additional gain can be applied to the sums.

In compressor pure-tone loudness model is used [60]. The loudness model assumes a completion point. The loudness for the impaired ear and normal ear is the same above the completion point. Below the completion point, the loudness model is a linear approximation of the loudness growth curve given in Fig. 2-14. The completion point 'M' is defined in algorithm as:

$$M = 0.8 \cdot HTL + 47dBSPL \tag{5.1}$$

HTL is the hearing threshold level for the impaired person. The slope 'S' of the loudness growth function below M is determined as:

$$S = (47 + 0.8 \cdot HTL)/(47 - 0.2 \cdot HTL) \tag{5.2}$$

In low frequency compressor there are three HTL's, which can be applied into algorithm.

The algorithm takes the average of these three HTL levels as the HTL of the low compressor.

In high frequency compressor there are four HTL's. The system feds the lowest HTL into algorithm.

Both low frequency and high frequency compressors apply a knee point at 30 dBSPL, so that noise is not amplified. The operation of loudness growth function is demonstrated for three different HTL's in Fig. 5-3. Normal sound level is mapped to impaired ears loudness perception. The compressors have 300 ms release time and 15 ms attack time.

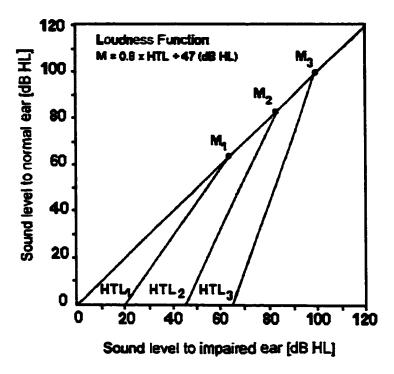


Fig. 5-3 I/O curve of loudness growth function

## 5.1.2 RangeEar Simulator

The RangeEar digital hearing instrument described in section 5.1.1 is simulated in Matlab's Simulink environment. The simulator is shown in Fig. 5-4.

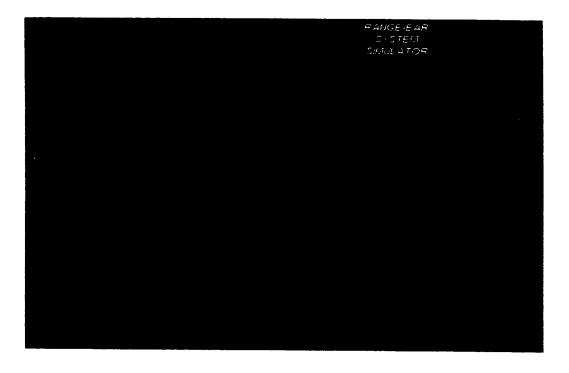


Fig. 5-4 RangeEar System Simulator in Simulink

To achieve the 15 ms attack time and 300 ms release time DynamEQ-II's twin average detection system is employed inside the compressors. The low frequency compressor block is shown in Fig. 5-5.

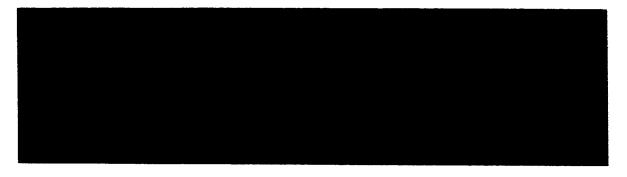


Fig. 5-5 RangeEar low-frequency compressor block

The slow and fast average detectors determine the intensity level of the input signal and they fed this value into RangeEar algorithm. The simulated I/O characteristics of the algorithm with increasing HTL are plotted in Fig. 5-6. The HTL is increased from 20 dBSPL by 10 dB up to 70 dBSPL. The completion point gets higher and the slope gets sharper with HTL increase. Input signals below 30 dBSPL are amplified linearly.

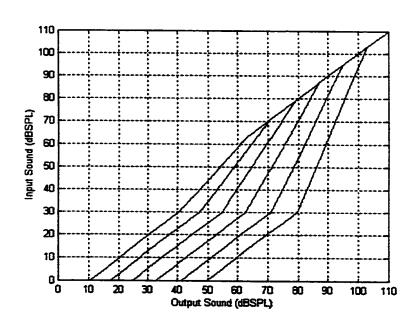


Fig. 5-6 RangeEar compression algorithm I/O response with increasing HTL

### 5.1.3 Modified RangeEar Simulator

In order to make a healthy comparison between the compression algorithms we have to use the same filter bank. Therefore the original RangeEar system is modified and the filter bank is replaced with the 60 dB IFIR filter bank design. The lower three bands are fed into low frequency compressor and the other five bands are processed by high frequency compressor. The compression algorithms are kept exactly the same.

# 5.2 Homomorphic Multiplicative AGC

The homomorphic multiplicative AGC (Automatic gain control) is based on a model of the response of the human auditory system to sound stimuli [62]. The model is developed from a similar model for the human visual system [63].

## 5.2.1 Theory of homomorphic multiplication

The block diagram of the loudness perception model is given in Fig. 5-7. According to the model the first operation is bandpass filtering by basilar membrane. Hair cells detect the intensity of the signal like an envelope detector in the band. After the envelope detection the intensity of the signal is logarithmically compressed. The high pass filter

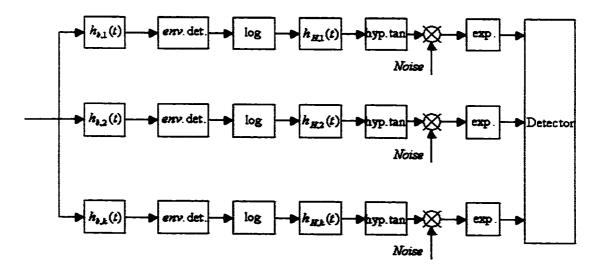


Fig. 5-7 Loudness perception model

provides loudness adaptation. The hyperbolic tangent mimics the firing of the inner hair cells. A multiplicative intrinsic noise source is added in the logarithmic domain. The exponential of the signal is taken and the loudness is detected by the neural network.

In this model the processing is done only on the envelope of the signal. That means if we define an acoustic signal s(t) as in Eq. 5.3, the v(t), which is the rapidly varying vibration is untouched [62].

$$s(t) = e(t) \cdot v(t) \tag{5.3}$$

The transfer function of the normal hearing is called as  $H_n(t)$  and the transfer function of the damaged ear is called as  $H_d(t)$ . Their responses to an acoustic signal are defined as:

$$n(t) = H_n(s(t)) \text{ and } d(t) = H_d(s(t))$$
 (5.4)

In order to obtain n(t) in a damaged ear the response of the normal ear should be cascaded with the inverse response of the damaged ear:

$$H_d(H_d^{-1}(n(t), \nu(t))) = n(t)$$
 (5.5)

In order to take the inverse response of the damaged ear, the information on fast varying part v(t) of the acoustic signal should be kept. Therefore v(t) is added to the transfer function. Eq. 5.5 shows that the audio processing we have to apply on input acoustic signal is given as:

$$H_d^{-1}(n(t), \nu(t)) = H_d^{-1}(H_n(s(t)), \nu(t))$$
 (5.6)

The inverse transfer function of damaged ear should be cascaded with the transfer function of the normal ear so that the desired response n(t) is obtained.

This cascade is expected to bring a very complex signal processing scheme, but most of the blocks in forward and inverse model cancel each other and the signal processing in one pass band is simplified to the form given in Fig. 5-8. The details of the simplification can be found in [62].

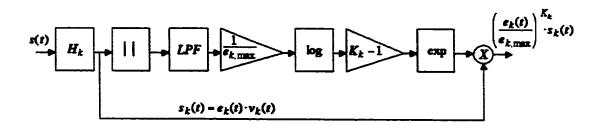


Fig. 5-8 The block diagram of homomorphic multiplicative AGC for one pass band

The system is called homomorphic multiplicative, because of the fact that after the intensity level is transformed into cepstrum domain by taking the natural logarithm, the signal is multiplied with  $K_k - 1$ . There isn't any homomorphic filtering in the structure, but multiplication in cepstrum domain.

In Fig. 5-8  $H_k$  is the band pass filter. The cascade of taking the absolute value of the signal and low pass filtering gives the envelope magnitude of the acoustic signal. The signal at the output of the envelope detector is normalized with  $e_{k,\max}$ , which is the UCL (upper comfortable level) of hearing. The normalized signal is mapped into cepstrum domain and homomorphically multiplied by  $K_k - 1$ .  $K_k$  is defined as:

$$K_{k} = \left[1 - \left(\frac{HearingLoss(dBSPL)}{UCL(dBSPL) - NHT(dBSPL)}\right)\right]$$
 (5.7)

The NHT is defined as 'Normal Hearing Threshold'. The processed signal is mapped back to time domain and multiplied with the original acoustical signal, which carries the fast varying signal (high frequency signal) information. The gain of the system is:

$$Gain(t) = \left(\frac{e_k(t)}{e_{k,\max}}\right)^{K_k - 1} \tag{5.8}$$

The signal processing explained above is done in each channel of the digital hearing instrument separately.

The performance evaluation of this compression algorithm has been done with a 12-band filter bank at 21.33 kHz sampling frequency [64]. The subject tests showed better results comparing to other digital hearing instruments.

# 5.2.2 Homomorphic multiplicative AGC hearing instrument simulator

The compression algorithm is simulated in Matlab-Simulink. The 8-band 60 dB IFIR filter bank design is used for band pass filtering. The compression algorithm takes UCL, NHT and HL (Hearing Loss) as control parameters. The values of these parameters determine the I/O curve of the compressor. The simulator is shown in Fig. 5-9 and its code is given in Appendix IV. The compression is done in each channel independent to each other. Therefore there are 24 parameters to set in the hearing instrument. One of the compressor blocks is shown in Fig. 5-10. The low pass filter is a 10 ms long moving average detector. The compressor block is the exact implementation of Fig. 5-8. The  $e_{k,\max}$  value is generated from the UCL level since it is the intensity value of UCL.

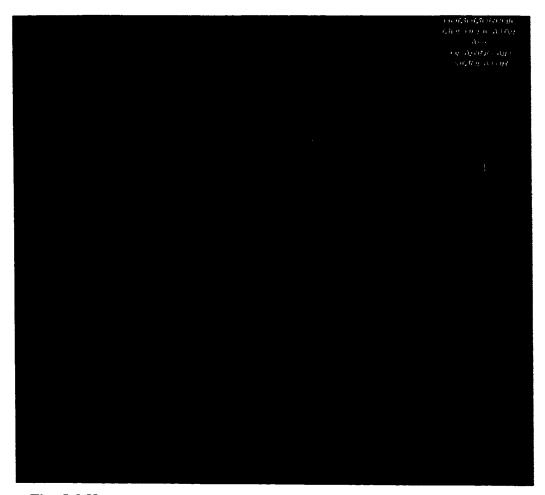


Fig. 5-9 Homomorphic multiplicative AGC Hearing Instrument Simulator

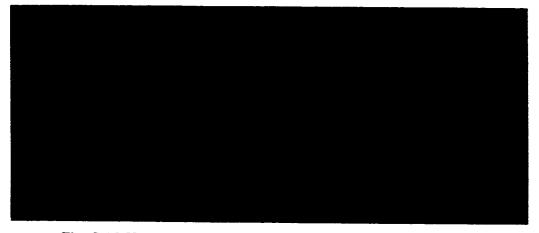


Fig. 5-10 Homomorphic multiplicative AGC compressor block

The effects of control parameters on compressors I/O curve are simulated. In first simulations the HL is varied, while the UCL is set at 110 dBSPL and NHT is set at 0 dBSPL. The effect of this sweep is plotted in Fig. 5-11.

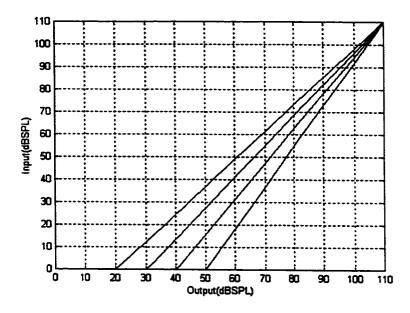


Fig. 5-11 The effect of HL increase on homomorphic I/O curve

The HL is increased from 20 dBSPL to 50 dBSPL by 10 dB. The lower starting point of the I/O curve is shifted to the right, while the upper completion point is kept constant at 110 dBSPL. That means the compression ratio is increased to map the input dynamic range. The upper completion point is set as UCL.

In second part the effect of the change in UCL is simulated. The HL is kept constant at 30 dBSPL, NHT is kept constant at 0 dBSPL. The response is plotted in Fig. 5-12.

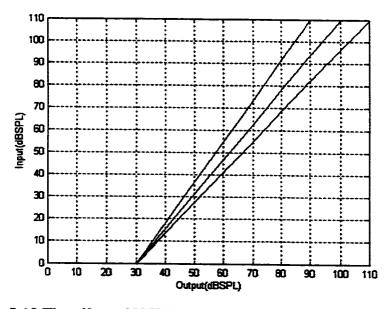


Fig. 5-12 The effect of UCL increase on homomorphic I/O curve

In Fig. 5-12 the UCL of the compressor is increased from 90 dBSPL to 110 dBSPL. The effect of this increase is the decrease in compression ratio. The completion point is increased, while the starting point remains at the same level.

The effect of the last control parameter NHT on compressor I/O curve is given in Fig. 5-13. This time UCL is kept constant at 110 dBSPL and HL is kept constant at 20 dBSPL.

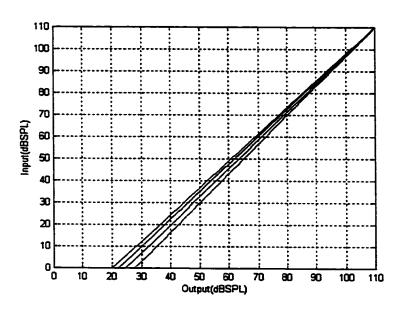


Fig. 5-13 The effect of NHT increase on homomorphic I/O curve

The NHT is increased by 10 dB from 0 dBSPL to 30 dBSPL. It is observed that this increase shifts the starting point of the I/O curve to right. The increase in the starting point is approximately 3 dB for every 10 dB increase in NHT.

## 5.2.3 Improved homomorphic multiplicative AGC algorithm

In previous section we observed that the only flexibility in I/O curve of the system is in starting point and completion point of the compression. No matter what the intensity level of the sound signal is, some degree of compression is applied on it. In hearing instruments the very low level signals shouldn't face much amplification, so that the

noise at these levels are kept at their original level. Therefore there should be limits of compression.

The homomorphic multiplicative AGC applies constant gain in cepstrum domain. The signal is multiplied with  $K_k$  -1 no matter what its intensity level is. The effect of taking the exponential after this multiplication causes the compression. At this cepstrum domain the gain can be varied according to the input intensity level too. A weighting factor is added to  $K_k$ . The factor increases with increasing intensity level of the input signal. The weighting factor is chosen as IL/330. IL is the intensity level of the acoustic signal. That means  $K_k$  is increased by an amount of 0 to 0.33, which depends on the input intensity level of the acoustic signal. The effect of this factor is plotted in Fig. 5-14.

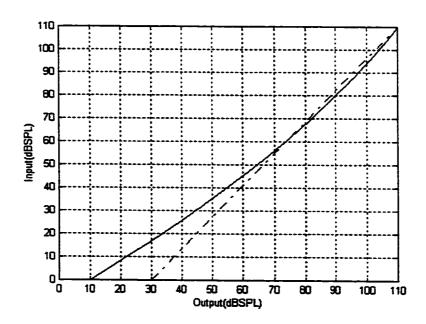


Fig. 5-14 Improved homomorphic multiplicative AGC I/O curve

In Fig. 5-14 the dashed line is the I/O curve of the original compression algorithm for HL = 30 dBSPL, UCL = 110 dBSPL and NHT = 0 dBSPL. The solid line is the response of new algorithm. To obtain this response the HL is pulled down to 10 dBSPL. We observe

that the improved response obtains almost the same characteristics for the input intensity levels higher than 60 dBSPL. For low level input range the signal is not overamplified. This is achieved by nonlinear compression rate.

The I/O curves in Fig. 5-14 are plotted again in terms of input and output voltages in Fig. 5-15. It is assumed that 110 dB SPL corresponds to 1 V. We observe that the two I/O characteristics converge to each other as the input level becomes 1V. Since we are using linear scale we can't make a healthy observation on the responses below 70 dB SPL or 0.01 V. We know that the new algorithm applies more gain to signals over 70 dB SPL and this characteristic is also observed in Fig. 5-15.

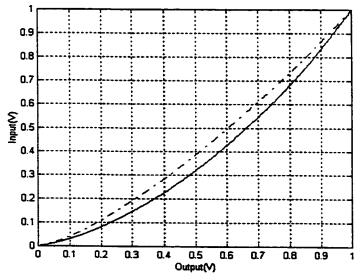


Fig. 5-15 Comparison of the homomorphic algorithms in terms of input, output voltages

The difference of these two I/O curves can be observed better on their compression ratio curves, which is given in Fig. 5-16. In Fig. 5-16 the dashed line shows the compression ratio of the original compression algorithm. We observe constant compression ratio over all the input dynamic range.

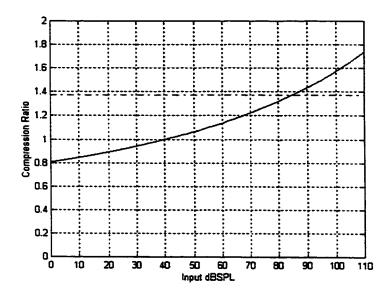


Fig. 5-16 Compression ratios of I/O curves of Fig. 5-14

The solid line is the compression ratio of the improved algorithm. It shows that the kneepoint for this response is 40 dBSPL. Over 40 dBSPL it starts the compression. Below this intensity level the system actually applies expansion to the system. Expansion is a common method used in communication channels to suppress the noise.

Another improvement in compressor system is obtained by implementing DynamEQ-II's twin average detection. With only one lowpass filter we have the same attack and release times. Twin average detection allows us to apply different attack and release times. The final form of the homomorphic multiplicative AGC compressor is given in Fig. 5-17.

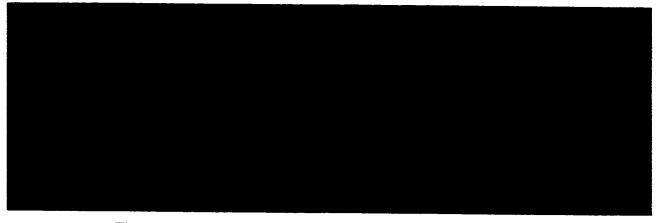


Fig. 5-17 Improved homomorphic multiplicative AGC algorithm

On left hand side of the Fig. 5-17 the twin average detector is located. The output of this detector is fed into compressor.

## 5.3 Hearing Loss Simulator

In order to evaluate the performances of the compression algorithms a digital hearing loss simulator is employed. Input signal is presented to a normal listener at the same loudness level, which would be perceived by an impaired listener. This is achieved by expansion simulation. The I/O characteristic of the simulator is determined by three parameters. The first parameter is  $T_n$ , which is the detection threshold of the normal hearing person. The second parameter is the detection threshold of the impaired person  $T_i$ . The final parameter is the threshold of recruitment  $T_i$ . This parameter is extracted from the first two using the following formula [65]:

$$T_r = T_n + (T_i - T_n) \cdot \frac{\tan(\alpha)}{\tan(\alpha - 1)}$$
 (5.9)

The angle of the recruitment curve  $\alpha$  (in degrees) is defined as:

$$\alpha = 47 + 0.45 \cdot (T_i - T_n) \tag{5.10}$$

The effect of  $T_n$  on expander I/O curve is plotted in Fig. 5-18.  $T_i$  is kept constant at 30 dBSPL. That means the hearing loss is 30 dBSPL and the normal hearing threshold level increases from 0 dBSPL to 25 dBSPL. In Fig 5-18 the increase of  $T_n$  changes the lower kneepoint of the expansion. Below this kneepoint linear gain is applied, above it the signal is expanded. Besides the lower kneepoint, the change in  $T_n$  also effects  $T_r$ , which is the completion point of expansion.

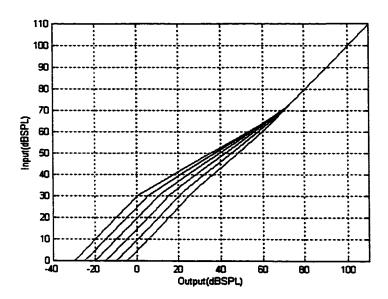


Fig. 5-18  $T_n$  parameter effect on loss simulator I/O curve

The effect on  $T_r$ , is very slight and it is located approximately at 70 dBSPL. On the other hand the lower kneepoint is equal to the difference between the impaired hearing threshold and normal hearing threshold. It should be noted that the x-axis doesn't start from 0 dBSPL. That means the input signal is mapped to negative intensity levels too. The acoustic signal, which lies below the lower kneepoint, is mapped to a signal, which lies below the normal hearing threshold level. That means it won't be recognized by the listener. This is very logical, because the lower kneepoint is located at impaired hearing threshold level on input signal axis.

The effect of  $T_i$ , the impaired hearing threshold level, on expander I/O curve is demonstrated by increasing its value from 30 dBSPL to 55 dBSPL by 5 dB. The normal hearing threshold level  $T_n$  is kept constant at 0 dBSPL. The I/O response is plotted in Fig. 5-19. The increase in  $T_i$  shifts both the expansion completion point and the lower kneepoint up in y-axis, which is the input sound intensity level.

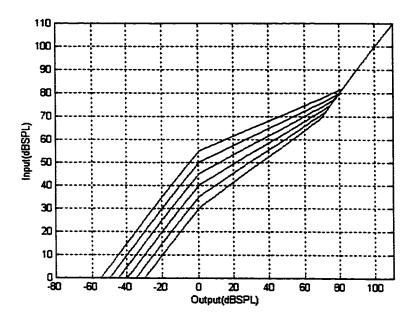


Fig. 5-19  $T_i$  parameter effect on loss simulator I/O curve

The kneepoint gets higher faster than the completion point, which brings higher expansion ratio. Above the completion point and below the kneepoint the gain is still constant.

The simulator has a 14-band filter bank. The filter bank consists of band pass filter with very high orders. The band pass filters are designed with Kaiser window method. They are 4000<sup>th</sup> order filters with very sharp transition bands and high stop band attenuations. The magnitude responses are plotted in Fig. 5-20. It divides the spectrum into octave bands. Because of their high order the magnitude responses look like boxcar windows.

The filter bank pass bands are plotted at 16 kHz sampling frequency in Fig. 5-20. The stop band attenuation is 75 dB. The noise floor doesn't have a flat response. It decays very fast. The total magnitude response of the bank is maximally flat.

The hearing loss simulator employs 20 ms long windows to perform the level estimation of the acoustic signal. The moving averages are taken separately in each channel and the detected intensity levels are fed into gain blocks.

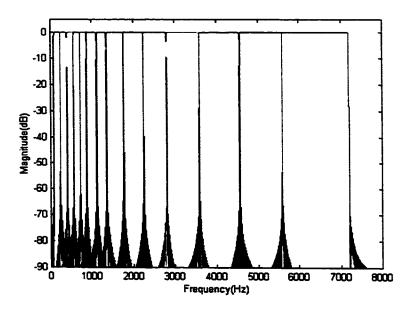


Fig. 5-20 Magnitude responses of loss simulator filter bank channels

Fig. 5-21 shows the implementation of hearing loss simulator in Matlab-Simulink. After the filter bank, the signals in each channel enter into level detectors. The output of this block, control parameters and the signal itself are fed into gain block, where the level dependant expansion is performed. The processed signals are summed up to construct the output of the loss simulator.

# 5.4 Performance Evaluation of Compression Algorithms

There isn't any standard to evaluate the performance of hearing instruments. In our research performances of the digital hearing instruments are evaluated with simulations.

# 5.4.1 Simulation Set-up For Performance Evaluation

In first step an example audiogram is prepared for simulations. An acoustic signal is chosen and it's fed into digital hearing instrument simulators, which are calibrated to compensate the hearing loss. The output of these hearing instruments is fed into digital

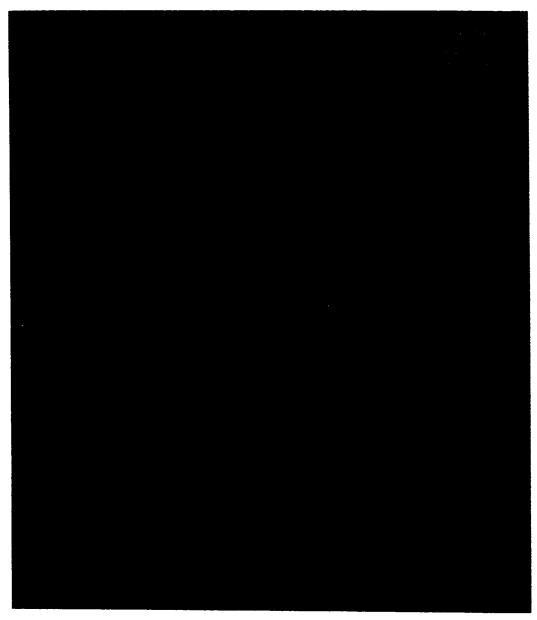


Fig. 5-21 Hearing Loss Simulator in Matlab-Simulink hearing loss simulator, which maps the loudness level perception of an impaired ear to a normal ear. The block diagram of this set-up is given in Fig. 5-22.

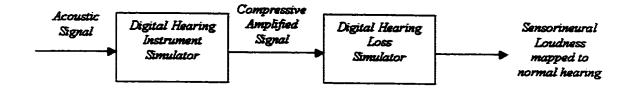


Fig. 5-22 Performance evaluation set-up

Ideally the output of this evaluation should be equal to the input signal. The signal envelope should have similar amplitudes and vibrations as input signal envelope. If speech is taken as input acoustic signal, the output should be clearly understandable. On the other hand, in frequency domain the output signal magnitude should have similar characteristics of the input signal magnitude.

### 5.4.2 Simulations of performance evaluation

For the first simulation the impaired hearing assumed to have the audiogram in Fig. 5-23.

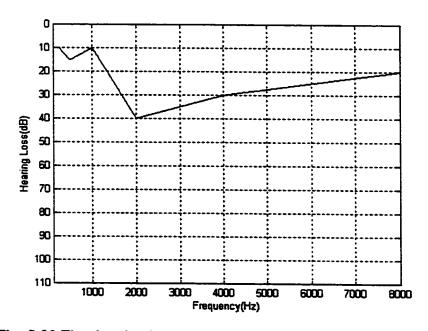


Fig. 5-23 First hearing loss audiogram for performance evaluation

The audiogram frequencies and hearing losses are given in Table 5-1. This has the characteristics of the noise induced hearing loss, which is pointed out in section 2.3.2.1. There is a sharp decrease in hearing around 2 kHz.

In first simulation a speech signal is chosen as the acoustic signal. The time waveform and spectrum of the speech signal are given in Fig. 5-24.

Frequency(Hz)	125	250	500	1000	2000	4000	8000
Hearing Loss(dB)	10	10	15	10	40	30	20

Table 5-1 Audiogram values for first part of simulations

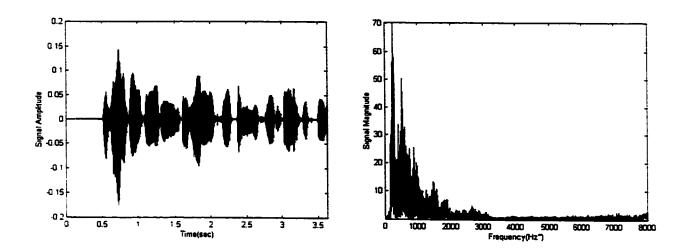


Fig. 5-24 Time waveform and spectrum of the speech signal for performance evaluation.

It is shown in chapter 3 that most of the frequency content of the speech signal lies below 3kHz. The same characteristic is observed for this example too.

To compare the performances of the compression algorithms we have to take the simulation results both in frequency domain and in time domain into consideration. It is very difficult to observe the differences between the responses, if we compare them on the graphs in Fig. 5-24.

It is pointed out in section 5.2.1 that the information bearing part of the input speech is its envelope. Therefore the envelope of the signal is extracted by taking the absolute value of the signal and applying a 30ms long moving average detector on this rectified signal. The same technique is applied also on the spectrum of the signal. The envelope of the time

waveform of the speech signal is given in Fig. 5-25. The envelope of the spectrum of this acoustic signal is given in Fig. 5-26.

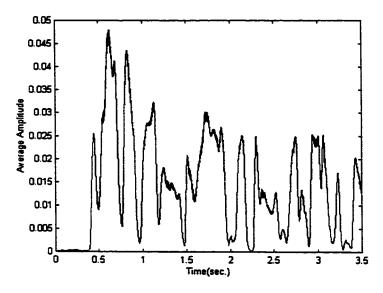


Fig. 5-25 Speech waveform envelope extracted as average amplitude

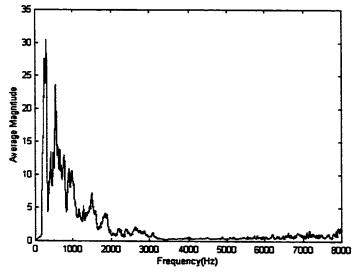


Fig.5-26 Speech spectrum envelope extracted as average magnitude

The first simulation is performed with RangeEar algorithm. The frequency shaping parameters are adjusted according to the sample audiogram given in Fig. 5.23. As shown in evaluation set-up in Fig. 5-22 the output of the hearing instrument is fed into hearing loss simulator, whose impaired hearing threshold parameters are set according to the

audiogram. Normal hearing threshold is taken as 0 dBSPL. The output of evaluation structure is 2103 samples delayed version of the input signal. It is because of the group delay of the hearing instrument filter bank (103 samples) and hearing loss simulator filter bank (2000 samples). To make a healthy comparison the first 2103 samples of the output signal are ignored and the output is plotted starting the 2104<sup>th</sup> sample. The time waveform envelope of the evaluation for RangeEar algorithm is plotted in Fig. 5-27. The solid line shows the output of the system with RangeEar algorithm, whereas the dashed line is the speech envelope given in Fig. 5-25. The amplitudes are not converted to corresponding intensity levels, so that the small variations can be observed clearly.

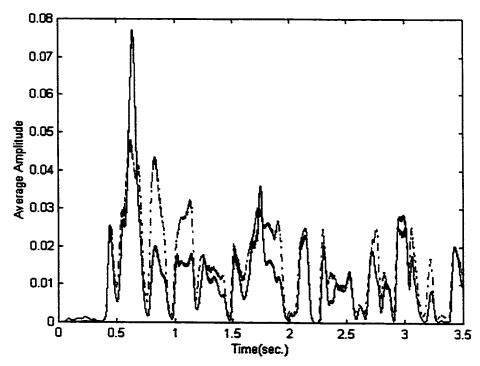


Fig. 5-27 RangeEar time waveform envelope for speech signal

In Fig. 5-27 we observe that the RangeEar envelope deviates around the desired envelope. It gets higher than the desired response around 0.7, 1.7 and 3 sec. On the other hand it lies below the desired envelope most of the time. Because of these fluctuations the

shape of the envelope is distorted. This effects the quality of the speech. In terms of intelligibility it is preferred to have a response slightly higher than the desired response. The RangeEar response drops down to almost half of the target response at 1sec.

The RangeEar spectrum envelope is given in Fig. 5-28. The dashed line shows the target envelope, which is plotted in Fig. 5-26.

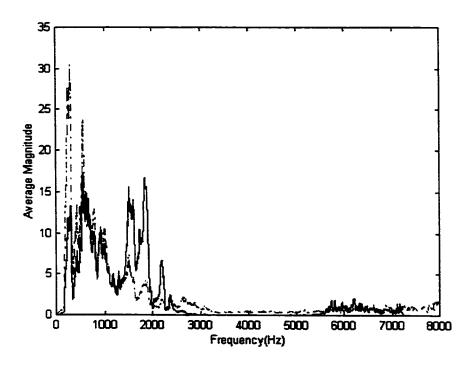


Fig. 5-28 RangeEar spectrum envelope for speech signal

For low frequencies the approximately 10 dB hearing loss can not be compensated successfully with RangeEar algorithm. On the other hand excessive gain is applied to the region between 1 kHz to 2 kHz, where the sharp decrease of hearing threshold occurs. After 3 kHz most of the upper midrange components, which are improving the intelligibility of speech, are lost.

The same speech signal is fed into test system with the homomorphic multiplicative AGC algorithm. The settings of the hearing loss simulator are kept the same and the parameters of the algorithm are set to compensate the hearing loss given in Fig. 5-23.

The time waveform envelope of the test system output with response to the input speech signal is plotted in Fig. 5-29. The same method for RangeEar evaluation is used as the desired response is plotted with dashed lines.

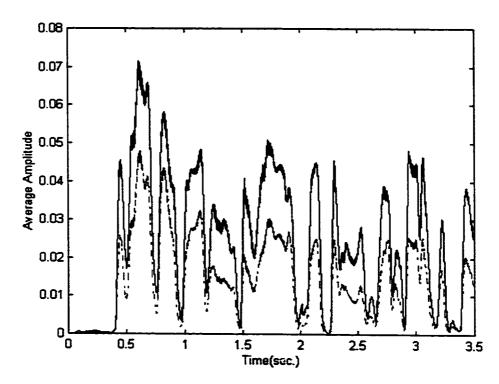


Fig. 5-29 Homomorphic multiplicative AGC time waveform envelope for speech signal We observe that the envelope is constantly higher than the desired envelope. It has almost the same shape as the original speech envelope. The important speech clues are successfully kept. The only defect is the slightly higher intensity level at the output. This defect can be useful in an environment where the speech is getting masked.

The homomorphic multiplicative AGC spectrum envelope is given in Fig. 5-30. The dashed line shows the desired signal average magnitude.

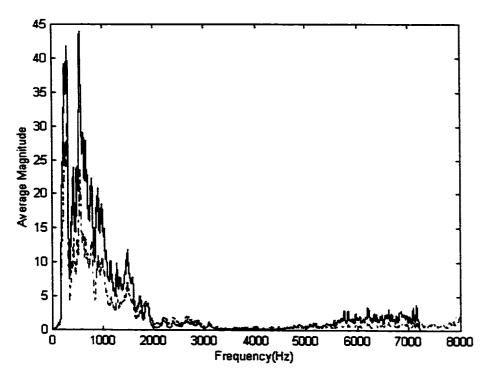


Fig. 5-30 Homomorphic multiplicative AGC spectrum envelope for speech signal

It is observed that the reason of the higher intensity levels in Fig. 5-29 is the excessive amplification of low frequency components up to 2 kHz in Fig. 5-30. The hearing loss after 2 kHz is recovered to the normal level. At higher frequencies above 6 kHz the signal faces an excessive amplification too. The processed envelope has similar shape to the original one.

For the second set of simulations another audiogram is chosen. The audiogram is given in Fig. 5-31. It shows moderate hearing loss at low frequencies up to 1 kHz. Between 1kHz and 2.5 kHz the loss is slight. It gets again to moderate level after 2.5 kHz.

The performances of algorithms are examined with another most commonly heard acoustic signal, the music.

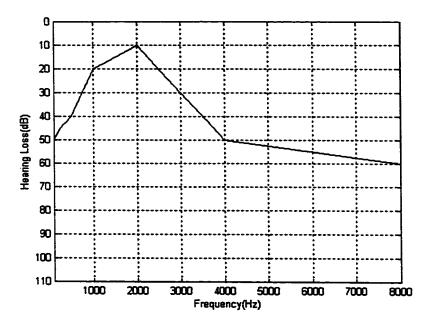


Fig. 5-31 Second hearing loss audiogram for performance evaluation

The audiogram values for the second set of simulations are listed in table 5-2:

Frequency(Hz)	125	250	500	1000	2000	4000	8000
Hearing Loss(dB)	50	45	40	20	10	50	60

Table 5-2 Audiogram values for second part of evaluation

The time waveform and spectrum of the music signal are plotted in Fig. 5-32.

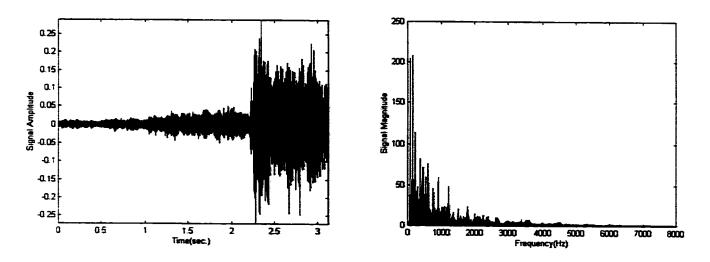


Fig. 5-32 Time waveform and spectrum of the music signal for performance evaluation

From the time waveform of the signal we observe that there is a sudden increase in the intensity level of the signal around 2.2 sec. This is one of the most difficult signals to handle with for hearing instruments. The reason is explained in section 3.2.1. In spectrum of the signal low frequency components are dominant.

The envelopes in time domain and frequency domain are extracted using the same length windows as in first set of simulations. The envelope of the time waveform is given in Fig. 5-33. The spectrum envelope is shown in Fig. 5-34.

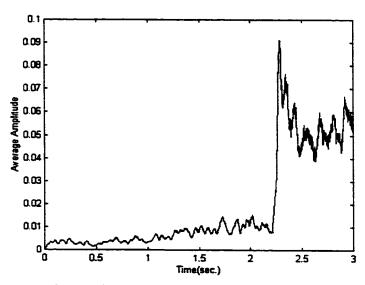


Fig. 5-33 Music time waveform envelope

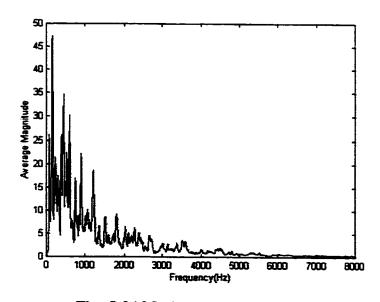


Fig. 5-34 Music spectrum envelope

The music signal is applied to the test system given in Fig. 5.22, which employs the RangeEar algorithm for the first part. The envelope of the output signal is plotted together with the envelope of the input acoustic signal in Fig. 5-35. The solid line gives the RangeEar test system output.

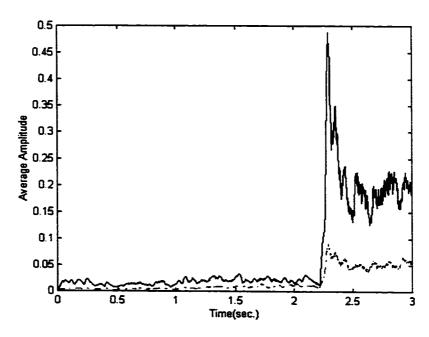


Fig. 5-35 RangeEar time waveform envelope for music

In Fig. 5-35 we observe that the RangeEar envelope is slightly over the desired envelope up to 2.2 sec. After this point the input signal gets a sharp increase and in response to this increase RangeEar envelope also gets a higher value. This time the difference between the desired envelope and RangeEar envelope gets really high. Since twin average detection system recovers really quickly to the transition, this difference is not because of the attack time. The I/O curve of RangeEar in Fig. 5-6 shows that there isn't any limiting applied to high level signals. That means the high intensity signals are tried to be kept as they are, but when a high level signal is multiplied with a slight different factor it can cause discomfort.

The spectrum envelopes of the same simulation are given in Fig. 5-36.

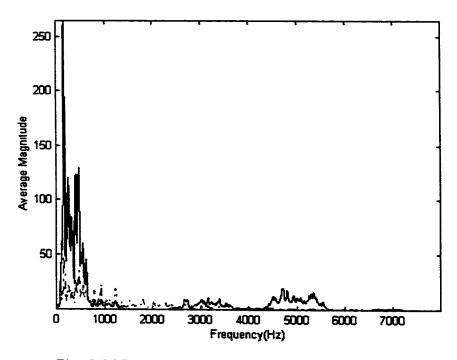


Fig. 5-36 RangeEar spectrum envelope for music signal

The reason of the big difference between the two envelopes in Fig. 5-35 is explained by Fig. 5-36. The RangeEar algorithm applies too much gain to the frequency ranges, which suffer from moderate or severe hearing loss. In the simulation with speech signal the moderate hearing loss is between 1 kHz and 3 kHz and RangeEar spectrum envelope is suffering in that range as shown in Fig. 5-28. For this simulation the same frequency range is the only part of the spectrum with slight hearing loss. Therefore the RangeEar envelope lies under the desired envelope only in this region. In the rest of the spectrum it is above the desired response.

The response of the system with homomorphic multiplicative AGC algorithm to music signal is observed. The first plotting is the time waveform envelopes of homomorphic signal and desired signal. They are plotted in Fig. 5-37.

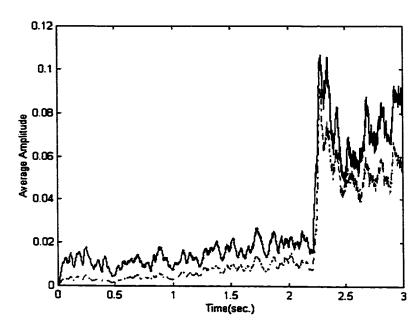


Fig. 5-37 Homomorphic multiplicative AGC time waveform envelope for music signal

The homomorphic multiplicative AGC algorithm shows the same characteristics it has shown for speech signal. The signal envelope characteristics are preserved and the algorithm response is slightly higher than the desired response. The effect of the algorithm is also examined in frequency domain as plotted in Fig. 5-38.

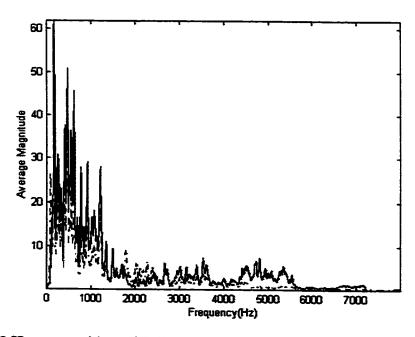


Fig. 5-38 Homomorphic multiplicative AGC spectrum envelope for music signal

In Fig. 5-38 we observe that the homomorphic spectrum envelope almost coincides with the desired envelope. For the slight hearing loss range the spectrum envelope is slightly lying below the desired envelope. At the upper frequency moderate hearing loss range the envelope of homomorphic algorithm signal is slightly above the desired spectrum envelope.

#### 5.5 Discussion

The RangeEar algorithm has the comfort of setting only the hearing loss amount read from the audiogram into frequency shaping. The algorithm makes the necessary compression adjustments by itself. The performance evaluation simulations show that the calibration is not very successful. There are couple reasons for that. The most important one is the fact that the algorithm applies two-channel compression. For a hearing loss with sharp slopes the compression should be different at very close frequencies. That means not only for frequency shaping, also for compression we need high frequency resolution. The reason of using two-channel compression system is not to distort the input speech signal. It has been seen that for hearing losses with rapidly varying audiograms the two-channel compression is more harmful than protective for speech. Taking the averages of three channels or the maximum of four channels into consideration degrades the frequency resolution for compression drastically.

The original homomorphic multiplicative AGC suffers from the fact that it doesn't utilize any kneepoints of compression. From the starting point till completion point the compression ratio is constant. This problem is solved by introducing nonlinear compression ratio through the addition of weighting function in cepstrum domain. The

signals below the lower kneepoint are expanded. On the other hand when the I/O curve gets closer to the completion point of the algorithm, which is the UCL, the compression ratio increases rapidly and applies compressive clipping to the input signal. That means by using high compression ratios the output signal is not allowed to pass the completion point. The performance of the algorithm is observed in simulations. The response is slightly higher than the desired one, but carries the same envelope characteristics.

In simulations both RangeEar and homomorphic multiplicative AGC algorithms are equipped with twin average detection system. The successful operation of this detection system is observed especially in music signal simulations.

The quantitative observations show the improved homomorphic multiplicative AGC algorithm as the best choice. The qualitative analysis, which is performed by listening the output of the hearing loss simulator, supports the choice.

### 5.6 Overall Discussion

DynamEQ-II hearing instrument has the drawback of low frequency resolution because of its two-band filter bank structure. Therefore digital filter bank algorithms are studied and 8-band 60 dB IFIR (interpolated finite impulse response) filter bank is selected as the optimum solution. The MPU (multiplications per unit time), APU (additions per unit time) and group delay characteristics of the studied filter bank structures determine the choice. Two state-of-the-art compression algorithms are studied and a new improved compression algorithm is achieved by intensity level dependant homomorphic multiplication. The improvement is demonstrated by employing MIT hearing loss simulator. Both quantitative and qualitative analyses support the choice of modified

homomorphic multiplicative AGC (automatic gain control). It is observed that multichannel signal processing is necessary not only for frequency shaping but also dynamic range compression.

## Chapter 6

### **CONCLUSIONS**

- 1. A sophisticated SIMULINK model, involving the use of audio files (16 bit \*.wav), was developed to evaluate the performance characteristics of the strategies and algorithms used in the DynamEQ-II hearing instrument from the Gennum Corporation of Burlington, Ontario. The simulator exhibited the same input-output audio responses as the DynamEQ-II.
- 2. The two-band filter bank used in the DynamEQ-II hearing instrument limits the resolution in the frequency domain required to compensate hearing loss more accurately. A high resolution digital filter bank has been developed that uses eight distinct bands designed using an interpolated finite impulse response (IFIR) prototype filter that has been optimized using delay elements to reduce the phase distortion so as to give a maximally flat overall magnitude response. The resulting group delay is a constant and less than the value where self-hearing and "lip reading" problems would occur.
- 3. A sophisticated SIMULINK model, involving the use of audio files (16 bit \*.wav), was developed to evaluate the performance characteristics of the RangeEAr algorithm as employed in the DigiFocus hearing instrument from the Oticon Company. The simulator incorporated the compression algorithm based on the pure tone loudness model.

- 4. An existing homomorphic multiplicative compression algorithm to provide automatic gain control (AGC) was studied and improved. The new compression algorithm is also based on a model of the human auditory system, but instead of multiplying the signal, after it has been transformed into the Cepstrum Domain, by a constant the new algorithm utilizes an acoustic signal intensity level weighted multiplication. The resulting nonlinear compression ratio expands low level signals and compresses high level signals in such a manner as to improve the signal to noise ratio and the intelligibility of the sound.
- 5. The use of the MIT hearing loss simulator was found to be a comprehensive and sophisticated tool to evaluate the effectiveness of the new proposed digital filter bank and compression algorithm for use in a hearing instrument, through both analysis and listening to actual test audio files.

#### 6-1 Future Work

The cascade of the 8-band filterbank with 60 dB noise floor and modified homomorphic multiplicative AGC should be implemented in hardware to evaluate the performance with field test, where patients with sensorineural hearing loss are employed.

The hardware implementation of these algorithms can employ MEMS microphones and actuators to carry the hearing instrument further inside the ear into middle ear, as explained in [66].

The control of the parameters of the digital hearing instrument can be achieved through wireless technology, which can co-operate with internet to bring more comfort to the hearing impaired individual.

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## Appendix I

### MATLAB CODE FOR HRTF DATA PLOTTING

```
%Using Shaw's azimuthal dependance results magnitude responses
%of different azimuths are plotted
T1 = [
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 ;
0.4 0.4 0.5 0.5 0.8 1.1 1.4 1.4 1.4 1.3 1.4 1.4 1.5 1.5 1.4;
0.7 0.8 1.0 1.1 1.7 2.2 2.6 2.6 2.6 2.5 2.6 2.7 2.9 2.8 2.7;
1.0 1.2 1.4 1.5 2.4 3.2 3.6 3.6 3.5 3.5 3.7 3.8 4.0 3.9 3.7;
1.3 1.5 1.8 1.9 2.8 3.8 4.3 4.3 4.3 4.4 4.5 4.7 4.9 4.9 4.7;
1.5 1.7 2.1 2.2 3.2 4.3 4.8 4.8 4.8 4.9 5.1 5.3 5.7 5.7 5.5;
1.6 1.8 2.2 2.3 3.4 4.5 5.0 5.0 5.0 5.1 5.3 5.6 6.1 6.1 5.7;
1.6 1.8 2.1 2.2 3.3 4.3 4.8 4.9 4.9 5.0 5.2 5.5 6.1 6.0 5.5;
1.4 1.6 1.9 2.0 3.0 3.9 4.4 4.5 4.6 4.7 5.0 5.4 6.0 5.9 5.4:
1.1 1.3 1.5 1.6 2.4 3.1 3.5 3.6 3.8 4.1 4.5 5.0 5.9 5.9 5.4;
0.7 0.8 0.9 0.9 1.4 2.0 2.4 2.5 2.7 3.2 3.7 4.3 5.2 5.2 5.0;
0.2 0.1 0 0 0.3 0.7 1.1 1.2 1.4 1.9 2.6 3.3 4.1 4.1 3.9 ;
-.2 -.5 -.7 .7 -.6 -.4 -.3 -.1 0.4 1.1 1.8 2.3 2.3 2.1;
-.5 -.9 -1.2 -1.3 -1.6 -1.7 -1.6 -1.6 -1.4 -1.2 -.8 -.3 0.2 0.2 0.2;
-.8 -1.3 -1.7 -1.8 -2.2 -2.5 -2.6 -2.6 -2.7 -2.8 -2.9 -2.8 -2.3 -2.2
-2.0;
-1.1 -1.5 -1.8 -1.9 -2.2 -2.5 -3.0 -3.1 -3.5 -3.9 -4.3 -4.5 -4.5 -4.5
-4.5;
-1.4 -1.6 -1.7 -1.7 -1.9 -2.0 -2.5 -2.6 -2.9 -3.2 -3.4 -3.6 -3.9 -4.1
-5.2;
-1.6 -1.6 -1.5 -1.5 -1.4 -1.4 -1.7 -1.8 -1.9 -2.0 -2.0 -2.0 -2.1 -2.4
-3.8;
-1.6 -1.5 -1.4 -1.4 -1.2 -1.0 -1.2 -1.3 -1.5 -1.5 -1.4 -1.2 -1.0 -1.1
-1.7;
-1.5 -1.4 -1.4 -1.4 -1.4 -1.4 -1.6 -1.7 -2.0 -2.3 -2.4 -2.5 -2.9 -3.1
-4.0;
-1.3 -1.3 -1.4 -1.4 -1.8 -2.2 -2.5 -2.6 -2.9 -3.4 -3.9 -4.4 -5.9 -6.3
-7.1;
-1.0 -1.1 -1.3 -1.4 -1.9 -2.4 -2.9 -3.0 -3.4 -4.1 -4.8 -5.4 -6.3 -6.3
-6.1;
-0.7 -0.8 -1.0 -1.1 -1.5 -2.0 -2.4 -2.5 -2.8 -3.2 -3.6 -3.9 -4.0 -3.9
-3.6;
-0.4 -0.4 -0.5 -0.5 -0.8 -1.1 -1.3 -1.3 -1.4 -1.6 -1.8 -1.9 -1.8 -1.8
-1.6;
1;
T2 = [
1.3 1.2 1.2 1.3 1.5 1.8 2.0 2.1 2.2 2.2 2.1 2.1 2.4 2.6 2.6;
2.5 2.3 2.3 2.4 2.8 3.1 3.5 3.7 3.9 3.7 3.5 3.8 4.5 5.0 5.1 ;
3.4 3.1 3.0 3.2 3.6 4.1 4.6 4.8 4.8 4.3 4.0 4.6 5.8 6.8 7.4 ;
4.2 3.7 3.3 3.5 4.0 4.6 4.9 4.8 4.6 3.8 3.3 4.4 6.2 7.7 8.8 ;
4.6 3.6 2.9 3.0 3.5 4.0 4.1 4.0 3.5 2.5 1.8 3.0 5.6 7.9 9.4 ;
4.5 3.1 2.0 1.7 2.1 2.4 2.4 2.3 1.9 0.7 -0.3 0.8 4.0 7.0 9.3 ;
```

```
4.1 2.2 0.8 -0.2 -0.2 0 0.1 0.1 -0.1 -1.2 -2.4 -1.7 1.7 4.8 7.7 ;
3.9 2.0 0.2 -1.3 -1.5 -1.4 -1.2 -1.2 -1.4 -2.3 -4.3 -4.2 -1.0 2.0 4.8 ;
4.0 2.2 0.4 -1.6 -1.9 -1.8 -1.8 -1.8 -1.9 -2.7 -5.2 -6.0 -3.8 -0.8 1.7;
3.8 2.2 0.6 -0.9 -1.5 -1.4 -1.3 -1.3 -1.4 -2.5 -4.9 -5.9 -4.9 -3.0
-1.0;
2.8 1.2 -0.2 -1.2 -1.5 -1.6 -1.5 -1.4 -1.5 -2.4 -4.3 -5.3 -4.9 -4.2
1.3 -0.2 -1.6 -2.5 -2.6 -2.5 -2.5 -2.5 -2.6 -3.4 -5.0 -5.4 -4.5 -5.0
-5.1;
-0.4 -2.0 -3.4 -4.3 -4.4 -4.3 -4.2 -4.2 -4.4 -5.3 -6.7 -6.6 -5.8 -6.4
-6.7;
-2.4 -3.8 -5.4 -6.5 -6.6 -6.6 -6.7 -6.7 -6.9 -7.8 -9.1 -9.2 -8.7 -9.0
-9.4;
-4.9 -6.2 -7.8 -9.0 -9.1 -9.1 -9.2 -9.5 -10.6 -12.3 -12.2 -11.4
-11.6 -11.9 ;
-7.1 -8.9 -10.0 -10.5 -10.6 -10.6 -10.8 -10.9 -11.3 -12.5 -13.8 -13.6
-12.8 -12.3 -12.5 ;
-5.8 -7.7 -9.0 -9.7 -10.0 -10.2 -10.6 -10.8 -11.3 -12.5 -13.8 -13.6
-12.6 -12.0 -12.2 ;
-3.1 -5.1 -6.9 -8.0 -8.3 -8.4 -8.8 -9.1 -9.9 -11.2 -13.2 -13.0 -11.9
-11.5 -11.4 ;
-5.9 -6.8 -7.0 -6.8 -7.0 -7.2 -7.7 -8.1 -8.9 -10.7 -12.9 -12.7 -11.7
-11.3 -11.1;
-7.3 -6.6 -6.0 -6.2 -6.6 -6.9 -7.0 -7.2 -8.0 -10.0 -11.9 -11.9 -11.1
-11.0 -10.9 ;
-5.3 -4.5 -4.3 -5.1 -5.8 -6.0 -6.0 -6.1 -6.7 -8.1 -9.3 -9.0 -8.6 -8.8
-8.9 ;
-3.1 -2.8 -2.7 -3.4 -3.9 -4.2 -4.4 -4.5 -4.8 -5.2 -5.8 -5.7 -5.6 -5.6
-5.5 ;
-1.4 -1.3 -1.3 -1.6 -1.9 -2.1 -2.3 -2.4 -2.4 -2.5 -2.6 -2.6 -2.6 -2.6
-2.6;
1;
T3 = [
000000000000;
2.6 2.6 2.4 2.3 2.1 2.1 2.1 2.2 2.3 2.4 2.3 2.0 1.2 ;
5.1 5.0 4.8 4.4 4.0 3.8 3.7 3.7 3.7 3.6 3.3 2.8 1.6 ;
7.4 7.3 7.0 6.3 5.6 5.1 4.7 4.4 4.4 4.3 3.7 3.0 1.6 ;
8.9 8.9 8.5 7.9 7.0 6.3 5.6 5.0 4.7 4.4 4.0 3.3 2.3 ;
9.9 10.0 9.7 9.1 8.1 7.2 6.4 5.9 5.4 5.2 5.1 5.0 5.0 ;
10.1 10.3 10.0 9.5 8.7 7.7 7.0 6.4 6.2 6.4 6.8 7.4 8.2 ;
8.8 9.2 9.0 8.6 7.9 7.2 6.7 6.4 6.4 6.6 7.3 8.0 9.0 ;
6.3 7.0 7.2 6.9 6.3 5.9 5.5 5.5 5.7 6.0 6.7 7.3 8.0 ;
3.3 4.0 4.6 4.3 3.8 3.4 3.3 3.6 4.0 4.5 5.1 5.6 6.2 ;
0.1 0.7 1.8 1.6 1.0 0.7 0.8 1.1 1.6 2.1 2.6 3.1 3.7 ;
-2.7 -2.2 -0.8 -1.0 -1.4 -1.8 -1.8 -1.5 -1.0 -0.7 -0.2 -0.2 0.5 ;
-4.8 -4.5 -3.2 -3.2 -3.8 -4.2 -4.4 -4.4 -4.0 -3.7 -3.3 -2.9 -2.5 ;
-6.6 -6.4 -5.7 -5.6 -5.9 -6.4 -6.8 -7.0 -6.9 -6.7 -6.3 -5.9 -5.2 ;
-9.3 -9.0 -8.1 -8.0 -8.2 -8.8 -9.3 -9.6 -9.7 -9.6 -9.4 -9.0 -8.5 ;
-11.7 -11.4 -10.6 -10.2 -10.5 -11.0 -11.9 -12.5 -12.9 -13.0 -12.9
-12.4 -11.6;
-12.4 -12.1 -11.5 -11.2 -11.5 -12.3 -13.3 -14.1 -14.6 -14.8 -14.8
-14.3 - 13.9;
-12.0 -11.7 -10.7 -10.4 -10.9 -11.9 -13.0 -13.9 -14.5 -14.8 -15.0
-14.8 -14.5 ;
-11.1 -10.6 -9.3 -8.9 -9.0 -9.6 -10.7 -12.0 -13.1 -13.7 -14.0 -14.2
-14.2;
```

```
-10.8 -10.4 -8.8 -8.0 -8.0 -8.9 -10.0 -11.0 -11.8 -12.1 -12.3 -12.2
-12.0:
-10.6 -10.2 -8.8 -8.2 -8.3 -9.0 -10.0 -11.0 -11.3 -11.3 -11.0 -10.0
-9.0;
-8.7 -8.4 -7.8 -7.6 -7.7 -8.7 -9.8 -10.7 -10.8 -10.4 -9.6 -8.1 -6.5;
-5.5 -5.5 -5.4 -5.2 -5.0 -5.4 -6.3 -7.0 -7.3 -7.0 -6.4 -5.1 -4.0 ;
-2.6 -2.6 -2.6 -2.5 -2.4 -2.4 -2.7 -3.0 -3.1 -3.0 -2.8 -2.3 -1.6;
1;
FF1 = [
0.5 1.0 1.3 1.4 1.5 1.8 2.3 2.4 2.8 3.1 3.0 2.6 2.7 3.0 4.1
1;
FF2 = [
6.1 9.0 12.0 15.9 16.8 16.8 15.8 15.4 14.9 14.7 14.3 12.8 10.7 8.9 7.3
];
6.4 5.8 4.3 3.1 1.8 0.5 -0.6 -1.7 -1.7 2.5 6.8 8.4 8.5
1;
F1 = [
0.2 0.25 0.3 0.32 0.4 0.5 0.6 0.63 0.7 0.8 0.9 1.0 1.2 1.25 1.4
1;
F2 = [
1.6 1.8 2.0 2.3 2.5 2.7 2.9 3.0 3.2 3.5 4.0 4.5 5.0 5.5 6.0
1;
F3 = [
6.3 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0 10.5 11.0 11.5 12.0
a = [0:15:345];
                        % Azimuth
D = [T1 \ T2 \ T3];
                        % Data matrix from Shaw
FF = [FF1 FF2 FF3];
                        % Free field to eardrum at 0 azimuth
F = [F1 F2 F3];
                        % Frequency
Fav=0;
for m=1:13
   Fav=Fav+D(m,:);
end
Fav=Fav./13;
Fav=Fav+FF;
figure
plot(F, Fav)
title('Average Frequency Response in the range of 0 to 180 degree');
ylabel('Magnitude Response (dBSPL)');
xlabel('Frequency(kHz)');
F30=D(3,:)+FF;
F60=D(5.:)+FF:
F90=D(7,:)+FF;
F120=D(9,:)+FF;
F150=D(11,:)+FF;
F180=D(13,:)+FF;
figure
plot(F,FF,'y',F,F30,'m',F,F60,'c',F,F90,'r',F,F120,'g',F,F150,'b',F,F18
0,'k')
```

```
%set(figure(1),'NumberTitle','off','Name','Magnitude Response 0-180');
title('magnitude');
ylabel('dBSPL');
xlabel('Frequency(kHz)');
text(2,4.5,'-yellow:0 azim');
text(2,3,'-magenta:30 azim');
text(2,1.5,'-cyan:60 azim');
text(2,0,'-red:90 azim');
text(2,-1.5,'-green:120 azim');
text(2,-3,'-blue:150 azim');
text(2,-4.5,'-black:180 azim');
zoom on
axis tight
F210=D(15,:)+FF;
F240=D(17,:)+FF;
F270=D(19,:)+FF;
F300=D(21,:)+FF;
F330=D(23,:)+FF;
figure
plot(F,F180,'y',F,F210,'m',F,F240,'c',F,F270,'r',F,F300,'g',F,F330,'b',
F, FF, 'k')
%set(figure(2),'NumberTitle','off','Name','Magnitude Response 180-
360');
title('magnitude');
ylabel('dB SPL');
xlabel('freq, kHz');
text(2,-5,'-yellow:180 azim');
text(2,-6.5,'-magenta:210 azim');
text(2,-8,'-cyan:240 azim');
text(2,-9.5,'-red:270 azim');
text(2,-11,'-green:300 azim');
text(2,-12.5,'-blue:330 azim');
text(2,-14,'-black:360(=0) azim');
M = ones(24, 43);
for i=1:24
   M(i,:)=FF;
end
MM=M+D;
theta=0:15:345;
figure
surface (F, theta, MM)
%set(figure(3),'NumberTitle','off','Name','3-D Plot of Magnitude
Responses');
xlabel('Frequency(kHz)');
ylabel('Theta(Degree)');
zlabel('Magnitude Response(dBSPL)');
zoom on
view(45,45)
axis tight
```

# Appendix II

## **OPTIMIZATION OF DELAY CHARACTERISTICS IN IFIR**

```
load hl
load hic
load h2
load h2c
load h3
load h3c
load h4
load h4c
load h5
load h5c
load h6
load h6c
load h7
load h7c
load h8
B1=conv(conv(h1,h2),conv(h4,h8));
B2=conv(conv(h1,h2),h4c);
B3=conv(conv(h1,h2c),h5);
B4=conv(conv(h1,h2c),h5c);
B5=conv(conv(h1c,h3),h6);
B6=conv(conv(h1c,h3),h6c);
B7=conv(conv(hlc,h3c),h7);
B8=conv(conv(h1c,h3c),h7c);
[H1,F] = FREQZ(B1,1,2000,12000);
[H3,F] = FREQZ(B3,1,2000,12000);
[H4,F] = FREQZ(B4,1,2000,12000);
[H5,F] = FREQZ(B5,1,2000,12000);
[H6,F] = FREQZ(B6,1,2000,12000);
[H7,F] = FREQZ(B7,1,2000,12000);
[H8,F] = FREQZ(B8,1,2000,12000);
Ec=100;
for i=0:24
   d=zeros(1,1+i):
   d(1+i)=1.0;
   B2d=conv(B2,d);
   [H2,F] = FREQZ(B2d,1,2000,12000);
   H=H1+H2+H3+H4+H5+H6+H7+H8;
   I=ones(250,1);
   E=sum(abs(I-abs(H(876:1125))));
   if E<Ec
      Ec=E;
      In=i;
   end
end
Ec=100;
In
```

```
d2 = zeros(1,12);
d2(12)=1;
B2d=conv(B2,d2);
[H2,F] = FREQZ(B2d,1,2000,12000);
for i=0:24
   d=zeros(1,1+i);
   d(1+i)=1.0;
   B3d=conv(B3,d);
   [H3,F] = FREQZ(B3d,1,2000,12000);
   H=H1+H2+H3+H4+H5+H6+H7+H8;
   I=ones(675,1);
   E=sum(abs(I-abs(H(451:1125))));
   if E<Ec
      Ec=E;
      In2=i;
   end
end
In2
Ec=100;
d2=zeros(1,12);
d3=zeros(1,13);
d5=zeros(1,13);
d2(12)=1;
d3(13)=1;
d5(13)=1;
B2d=conv(B2,d2);
B3d=conv(B3,d3);
B5d=conv(B5,d5);
[H2,F] = FREQZ(B2d,1,2000,12000);
[H3,F] = FREQZ(B3d,1,2000,12000);
[H5,F] = FREQZ(B5d,1,2000,12000);
for i=0:24
   d=zeros(1,1+i);
   d(1+i)=1.0;
   Bld=conv(B1,d);
   [H1,F] = FREQZ(Bld,1,2000,12000);
   H=H1+H2+H3+H4+H5+H6+H7+H8;
   I=ones(1125,1);
   E=sum(abs(I-abs(H(1:1125))))
   if E<Ec
      Ec=E;
      In4=i;
   end
end
In4
Ec=100;
d2=zeros(1,12);
d3=zeros(1,13);
d5=zeros(1,13);
d1=zeros(1,11);
d2(12)=1;
d3(13)=1;
d5(13)=1;
d1(11)=1;
B2d=conv(B2,d2);
B3d=conv(B3,d3);
B5d=conv(B5,d5);
```

```
Bld=conv(Bl,dl);
[H2,F] = FREQZ(B2d,1,2000,12000);
[H3,F] = FREQZ(B3d,1,2000,12000);
[H5,F] = FREQZ(B5d,1,2000,12000);
[H1,F] = FREQZ(Bld,1,2000,12000);
for i=0:24
   d=zeros(1,1+i);
   d(1+i)=1.0;
   B4d=conv(B4,d);
   [H4,F] = FREQZ(B4d,1,2000,12000);
   H=H1+H2+H3+H4+H5+H6+H7+H8;
   I=ones(1550,1);
   E=sum(abs(I-abs(H(1:1550))))
   if E<Ec
      Ec=E;
      In5=i;
   end
end
In5
d2=zeros(1,12);
d3=zeros(1,13);
d5=zeros(1,13);
dl=zeros(1,11);
d4=zeros(1,13);
d2(12)=1;
d3(13)=1;
d5(13)=1;
d1(11)=1;
d4(13)=1;
B2d=conv(B2,d2);
B3d=conv(B3,d3);
B5d=conv(B5,d5);
Bld=conv(Bl,dl);
B4d=conv(B4,d4);
[H2,F] = FREQZ(B2d,1,2000,12000);
[H3,F] = FREQZ(B3d,1,2000,12000);
[H5,F] = FREQZ(B5d,1,2000,12000);
[H1,F] = FREQZ(B1d,1,2000,12000);
[H4,F] = FREQZ(B4d,1,2000,12000);
for i=0:24
   d=zeros(1,1+i);
   d(1+i)=1.0;
   B6d=conv(B6,d);
   [H6,F] = FREQZ(B6d,1,2000,12000);
   H=H1+H2+H3+H4+H5+H6+H7+H8;
   I=ones(1810,1);
   E=sum(abs(I-abs(H(1:1810))))
   if E<Ec
      Ec=E;
      In6=i;
   end
enđ
In6
```

## **Appendix III**

### MATLAB CODE FOR EIGENFILTER DESIGN

```
wp=0.035*pi;
ws=0.09*pi;
alpha=0.5;
N=32; *this is actually (N-1)/2
for n=0:1:N
   for m=0:1:N
      if n==0&m==0
         A=0;
         B=0;
         C=pi;
         D=ws;
      elseif n==0 | m==0
         A=0;
         B=0;
         x=pi;
         C=1/2*sin((-n+m)*x)/(-n+m)+1/2*sin((n+m)*x)/(n+m);
         D=1/2*sin((-n+m)*x)/(-n+m)+1/2*sin((n+m)*x)/(n+m);
      elseif n==m
         x=wp;
         A=x-2*sin(n*x)/n+(1/2*cos(n*x)*sin(n*x)+1/2*n*x)/n;
         B=x-2*sin(n*x)/n+(1/2*cos(n*x)*sin(n*x)+1/2*n*x)/n;
         x=pi;
         C=(1/2*cos(n*x)*sin(n*x)+1/2*n*x)/n;
         D=(1/2*cos(n*x)*sin(n*x)+1/2*n*x)/n;
      else
         x=wp;
         A=x-\sin(m^*x)/m-\sin(n^*x)/n+1/2*\sin((-n+m)^*x)/(-n+m)^*x
n+m) +1/2*sin((n+m)*x)/(n+m);
         x=0;
         B=x-\sin(m*x)/m-\sin(n*x)/n+1/2*\sin((-n+m)*x)/(-n+m)*x
n+m) +1/2*sin((n+m)*x)/(n+m);
         x=pi;
         C=1/2*sin((-n+m)*x)/(-n+m)+1/2*sin((n+m)*x)/(n+m);
         D=1/2*sin((-n+m)*x)/(-n+m)+1/2*sin((n+m)*x)/(n+m);
      P(n+1,m+1) = ((1-alpha)/pi)*(A-B)+(alpha/pi)*(C-D);
   end
end
[v,d]=eig(P)
[Y, I] =min(diag(d, 0));
b=v(:,I)
L=length(b);
```

```
h=ones((2*L)-1,1);
h(L)=b(1);
h(L+1:1:length(h))=b(2:1:L)/2;
h((L-1):-1:1)=b(2:1:L)/2
freqz(h)
```

## **Appendix IV**

# SIMULINK CODE OF HOMOMORPHIC MULTIPLICATIVE AGC ALGORITHM WITH 8-BAND IFIR FILTER BANK

Important Note: Because of the excessive length of simulink codes only this simulators code is given.

```
Model {
                                                  SignalLabelMismatchMsg *none*
                "sonic"
                                                                        off.
 Name
                                                  ConsistencyChecking
  Version
                3.00
                                                  ZeroCross
                                                                on
  SimParamPage
                   "Solver"
                                                  SimulationMode
                                                                     "normal"
  SampleTimeColors off
                                                  BlockDataTips
  InvariantConstants
                       off
                                                  BlockParametersDataTip on
  WideVectorLines off
                                                  BlockAttributesDataTip off
  ShowLineWidths
                   off
                                                  BlockPortWidthsDataTip off
  ShowPortDataTypes
                       off
                                                  BlockDescriptionStringDataTip
                *0.0*
                                                  BlockMaskParametersDataTip off
  StartTime
                *3.6251*
  StopTime
                                                  ToolBar
                                                                on
  SolverMode
                   *Auto*
                                                  StatusBar
                                                                on
               "ode45"
  Solver
                                                  BrowserShowLibraryLinks off
                "1e-3"
  RelTol
                                                  BrowserLookUnderMasks
                                                                           off
                "auto"
  AbsTol
                                                  OptimizeBlockIOStorage on
                -1-
  Refine
                                                  BufferReuse
                                                                    on
                "auto"
  MaxStep
                                                  BooleanDataType
                                                                    off
  InitialStep
                    "auto"
                                                                       "grt.tlc"
                                                  RTWSystemTargetFile
  FixedStep
                "auto"
                                                  RTWInlineParameters
                                                                        off
  MaxOrder
                                                  RTWRetainRTWFile
                                                                   off
  OutputOption
                    "RefineOutputTimes"
                                                  RTWTemplateMakefile
  OutputTimes
                                                "grt_default_tmf"
  LoadExternalInput
                        off
                                                  RTWMakeCommand
                                                                    "make_rtw"
  ExternalInput
                        "[t, u]"
                                                  RTWGenerateCodeOnly off
  SaveTime
                on
                                                                    "ext_comm"
                                                  ExtModeMexFile
  TimeSaveName 'SaveState off
                                                  ExtModeBatchMode off
                    "tout"
                                                  ExtModeTrigType
                                                                     "manual"
  StateSaveName
                        "xout"
                                                                    "oneshot"
                                                  ExtModeTrigMode
  SaveOutput
                    on
                                                  ExtModeTrigPort
  OutputSaveName
                    "yout"
                                                  ExtModeTrigElement
                                                                        "any"
  LoadInitialState
                    off
                                                  ExtModeTrigDuration
                                                                        1000
  InitialState
                    "xInitial"
                                                  ExtModeTrigHoldOff
                                                                        0
  SaveFinalState
                    off
                                                  ExtModeTrigDelay 0
  FinalStateName
                    "xFinal"
                                                  ExtModeTrigDirection
                                                                       "rising"
                    "Matrix"
  SaveFormat
                                                  ExtModeTrigLevel 0
  LimitMaxRows
                    off
                                                  ExtModeArchiveMode
                -1000-
  MaxRows
                                                  ExtModeAutoIncOneShot
                                                                           off
  Decimation
                    -1-
                                                  ExtModeIncDirWhenArm off
  AlgebraicLoopMsg "warning"
                                                  ExtModeAddSuffixToVar
                                                                           off
  MinStepSizeMsg
                    "warning"
                                                  ExtModeWriteAllDataToWs off
  UnconnectedInputMsg "warning"
                                                  ExtModeArmWhenConnect
                                                                           off
  UnconnectedOutputMsg *warning*
                                                  Created
                                                                "Mon Nov 06 14:32:34
  UnconnectedLineMsg
                        "warning"
                                                2000*
  InheritedTsInSrcMsg
                                                  UpdateHistory
                        "warning"
  IntegerOverflowMsg
                        "warning"
                                                "UpdateHistoryNever"
  UnnecessaryDatatypeConvMsg *none*
                                                 ModifiedByFormat
                                                                    "%<Auto>"
  Int32ToFloatConvMsg
                        "warning"
                                                  LastModifiedBy
```

```
ModifiedDateFormat
                         "%<Auto>"
                                                         BackgroundColor
                                                                                 "red"
                     *Tue Dec 19 23:55:55
  LastModifiedDate
                                                         Value
                                                                         -10-
2000*
  ModelVersionFormat
                                                       Block (
"1.%<AutoIncrement:16>"
                                                         BlockType
                                                                                 Constant
                                                                         "HL4"
  ConfigurationManager
                         "none"
                                                         Name
  BlockDefaults {
                                                         Position
                                                                             [265, 359, 290,
                                                   381]
    Orientation
                            "right"
    ForegroundColor
                            "black"
                                                         BackgroundColor
                                                                                 "red"
    BackgroundColor
                            "white"
                                                                         *15*
                                                         Value
                        off
    DropShadow
    NamePlacement
                        "normal"
                                                       Block {
                                                         BlockType
    FontName
                        "Helvetica"
                                                                                 Constant
    FontSize
                                                                          "HL5"
                        10
                                                         Name
    FontWeight
                        "normal"
                                                         Position
                                                                            [270, 449, 295,
    FontAngle
                        "normal"
                                                   4711
    ShowName
                        on
                                                         BackgroundColor
                                                                                 "red"
                                                          Value
  AnnotationDefaults {
                                "center"
    HorizontalAlignment
                                                        Block {
                                                         BlockType
    VerticalAlignment
                            "middle"
                                                                                 Constant
    ForegroundColor
                            "black"
                                                         Name
                                                                          "HL6"
    BackgroundColor
                            "white"
                                                                             [270, 539, 295,
                                                          Position
    DropShadow
                        off
                                                   561]
    FontName
                        "Helvetica"
                                                                                 "red"
                                                          BackgroundColor
    FontSize
                        10
                                                                          -10-
                                                         Value
    FontWeight
                        "normal"
    FontAngle
                        "normal"
                                                        Block {
                                                          BlockType
                                                                                 Constant
  LineDefaults {
                                                                          "HL7"
                                                          Name
    FontName
                        "Helvetica"
                                                          Position
                                                                             [270, 629, 295,
    FontSize
                                                   6511
    FontWeight
                        "normal"
                                                          BackgroundColor
                                                                                  "red"
    FontAngle
                        "normal"
                                                          Value
  System {
                                                        Block {
    Name
                    "sonic"
                                                          BlockType
                                                                                 Constant
    Location
                        [8, 74, 1028, 724]
                                                                          "HL8"
                                                          Name
    Open
                    on
                                                          Position
                                                                             [275, 719, 300,
    ModelBrowserVisibility off
                                                   741]
    ModelBrowserWidth
                          200
                                                                                  "red"
                                                          BackgroundColor
    ScreenColor
                            "lightBlue"
                                                          Value
                            "landscape"
    PaperOrientation
    PaperPositionMode
                            "auto"
                                                        Block (
    PaperType
                        "usletter"
                                                          BlockType
                                                                                 Constant
    PaperUnits
                        "inches"
                                                                          "NHT1"
                                                          Name
                        *84*
    ZoomFactor
                                                          Position
                                                                             [345, 89, 370,
    AutoZoom
                        on
                                                    111]
    ReportName
                        "simulink-
                                                          BackgroundColor
                                                                                  "red"
default.rpt*
                                                          Value
    Block {
      BlockType
                              Constant
                                                        Block {
                       "HL1"
      Name
                                                          BlockType
                                                                                 Constant
       Position
                          [255, 89, 280,
                                                                          "NHT2"
                                                          Name
1111
                                                          Position
                                                                             [350, 179, 375,
       BackgroundColor
                               "red"
                                                    2011
       Value
                                                          BackgroundColor
                                                                                  "red"
                                                          Value
    Block {
      BlockType
                                                        Block {
                              Constant
                       "HL2"
                                                          BlockType
       Name
                                                                                 Constant
                          [260, 179, 285,
       Position
                                                          Name
                                                                          "NHT3"
201i
                                                          Position
                                                                              [355, 269, 380,
       BackgroundColor
                              "red"
                                                   2911
       Value
                       -0-
                                                          BackgroundColor
                                                                                  "red"
                                                          Value
    Block {
       BlockType
                              Constant
                                                        Block {
                       •HL3•
       Name
                                                          BlockType
                                                                                 Constant
       Position
                           [265, 269, 290,
                                                          Name
                                                                          *NHT4*
2911
```

	Position	[355, 359, 380,	Position	[120, 16, 185,
381]	Packers, adCalar		734]	
	BackgroundColor Value	"red"	BackgroundCole ShowPortLabels	
}		•	System {	<b>.</b>
3	lock {		<b>-</b>	'Subsystem'
	BlockType	Constant		[116, 101, 763, 539]
	Name	"NHT5"	<b>-</b>	off
4731	Position	[360, 449, 385,	ModelBrowserVisi	
471]	BackgroundColor	red"	ModelBrowserWidt ScreenColor	in 200 'white"
	Value	*0*	PaperOrientation	
}		_	PaperPositionMod	
E	lock {			'usletter"
	BlockType	Constant	•	'inches"
	Name Registion	"NHT6"		100"
5611	Position	[360, 539, 385,	AutoZoom (	on
3011	BackgroundColor	r *red*	BlockType	Inport
	Value	*0*	Name	"Inl"
)	•		Position	[35, 258, 65, 272]
Ε	Block (		Port	*1*
	BlockType	Constant	PortWidth	*-1*
	Name Position	"NHT7"	SampleTime	*-1*
6511	POSICION	[360, 629, 385,	DataType SignalType	"auto" "auto"
0321	BackgroundColor	r "red"	Interpolate	on
	Value	*0*	}	<b>011</b>
	}		Block {	
E	Block (	_	BlockType	Reference
	BlockType	Constant	Name	"Delay"
	Name Position	[365, 719, 390,	Ports	[1, 1, 0, 0, 0]
7411	105111011	(303, 713, 330,	Position SourceBlock	[410, 41, 455, 79] "dspbdsp/Delay"
Ť	BackgroundColo	r *red*	SourceType	"Delay"
	Value	-0-	N •2	
	}		ic	*0*
I	Block (	Matta wisers a s	}	•
I	BlockType	ToWorkspace	} Block {	Tofour.
I	-	"Output signal"	} Block { BlockType	Reference
449]	BlockType Name		} Block {	"Delay1"
	BlockType Name Position BackgroundColo	"Output signal" [755, 411, 800, r "magenta"	} Block { BlockType Name	
	BlockType Name Position BackgroundColo DropShadow	"Output signal" [755, 411, 800, r "magenta" on	} Block { BlockType Name Ports Position SourceBlock	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139] "dspbdsp/Delay"
	BlockType Name Position BackgroundColo DropShadow FontName	"Output signal" [755, 411, 800,  r "magenta"  on "Arial"	} Block { BlockType Name Ports Position SourceBlock SourceType	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139] "dspbdsp/Delay" "Delay"
	BlockType Name Position BackgroundColo DropShadow	"Output signal" [755, 411, 800,  r "magenta" on "Arial" "compress"	Block { BlockType Name Ports Position SourceBlock SourceType N -2	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139] "dspbdsp/Delay" "Delay" 5"
	BlockType Name Position BackgroundColo: DropShadow FontName VariableName	"Output signal" [755, 411, 800,  r "magenta"  on "Arial"	} Block { BlockType Name Ports Position SourceBlock SourceType	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139] "dspbdsp/Delay" "Delay"
	BlockType Name Position  BackgroundColo: DropShadow FontName VariableName Buffer Decimation SampleTime	"Output signal" [755, 411, 800,  " "magenta" on "Arial" "compress" "inf" "1" "-1"	Block { BlockType Name Ports Position SourceBlock SourceType N *2	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139] "dspbdsp/Delay" "Delay" 5"
449]	BlockType Name Position  BackgroundColo: DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat	"Output signal" [755, 411, 800,  " "magenta"  on  "Arial"  "compress"  "inf"  "1"	Block {     BlockType     Name     Ports     Position     SourceBlock     SourceType     N     ic } Block {     BlockType	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139] "dspbdsp/Delay" "Delay" 5" "O"  Reference
449]	BlockType Name Position  BackgroundColo: DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat	"Output signal" [755, 411, 800,  " "magenta" on "Arial" "compress" "inf" "1" "-1"	Block {     BlockType     Name     Ports     Position     SourceBlock     SourceType     N *2     ic } Block {     BlockType     Name	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  5"     "0"  Reference     "Delay2"
449]	BlockType Name Position  BackgroundColo: DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat } Block {	"Output signal" [755, 411, 800,  " "magenta"  on  "Arial"  "compress"  "inf"  "1"  "-1"  "Matrix"	Block {     BlockType     Name     Ports     Position     SourceBlock     SourceType     N *2     ic     } Block {     BlockType     Name     Ports	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  5"     "0"  Reference     "Delay2" [1, 1, 0, 0, 0]
449]	BlockType Name Position  BackgroundColo: DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat	"Output signal" [755, 411, 800,  " "magenta" on "Arial" "compress" "inf" "1" "-1"	Block {     BlockType     Name     Ports     Position     SourceBlock     SourceType     N	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  5"     "0"  Reference     "Delay2" [1, 1, 0, 0, 0] [410, 161, 455, 199]
449]	BlockType Name Position  BackgroundColo: DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat } Block { BlockType	"Output signal" [755, 411, 800,  r "magenta" on "Arial" "compress" "inf" "1" "-1" "Matrix"  Reference	Block {     BlockType     Name     Ports     Position     SourceBlock     SourceType     N	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  5"     "0"  Reference     "Delay2" [1, 1, 0, 0, 0] [410, 161, 455, 199]     "dspbdsp/Delay"
449]	BlockType Name Position  BackgroundColor DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat } Block { BlockType Name al\nfrom\nWorksp. Ports	"Output signal" [755, 411, 800,  " "magenta"  on  "Arial"  "compress"  "inf"  "1"  "-1"  "Matrix"  Reference  "Sound ace" [0, 1, 0, 0, 0]	Block {     BlockType     Name     Ports     Position     SourceBlock     SourceType     N	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  5"     "0"  Reference     "Delay2" [1, 1, 0, 0, 0] [410, 161, 455, 199]
449]	BlockType Name Position  BackgroundColor DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat } Block { BlockType Name al\nfrom\nWorkspe	"Output signal" [755, 411, 800,  " "magenta"  on  "Arial"  "compress"  "inf"  "1"  "-1"  "Matrix"  Reference "Sound ace"	Block { BlockType Name Ports Position SourceBlock SourceType N *2 ic } Block { BlockType Name Ports Position SourceBlock SourceType Name Ports Position SourceBlock SourceType N *2	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]    "dspbdsp/Delay"    "Delay"  5"    "0"  Reference    "Delay2" [1, 1, 0, 0, 0] [410, 161, 455, 199]    "dspbdsp/Delay"    "Delay"
449]	BlockType Name Position  BackgroundColo: DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat } Block { BlockType Name al\nfrom\nWorksp. Ports Position	"Output signal" [755, 411, 800,  " "magenta"  on  "Arial"  "compress"  "inf"  "1"  "-1"  "Matrix"  Reference "Sound ace" [0, 1, 0, 0, 0]  [20, 364, 80,	Block {     BlockType     Name     Ports     Position     SourceBlock     SourceType     N	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  **  Reference     "Delay2" [1, 1, 0, 0, 0] [410, 161, 455, 199]     "dspbdsp/Delay"     "Delay"  **Delay"  **Delay**  **Delay**  **Delay**  **Delay**  **Delay**  **Delay**
449]	BlockType Name Position  BackgroundColor DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat } Block { BlockType Name al\nfrom\nWorksp Ports Position BackgroundColor	"Output signal" [755, 411, 800,  " "magenta" on  "Arial"  "compress"  "inf"  "1"  "-1"  "Matrix"  Reference  "Sound ace" [0, 1, 0, 0, 0]  [20, 364, 80,	Block {     BlockType     Name     Ports     Position     SourceBlock     SourceType     N *2     ic } Block {     BlockType     Name     Ports     Position     SourceBlock     SourceType     Name     Ports     Position     SourceBlock     SourceType     N *2     ic } Block {	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  5"  "O"  Reference     "Delay2" [1, 1, 0, 0, 0] [410, 161, 455, 199]     "dspbdsp/Delay"     "Delay"  6" "O"
449] Signa 386]	BlockType Name Position  BackgroundColo: DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat } Block { BlockType Name al\nfrom\nWorksp. Ports Position	"Output signal" [755, 411, 800,  " "magenta"  on  "Arial"  "compress"  "inf"  "1"  "-1"  "Matrix"  Reference "Sound ace" [0, 1, 0, 0, 0]  [20, 364, 80,	Block {     BlockType     Name     Ports     Position     SourceBlock     SourceType     N *2     ic } Block {     BlockType     Name     Ports     Position     SourceBlock     SourceType     Name     Ports     Position     SourceBlock     SourceType     N *2     ic } Block {     BlockType	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  5"  "0"  Reference     "Delay2" [1, 1, 0, 0, 0] [410, 161, 455, 199]     "dspbdsp/Delay"     "Delay"  6"  "0"  Reference
449] Signa 386]	BlockType Name Position  BackgroundColo: DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat } Block { BlockType Name al\nfrom\nWorksp. Ports Position  BackgroundColo: SourceBlock	"Output signal" [755, 411, 800,  " "magenta" on  "Arial"  "compress"  "inf"  "1"  "-1"  "Matrix"  Reference  "Sound ace" [0, 1, 0, 0, 0]  [20, 364, 80,	Block {     BlockType     Name     Ports     Position     SourceBlock     SourceType     N *2     ic } Block {     BlockType     Name     Ports     Position     SourceBlock     SourceType     Name     Ports     Position     SourceBlock     SourceType     N *2     ic } Block {	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  5"     "0"  Reference     "Delay2" [1, 1, 0, 0, 0] [410, 161, 455, 199]     "dspbdsp/Delay"     "Delay"  6"     "0"  Reference     "Delay3"
449] Signa 386]	BlockType Name Position  BackgroundColor DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat } Block { BlockType Name al\nfrom\nWorksp. Ports Position  BackgroundColor SourceBlock \nWorkspace* SourceType space*	"Output signal" [755, 411, 800,  " "magenta"  on  "Arial"  "compress"  "inf"  "1"  "-1"  "Matrix"  Reference  "Sound ace" [0, 1, 0, 0, 0]  [20, 364, 80,  " "cyan"  "dspsrcs2/Signal  "Signal From	Block {     BlockType     Name     Ports     Position     SourceBlock     SourceType     N	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  5"  "0"  Reference     "Delay2" [1, 1, 0, 0, 0] [410, 161, 455, 199]     "dspbdsp/Delay"     "Delay"  6"  "0"  Reference
449] Signa 386]	BlockType Name Position  BackgroundColor DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat  Block { BlockType Name al\nfrom\nWorksp. Ports Position  BackgroundColor SourceBlock \nWorkspace* SourceType space* X	"Output signal" [755, 411, 800,  " "magenta"  on  "Arial"  "compress"  "inf"  "1"  "-1"  "Matrix"  Reference  "Sound ace" [0, 1, 0, 0, 0]  [20, 364, 80,  r "cyan"  "dspsrcs2/Signal  "Signal From  "Y"	Block { BlockType Name Ports Position SourceBlock SourceType N *2 ic } Block { BlockType Name Ports Position SourceBlock SourceType N *2 ic } Block { BlockType Name Ports Position SourceBlock SourceType N *2 ic } Block { BlockType Name Ports Position SourceBlock SourceBlock SourceBlock	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  5"  Reference     "Delay2" [1, 1, 0, 0, 0] [410, 161, 455, 199]     "dspbdsp/Delay"     "Delay"  66"  Reference     "Delay3" [1, 1, 0, 0, 0]
449] Signa 386]	BlockType Name Position  BackgroundColor DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat } Block { BlockType Name al\nfrom\nWorksp. Ports Position  BackgroundColor SourceBlock \nWorkspace* SourceType space* X Ts	"Output signal" [755, 411, 800,  " "magenta" on "Arial" "compress" "inf" "1" "-1" "Matrix"  Reference "Sound ace" [0, 1, 0, 0, 0] [20, 364, 80,  " "cyan" "dspsrcs2/Signal "Signal From "Y" "1/Fs"	Block { BlockType Name Ports Position SourceBlock SourceType N *2 ic } Block { BlockType Name Ports Position SourceBlock SourceType N *2 ic } Block { BlockType Name Ports Position SourceBlock SourceType N *2 ic }	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  5"     "0"  Reference     "Delay2" [1, 1, 0, 0, 0] [410, 161, 455, 199]     "dspbdsp/Delay"     "Delay"  6-     "0"  Reference     "Delay3" [1, 1, 0, 0, 0] [410, 221, 455, 259]     "dspbdsp/Delay"     "Delay"     "Delay"     "Delay"
449] Signa 386] From	BlockType Name Position  BackgroundColor DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat } Block { BlockType Name al\nfrom\nWorksp. Ports Position  BackgroundColor SourceBlock \nWorkspace* SourceType space* X Ts nsamps	"Output signal" [755, 411, 800,  " "magenta"  on  "Arial"  "compress"  "inf"  "1"  "-1"  "Matrix"  Reference  "Sound ace" [0, 1, 0, 0, 0]  [20, 364, 80,  r "cyan"  "dspsrcs2/Signal  "Signal From  "Y"	Block { BlockType Name Ports Position SourceBlock SourceType N *2 ic } Block { BlockType Name Ports Position SourceBlock SourceType N *2 ic } Block { BlockType Name Ports Position SourceBlock SourceType Name Ports Position	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  "Delay"  Reference     "Delay2" [1, 1, 0, 0, 0] [410, 161, 455, 199]     "dspbdsp/Delay"     "Delay"  **O**  Reference     "Delay3" [1, 1, 0, 0, 0] [410, 221, 455, 259]     "dspbdsp/Delay"     "Delay"  **Delay"  6**
449] Signa 386] From	BlockType Name Position  BackgroundColor DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat } Block { BlockType Name al\nfrom\nWorksp. Ports Position  BackgroundColor SourceBlock \nWorkspace* SourceType space* X Ts nsamps }	"Output signal" [755, 411, 800,  " "magenta" on "Arial" "compress" "inf" "1" "-1" "Matrix"  Reference "Sound ace" [0, 1, 0, 0, 0] [20, 364, 80,  " "cyan" "dspsrcs2/Signal "Signal From "Y" "1/Fs"	Block { BlockType Name Ports Position SourceBlock SourceType N *2 ic } Block { BlockType Name Ports Position SourceBlock SourceType N *2 ic } Block { BlockType Name Ports Position SourceBlock SourceType N *2	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  *"O"  Reference     "Delay2" [1, 1, 0, 0, 0] [410, 161, 455, 199]     "dspbdsp/Delay"     "Delay"  *O"  Reference     "O"  Reference     "Delay3" [1, 1, 0, 0, 0] [410, 221, 455, 259]     "dspbdsp/Delay"     "Delay"  "Delay"  "Delay"
449] Signa 386] From	BlockType Name Position  BackgroundColor DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat } Block { BlockType Name al\nfrom\nWorksp. Ports Position  BackgroundColor SourceBlock \nWorkspace* SourceType space* X Ts nsamps	"Output signal" [755, 411, 800,  " "magenta" on "Arial" "compress" "inf" "1" "-1" "Matrix"  Reference "Sound ace" [0, 1, 0, 0, 0] [20, 364, 80,  " "cyan" "dspsrcs2/Signal "Signal From "Y" "1/Fs"	Block {     BlockType     Name     Ports     Position     SourceBlock     SourceType     N	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  **O"  Reference     "Delay2" [1, 1, 0, 0, 0] [410, 161, 455, 199]     "dspbdsp/Delay"     "Delay"  **O"  Reference     "Delay3" [1, 1, 0, 0, 0] [410, 221, 455, 259]     "dspbdsp/Delay"     "Delay"  **Delay"  **Delay"  **O"
449] Signa 386] From	BlockType Name Position  BackgroundColor DropShadow FontName VariableName Buffer Decimation SampleTime SaveFormat } Block { BlockType Name al\nfrom\nWorksp. Ports Position  BackgroundColor SourceBlock \nWorkspace* SourceType space* X Ts nsamps } Block {	"Output signal" [755, 411, 800,  " "magenta"  on  "Arial"  "compress"  "inf"  "1"  "-1"  "Matrix"  Reference "Sound ace" [0, 1, 0, 0, 0]  [20, 364, 80,  " "cyan"  "dspsrcs2/Signal  "Signal From "Y"  "1/Fs"  "1"	Block { BlockType Name Ports Position SourceBlock SourceType N *2 ic } Block { BlockType Name Ports Position SourceBlock SourceType N *2 ic } Block { BlockType Name Ports Position SourceBlock SourceType N *2	"Delay1" [1, 1, 0, 0, 0] [410, 101, 455, 139]     "dspbdsp/Delay"     "Delay"  **O"  Reference     "Delay2" [1, 1, 0, 0, 0] [410, 161, 455, 199]     "dspbdsp/Delay"     "Delay"  **O"  Reference     "Delay3" [1, 1, 0, 0, 0] [410, 221, 455, 259]     "dspbdsp/Delay"     "Delay"  **Delay"  **Delay"  **O"

```
[1, 1, 0, 0, 0]
     Ports
     Position
                   [410, 281, 455, 319]
                                                      Block {
                        "dspbdsp/Delay"
     SourceBlock
                                                        BlockType
                                                                             Outport
     SourceType
                       "Delay"
                                                                       "Outl"
                                                         Name
               *28*
     N
                                                         Position
                                                                          [220, 58,
                   •0•
     ic
                                               250, 72]
                                                         Port
   Block (
                                                         OutputWhenDisabled
                                                                                "held"
     BlockType
                  Reference
                                                         InitialOutput
                                                                               -[]-
     Name
                    "Delay5"
                    [1, 1, 0, 0, 0]
     Ports
                                                       Block {
     Position
                   [410, 351, 455, 389]
                                                         BlockType
                                                                              Outport
                                                                        "Out2"
     SourceBlock
                       "dspbdsp/Delay"
                                                         Name
     SourceType
                        "Delay"
                                                         Position
                                                                        [220, 133,
                *28*
                                               250, 1471
                   •0•
     ic
                                                         Port
                                                         OutputWhenDisabled
                                                                                "held"
   Block (
                                                         InitialOutput
                                                                              -[]-
     BlockType
                    SubSystem
     Name
                    "Subsystem"
                                                       Line {
     Ports
                    [1, 2, 0, 0, 0]
                                                        SrcBlock
                                                                           "Inl"
     Position
                   [95, 239, 130, 286]
                                                         SrcPort
     ShowPortLabels
                      on
                                                         Points
                                                                           [30, 0]
     System (
                                                        Branch {
       Name
                     "Subsystem"
                                                      DstBlock
                                                                      "Discrete Filter"
       Location
                       [256, 122,
                                                       DstPort
622, 329]
                                                         }
       Open
                     off
                                                         Branch (
       ModelBrowserVisibility off
                                                       DstBlock
                                                                      *Discrete Filterl*
       ModelBrowserWidth
                                                       DstPort
       ScreenColor
                             "white"
       PaperOrientation
"landscape"
                                                       Line {
                            "auto"
       PaperPositionMode
                                                         SrcBlock
                                                                           *Discrete
                         "usletter"
       PaperType
                                               Filter*
       PaperUnits
                         "inches"
                                                         SrcPort
                         "100"
       ZoomFactor
                                                         DstBlock
                                                                           "Out1"
       AutoZoom
                         on
                                                         DstPort
       Block {
                        Inport
         BlockType
                                                       Line {
         Name
                                                         SrcBlock
                                                                           *Discrete
         Position
                           [35, 98, 65,
                                               Filter1*
112]
                                                         SrcPort
         Port
                                                         DstBlock
                                                                            *Out2*
         PortWidth
                                                         DstPort
                                                                           1
                            -1-
         SampleTime
         DataType
                            "auto"
                                                     }
         SignalType
                           "auto"
         Interpolate
                           on
                                                   Block {
                                                     BlockType
                                                                    SubSystem
       Block {
                                                     Name
                                                                    "Subsystem1"
         BlockType
                                                                    [1, 2, 0, 0, 0]
                                                     Ports
DiscreteFilter
                                                     Position
                                                                    [170, 139, 205, 186]
                        *Discrete
         Name
                                                     ShowPortLabels
                                                                       on
Filter*
                                                     System (
         Position
                            [115, 47,
                                                       Name
                                                                      "Subsystem1"
175, 83]
                                                       Location
                                                                         [190, 242,
         Numerator
                               "h1"
                                               556, 449]
         Denominator
                           "[1]"
                                                       Open
                                                                      off
         SampleTime
                           "1/Fs"
                                                       ModelBrowserVisibility off
                                                       ModelBrowserWidth 200
       Block {
                                                       ScreenColor
                                                                             "white"
         BlockType
                                                       PaperOrientation
DiscreteFilter
                                                "landscape"
                        *Discrete
                                                                           "auto"
                                                       PaperPositionMode
Filter1*
                                                       PaperType
                                                                         "usletter"
         Position
                            [115, 122,
                                                                         "inches"
                                                       PaperUnits
175, 158]
                                                       ZoomFactor
                                                                         *100*
         Numerator
                               "hic"
                                                       AutoZoom
                                                                         on
         Denominator
                           ·[1]·
                                                       Block {
         SampleTime
                            "1/Fs"
                                                         BlockType
                                                                               Inport
```

```
Name
                       "Inl"
                                                       SrcBlock
                                                                          *Discrete
         Position
                        [35, 98, 65,
                                              Filterl*
112]
                                                       SrcPort
         Port
                                                       DstBlock
                                                                          "Out2"
                              -1-
         PortWidth
                                                       DstPort
                                                                          1
                          -1-
         SampleTime
                                                     }
         DataType
                           "auto"
                                                   }
                          "auto"
         SignalType
         Interpolate
                           on
                                                  Block {
                                                    BlockType
                                                                  SubSystem
       Block {
                                                                  *Subsystem2*
                                                    Name
                                                                  [1, 2, 0, 0, 0]
[170, 344, 205, 391]
         BlockType
                                                    Ports
DiscreteFilter
                                                    Position
         Name
                       "Discrete
                                                    ShowPortLabels
                                                                     on
Filter*
                                                    System (
         Position
                           [115, 47,
                                                                  "Subsystem2"
                                                      Name
175, 831
                                                      Location
                                                                       [308, 275,
         Numerator
                              "h2"
                                              674, 482]
         Denominator
                           "[1]"
                                                      Open
                                                                    off
                           "1/Fs"
         SampleTime
                                                      ModelBrowserVisibility off
                                                      ModelBrowserWidth 200
ScreenColor "white"
       Block {
         BlockType
                                                      PaperOrientation
DiscreteFilter
                                               "landscape"
         Name
                       *Discrete
                                                      PaperPositionMode
                                                                          "auto"
Filter1*
                                                      PaperType "usletter"
                                                                       "inches"
         Position
                           [115, 122,
                                                      PaperUnits
175, 158]
                                                      ZoomFactor
                                                                       -100-
         Numerator
                              "h2c"
                                                      AutoZoom
                                                                       on
         Denominator
                           "[1]"
                                                      Block {
                                                                      Inport
                                                        BlockType
         SampleTime
                           *1/Fs*
                                                        Name
       Block (
                        Outport
                                                        Position
                                                                        [35, 98, 65,
         BlockType
                                               112]
         Name
                                                        Port
                                                                          --1-
         Position
                          [220, 58,
                                                        PortWidth
250, 721
                                                        SampleTime
         Port
                                                        DataType
                                                                         "auto"
         OutputWhenDisabled
                                "held"
                                                        SignalType
                                                                          "auto"
         InitialOutput
                               -[]-
                                                        Interpolate
                                                                          on
       Block (
                                                      Block {
                        Outport
         BlockType
                                                        BlockType
         Name
                                               DiscreteFilter
                         [220, 133,
         Position
                                                        Name
                                                                       "Discrete
250, 147]
                                               Filter*
         Port
                                                        Position
                                                                          [115, 47,
         OutputWhenDisabled
                                "held"
                                               175, 831
         InitialOutput
                              -[]-
                                                        Numerator
                                                                             "h3"
                                                        Denominator
                                                                          "[1]"
        Line {
                                                        SampleTime
                                                                          *1/Fs*
         SrcBlock
                           "Inl"
         SrcPort
                                                      Block {
                                                        BlockType
         Points
                           [30, 0]
         Branch {
                                               DiscreteFilter
       DstBlock
                      "Discrete Filter"
                                                       Name
                                                                       *Discrete
       DstPort
                                               Filter1*
         1
                                                        Position
                                                                          [115, 122,
         Branch {
                                               175, 1581
       DstBlock
                      *Discrete Filter1*
                                                        Numerator
                                                                             "h3c"
       DstPort
                                                        Denominator
                                                                          "[I]"
         }
                                                        SampleTime
                                                                          "1/Fs"
       Line {
                                                      Block {
                                                                      Outport
         SrcBlock
                           "Discrete
                                                        BlockType
Filter*
                                                        Name
         SrcPort
                                                        Position
                                                                         [220, 58,
         DstBlock
                           "Outl"
                                               250, 72]
         DstPort
                           1
                                                        OutputWhenDisabled
                                                                              "held"
       Line {
                                                        InitialOutput
                                                                             •[]•
```

```
Block {
                                                      Block {
                       Outport
         BlockType
                                                        BlockType
         Name
                                               DiscreteFilter
         Position
                           [220, 133,
                                                                       *Discrete
                                                        Name
250, 147]
                                               Filter*
         Port
                                                        Position
                                                                           [95, 87,
                               "held"
         OutputWhenDisabled
                                               155, 123]
                             •11•
                                                                              *h8*
         InitialOutput
                                                        Numerator
                                                                          ·[1]·
                                                        Denominator
       Line {
                                                        SampleTime
                                                                           "1/Fs"
         SrcBlock
                           "Inl"
         SrcPort
                                                      Block {
                                                                       Outport
                                                        BlockType
         Points
                           [30, 0]
        Branch {
                                                        Name
       DstBlock
                     *Discrete Filter*
                                                        Position
                                                                        [185, 98,
       DstPort
                                               215, 112]
                                                                       -1-
         }
                                                        Port
         Branch {
                                                        OutputWhenDisabled
                                                                              "held"
       DstBlock
                      "Discrete Filter1"
                                                        InitialOutput
                                                                             -[]-
       DstPort
         }
                                                      Line {
                                                        SrcBlock
                                                                           "Inl"
       Line (
                                                        SrcPort
                           *Discrete
         SrcBlock
                                                        DstBlock
                                                                           *Discrete
Filter"
                                               Filter*
         SrcPort
                                                        DstPort
         DstBlock
                           "Outl"
         DstPort
                                                      Line {
                                                        SrcBlock
                                                                           *Discrete
       Line {
                                               Filter*
         SrcBlock
                           *Discrete
                                                        SrcPort
Filter1*
                                                        DstBlock
                                                                           "Outl"
         SrcPort
                                                        DstPort
                                                                           1
         DstBlock
                            "Out2"
         DstPort
                                                    }
       }
     }
                                                   Block {
                                                     BlockType
                                                                   SubSystem
    Block {
                                                     Name
                                                                   "Subsystem4"
                                                                   [1, 2, 0, 0, 0]
[250, 89, 285, 136]
     BlockType
                    SubSystem
                                                     Ports
     Name
                    "Subsystem3"
                                                    Position
      Ports
                    [1, 1, 0, 0, 0]
                                                     ShowPortLabels
                                                                     on
      Position
                    [315, 36, 350, 84]
                                                     System (
      ShowPortLabels
                       on
                                                      Name
                                                                     "Subsystem4"
      System {
                                                       Location
                                                                       [305, 184,
       Name
                      "Subsystem3"
                                               671, 391]
       Location
                        [256, 172,
                                                      Open
                                                                     off
622, 379]
                                                      ModelBrowserVisibility off
       Open
                     off
                                                       ModelBrowserWidth 200
       ModelBrowserVisibility off
                                                       ScreenColor
                                                                             "white"
        ModelBrowserWidth 200
                                                      PaperOrientation
        ScreenColor
                             "white"
                                               "landscape"
       PaperOrientation
                                                       PaperPositionMode
                                                                            "auto"
"landscape"
                                                       PaperType
                                                                        "usletter"
       PaperPositionMode
                           "auto"
                                                                        *inches*
                                                       PaperUnits
                         "usletter"
        PaperType
                                                                        -100-
                                                       ZoomFactor
                         "inches"
        PaperUnits
                                                       AutoZoom
                                                                         on
                         *100*
        ZoomFactor
                                                       Block {
                                                                       Inport
        AutoZoom
                                                        BlockType
                         on
       Block {
                                                        Name
                        Import
         BlockType
                                                        Position
                                                                         [35, 98, 65,
         Name
                                               112]
         Position
                           [35, 98, 65,
                                                         Port
112]
                                                        PortWidth
         Port
                                                         SampleTime
                                                                           -1-
         PortWidth
                                                        DataType
                                                                           "auto"
         SampleTime
                           -1-
                                                        SignalType
                                                                           "auto"
         DataType
                            "auto"
                                                        Interpolate
                                                                           on
         SignalType
                           "auto"
         Interpolate
                           on
                                                       Block (
```

```
Ports [1, 2, 0, 0, 0]
Position [250, 184, 285, 231]
         BlockType
DiscreteFilter
                      *Discrete
        Name
                                                   ShowPortLabels
                                                                    on
Filter*
                                                   System (
         Position
                           [115, 47,
                                                                   "Subsystem5"
                                                     Name
175, 83]
                                                     Location
                                                                      [434, 241,
                              "h4"
                                              800, 448]
         Numerator
                           -[1]-
         Denominator
                                                     0pen
                                                                   off
                                                     ModelBrowserVisibility off
         SampleTime
                           "1/Fs"
                                                     ModelBrowserWidth 200
       Block (
                                                     ScreenColor
                                                                           "white"
         BlockType
                                                     PaperOrientation
DiscreteFilter
                                              "landscape"
        Name
                       *Discrete
                                                                          "auto"
                                                     PaperPositionMode
Filter1"
                                                     PaperType
                                                                       "usletter"
        Position
                           [115, 122,
                                                     PaperUnits
                                                                       "inches"
175. 1581
                                                     ZoomFactor
                                                                       "100"
         Numerator
                              "h4c"
                                                     AutoZoom
                                                                       on
         Denominator
                           "[1]"
                                                     Block {
                                                                      Inport
         SampleTime
                           "1/Fs"
                                                       BlockType
                                                       Name
       Block {
                                                       Position
                                                                        [35, 98, 65,
                       Outport
         BlockType
                                              112]
         Name
                                                                      -1-
                                                       Port
         Position
                          [220, 58,
                                                       PortWidth
250, 72]
                                                       SampleTime
                                                                         -1-
                                                       DataType
                                                                         "auto"
         OutputWhenDisabled
                                "held"
                                                       SignalType
                                                                         "auto"
                             "[]"
         InitialOutput
                                                       Interpolate
                                                                         on
       Block (
                       Outport
                                                     Block {
         BlockType
                                                       BlockType
         Name
                                              DiscreteFilter
         Position
                          [220, 133,
                                                       Name
                                                                      *Discrete
250, 1471
                                               Filter*
                       *2*
         Port
                                                       Position
                                                                          [115, 47,
         OutputWhenDisabled
                               "held"
                                               175, 83]
         InitialOutput
                               -[]-
                                                       Numerator
                                                                             "h5"
                                                        Denominator
                                                                         "[1]"
       Line (
                                                        SampleTime
                                                                         "1/Fs"
        SrcBlock
                           "Inl"
         SrcPort
                                                     Block {
         Points
                          [30, 0]
                                                       BlockType
        Branch {
                                               DiscreteFilter
       DstBlock
                     "Discrete Filter"
                                                       Name
                                                                      *Discrete
       DstPort
                                              Filter1*
                                                       Position
                                                                          [115, 122,
         Branch {
                                               175, 158]
       DstBlock
                     *Discrete Filter1*
                                                       Numerator
                                                                             "h5c"
       DstPort
                     1
                                                        Denominator
                                                                          "[1]"
        }
                                                        SampleTime
                                                                          "1/Fs"
       Line {
                                                      Block {
                                                                      Outport
                                                       BlockType
         SrcBlock
                           *Discrete
Filter"
                                                        Name
         SrcPort
                                                       Position
                                                                        [220, 58,
         DstBlock
                           "Outl"
                                              250, 72]
         DstPort
                           1
                                                        Port
       3
                                                        OutputWhenDisabled
                                                                             "held"
       Line {
                                                        InitialOutput
                                                                             -[]-
                           *Discrete
        SrcBlock
Filterl*
                                                      Block {
         SrcPort
                           1
                                                       BlockType
                                                                            Outport
         DstBlock
                           "Out2"
                                                       Name
                                                                      *Out2*
         DstPort
                           1
                                                       Position
                                                                         [220, 133,
       }
                                               250, 147]
     }
                                                       Port
                                                       OutputWhenDisabled
                                                                             "held"
    Block {
                                                       InitialOutput
                                                                            -[]-
     BlockType
                    SubSystem
     Name
                    *Subsystem5*
                                                      Line {
```

```
SrcBlock
                            "Inl"
         SrcPort
                                                        Block {
                            [30, 0]
         Points
                                                          BlockType
         Branch {
                                                DiscreteFilter
       DstBlock
                      "Discrete Filter"
                                                                         *Discrete
                                                          Name
       DstPort
                                                Filterl*
                                                          Position
                                                                             [115, 122,
         Branch {
                                                175, 158]
       DstBlock
                      "Discrete Filter1"
                                                          Numerator
                                                                                "h6c"
       DstPort
                                                          Denominator
                                                                             *[1]*
         }
                                                          SampleTime
                                                                             "1/Fs"
       Line {
                                                        Block (
                                                                         Outport
         SrcBlock
                            *Discrete
                                                          BlockType
Filter"
                                                          Name
         SrcPort
                                                                           [220, 58,
                                                          Position
         DstBlock
                             "Outl"
                                                250, 721
         DstPort
                            1
                                                                         -1-
                                                          Port
                                                          OutputWhenDisabled
                                                                                 "held"
       Line {
                                                          InitialOutput
                                                                                 -[]-
                            *Discrete
         SrcBlock
Filter1"
                                                        Block (
                                                                         Outport
         SrcPort
                                                          BlockType
         DstBlock
                             "Out2"
                                                          Name
         DstPort
                            1
                                                          Position
                                                                             [220, 133,
       }
                                                 250, 1471
     }
                                                                         -2-
                                                          Port
                                                                                  "held"
                                                          OutputWhenDisabled
   Block {
                                                          InitialOutput
                                                                                 -[]-
     BlockType
                    SubSystem
                    "Subsystem6"
     Name
                                                        Line {
                    [1, 2, 0, 0, 0]
[250, 309, 285, 356]
     Ports
                                                          SrcBlock
                                                                             "Inl"
     Position
                                                          SrcPort
     ShowPortLabels
                        on
                                                          Points
                                                                             [30, 0]
      System (
                                                          Branch (
                      "Subsystem6"
       Name
                                                        DstBlock
                                                                       "Discrete Filter"
       Location
                          [318, 229,
                                                        DstPort
                                                                       1
684, 436]
                                                          }
       Open
                      off
                                                          Branch {
       ModelBrowserVisibility off
ModelBrowserWidth 200
                                                        DstBlock
                                                                       "Discrete Filterl"
                                                        DstPort
        ScreenColor
                              "white"
                                                          }
        PaperOrientation
"landscape"
                                                        Line {
        PaperPositionMode
                             "auto"
                                                           SrcBlock
                                                                              "Discrete
        PaperType
                          "usletter"
                                                 Filter*
                          "inches"
        PaperUnits
                                                          SrcPort
        ZoomFactor
                          "100"
                                                          DstBlock
                                                                              "Outl"
        AutoZoom
                          on
                                                          DstPort
        Block {
                         Inport
         BlockType
                                                         Line {
         Name
                                                           SrcBlock
                                                                              *Discrete
         Position
                            [35, 98, 65,
                                                 Filter1*
112]
                                                          SrcPort
                                                          DstBlock
                                                                              "Out2"
          PortWidth
                                --1-
                                                          DstPort
                             -1-
          SampleTime
                                                        ł
          DataType
                             "auto"
                                                      }
          SignalType
                             "auto"
         Interpolate
                            on
                                                    Block {
                                                      BlockType
                                                                     SubSystem
        Block {
                                                      Name
                                                                      "Subsystem?"
          BlockType
                                                      Ports
                                                                      [1, 2, 0, 0, 0]
DiscreteFilter
                                                      Position
                                                                      [250, 404, 285, 451]
         Name
                         *Discrete
                                                       ShowPortLabels
                                                                       on
Filter"
                                                       System {
         Position
                             [115, 47,
                                                        Name
                                                                       "Subsystem7"
175, 83]
                                                        Location
                                                                           [63, 196, 429,
         Numerator
                                *b6*
                                                 4031
                             -[1]-
          Denominator
                                                        Open
                                                                       off
          SampleTime
                             "1/Fs"
                                                        ModelBrowserVisibility off
```

```
ModelBrowserWidth
                               200
                                                         DstPort
       ScreenColor
                               "white"
                                                           }
       PaperOrientation
"landscape"
                                                         Line (
                              "auto"
       PaperPositionMode
                                                           SrcBlock
                                                                               "Discrete
                           "usletter"
       PaperType
                                                 Filter*
                          "inches"
        PaperUnits
                                                           SrcPort
                                                                               1
                           -100-
        ZoomFactor
                                                           DstBlock
                                                                               "Outl"
        AutoZoom
                           on
                                                           DstPort
        Block {
          BlockType
                                Inport
                                                         Line {
                         "Inl"
          Name
                                                            SrcBlock
                                                                               *Discrete
                            [35, 98, 65,
          Position
                                                  Filterl*
112!
                                                           SrcPort
                                                                               1
          Port
                         -1-
                                                            DstBlock
                                                                               "Out2"
          PortWidth
                                                           DstPort
                                                                               1
                             --1-
          SampleTime
                                                         }
                             "auto"
          DataType
                                                       }
          SignalType
                             "auto"
                                                      }
          Interpolate
                             on
                                                      Block {
                                                        BlockType
                                                                       Outport
        Block {
                                                        Name
                                                                       "Outl"
          BlockType
                                                       Position
                                                                       [510, 53, 540, 67]
DiscreteFilter
                                                        Port
                                                                       -1-
          Name
                         "Discrete
                                                        OutputWhenDisabled
                                                                               "held"
Filter*
                                                        InitialOutput
                                                                               -11-
          Position
                             [115, 47,
175, 831
                                                      Block {
          Numerator
                                 "h7"
                                                        BlockType
                                                                       Outport
          Denominator
                             -[1]-
                                                        Name
                                                                       "Out2"
          SampleTime
                             "1/Fs"
                                                        Position
                                                                       [510, 113, 540, 127]
                                                        Port
                                                                        -2-
        Block (
                                                        OutputWhenDisabled
                                                                               "held"
          BlockType
                                                        InitialOutput
                                                                               *[]*
DiscreteFilter
                         "Discrete
          Name
                                                      Block {
Filterl"
                                                        BlockType
                                                                       Outport
          Position
                              [115, 122,
                                                        Name
                                                                       "Out3"
175, 1581
                                                        Position
                                                                       [510, 173, 540, 187]
          Numerator
                                 "h7c"
                                                        Port
          Denominator
                             "[1]"
                                                        OutputWhenDisabled
                                                                               "held"
          SampleTime
                              "1/Fs"
                                                        InitialOutput
                                                                               •[]•
        Block {
                                                      Block (
                          Outport
                                                        BlockType
          BlockType
                                                                       Outport
          Name
                                                        Name
                                                                       "Out4"
          Position
                             [220, 58,
                                                        Position
                                                                       [510, 233, 540, 247]
250, 72]
                                                        Port
                                                                       -4-
                          -1-
          Port
                                                        OutputWhenDisabled
                                                                               "held"
                                  "held"
          OutputWhenDisabled
                                                                               •11•
                                                        InitialOutput
          InitialOutput
                                 *[]*
                                                      Block {
        Block {
                                                        BlockType
                                                                       Outport
          BlockType
                                 Outport
                                                                        "Out5"
                                                        Name
                          "Out2"
          Name
                                                        Position
                                                                       [510, 293, 540, 307]
          Position
                             [220, 133,
                                                        Port
                                                                       -5-
250, 147]
                                                        OutputWhenDisabled
                                                                               "held"
          Port
                                                        InitialOutput
                                                                               -[]-
          OutputWhenDisabled
                                  "held"
          InitialOutput
                                 -[]-
                                                      Block {
                                                        BlockType
                                                                       Outport
        Line {
                                                        Name
                                                                       "Out6"
          SrcBlock
                             "Inl"
                                                        Position
                                                                       [510, 363, 540, 377]
          SrcPort
                                                                       -6-
                                                        Port
          Points
                              [30, 0]
                                                        OutputWhenDisabled
                                                                               "held"
          Branch {
                                                        InitialOutput
                                                                               -[]-
        DstBlock
                       "Discrete Filter"
        DstPort
                                                      Block {
                                                        BlockType
                                                                       Outport
          Branch (
                                                        Name
                                                                        "Out7"
        DstBlock
                       *Discrete Filter1*
                                                        Position
                                                                       [510, 408, 540, 422]
```

```
DstPort
                                                                     1
  Port
  OutputWhenDisabled
                          "held"
  InitialOutput
                          -[]-
                                                   Line {
                                                     SrcBlock
                                                                      *Subsystem4*
Block {
                                                     SrcPort
  BlockType
                  Outport
                                                     Points
                                                                      [105, 0]
                  "Out8"
                                                     DstBlock
                                                                      "Delay1"
  Name
                  [510, 438, 540, 452]
  Position
                                                     DstPort
                                                                      1
                  -8-
  Port
  OutputWhenDisabled
                          "held"
                                                   Line {
  InitialOutput
                          -[]-
                                                      SrcBlock
                                                                      *Subsystem5*
                                                     SrcPort
Line {
                                                     Points
                                                                      [45, 0; 0, -15]
  SrcBlock
                  "Inl"
                                                     DstBlock
                                                                      Delay2
  SrcPort
                                                     DstPort
  DstBlock
                  "Subsystem"
  DstPort
                                                   Line {
                                                      SrcBlock
                                                                      "Subsystem5"
Line {
                                                      SrcPort
                  "Subsystem"
  SrcBlock
                                                      Points
                                                                      [60, 0; 0, 20]
  SrcPort
                                                      DstBlock
                                                                      "Delay3"
                  [20. 0]
  Points
                                                      DstPort
  DstBlock
                  "Subsystem2"
  DstPort
                                                    Line {
                                                      SrcBlock
                                                                      "Subsystem6"
Line {
                                                      SrcPort
  SrcBlock
                  "Subsystem"
                                                      Points
                                                                      [40, 0; 0, -20]
  SrcPort
                                                      DstBlock
                                                                      "Delay4"
  Points
                  [20, 0]
                                                      DstPort
  DstBlock
                  "Subsystem1"
  DstPort
                                                    Line {
                                                                      *Subsystem6*
                                                      SrcBlock
Line {
                                                      SrcPort
  SrcBlock
                  "Subsystem1"
                                                      Points
                                                                      [40, 0; 0, 25]
  SrcPort
                                                      DstBlock
                                                                      "Delay5"
  Points
                  [25, 0]
                                                      DstPort
  DstBlock
                  "Subsystem4"
  DstPort
                                                    Line (
                                                      SrcBlock
                                                                      *Subsystem7*
Line {
                                                      SrcPort
                  "Subsysteml"
  SrcBlock
                                                      DstBlock
                                                                      "Out7"
  SrcPort
                  2
                                                      DstPort
  Points
                  [25, 0]
  DstBlock
                   *Subsystem5*
                                                    Line {
  DstPort
                                                      SrcBlock
                                                                      "Subsystem7"
                                                      SrcPort
Line {
                                                      Points
                                                                      [205, 0]
  SrcBlock
                  "Subsystem4"
                                                      DstBlock
                                                                      *Out8*
  SrcPort
                  1
                                                      DstPort
  Points
                  [10, 0]
  DstBlock
                   "Subsystem3"
                                                    Line (
  DstPort
                                                      SrcBlock
                                                                      "Delay"
                                                      SrcPort
Line {
                                                      DstBlock
                                                                      "Out1"
  SrcBlock
                  *Subsystem2*
                                                      DstPort
  SrcPort
                  1
  Points
                  [25, 0]
                                                    Line {
  DstBlock
                  *Subsystem6*
                                                      SrcBlock
                                                                      "Delay1"
  DstPort
                                                      SrcPort
                                                      DstBlock
                                                                      "Out2"
Line {
                                                      DstPort
                                                                      7
  SrcBlock
                  *Subsystem2*
  SrcPort
                  2
                                                    Line {
  Points
                  [25, 0]
                                                      SrcBlock
                                                                      "Delay2"
  DstBlock
                  "Subsystem7"
                                                      SrcPort
  DstPort
                                                      DstBlock
                                                                      *Out3*
                                                      DstPort
Line {
  SrcBlock
                  "Subsystem3"
                                                    Line {
  SrcPort
                                                      SrcBlock
                                                                      "Delay3"
  DstBlock
                   "Delay"
                                                      SrcPort
```

```
BlockType
     DstBlock
                    "Out4"
                                                                             Constant
                                                                      "UCL6"
     DstPort
                    7
                                                       Name
                                                                       [315, 539, 340.
                                                       Position
                                                 561]
   Line {
     SrcBlock
                    "Delay4"
                                                       BackgroundColor
                                                                              "red"
                                                                      -90-
     SrcPort
                                                       Value
     DstBlock
                     "Out5"
     DstPort
                                                     Block {
                                                       BlockType
                                                                      "UCL7"
   Line (
                                                       Name
     SrcBlock
                     "Delay5"
                                                       Position
                                                                        [315, 629, 340,
     SrcPort
                                                 651]
     DstBlock
                     "Out6"
                                                       BackgroundColor
                                                                              "red"
                                                                      -90-
     DstPort
                                                       Value
   }
     }
                                                     Block (
                                                       BlockType
                                                                             Constant
    Block {
                                                                      "UCL8"
                                                       Name
     BlockType
                            Sum
                                                       Position
                                                                        [320, 719, 345,
      Name
                     "Sum"
                                                 7411
                     [8, 1, 0, 0, 0]
      Ports
                                                       BackgroundColor
                                                                              "red"
      Position
                         [670, 340, 700,
                                                       Value
520]
      BackgroundColor
                             "green"
                                                     Block {
      ShowName
                         off
                                                       BlockType
                                                                              SubSystem
      IconShape
                                                       Name
"rectangular"
                                                 "homomorphic\nmultiplicative AGC1"
                                                      Ports [4, 1, 0, 0, 0]
     Inputs
      SaturateOnIntegerOverflow on
                                                       Position
                                                                          [440, 54, 470,
                                                 111]
                                                       BackgroundColor
                                                                              "orange"
      BlockType
                            Constant
                                                       DropShadow
                                                                          on
                     "UCL1"
      Name
                                                       ShowPortLabels
                                                                              off
      Position
                      [300, 89, 325,
                                                       System (
1111
                                                     Name
      BackgroundColor
                             "red"
                                                     "homomorphic\nmultiplicative AGC1"
                     -90-
      Value
                                                     Location [8, 74, 1028, 724]
                                                                    off
                                                     Open
    Block {
                                                     ModelBrowserVisibility off
                     Constant
      BlockType
                                                     ModelBrowserWidth 200
                                                     ScreenColor *lightBlue*
      Name
      Position
                       [305, 179, 330,
                                                     PaperOrientation "landscape"
PaperPositionMode "auto"
2011
      BackgroundColor
                             "red"
                                                     PaperType
                                                                    "usletter"
                     -90-
      Value
                                                     PaperUnits
                                                                    "inches"
                                                                    *76*
                                                     ZoomFactor
    Block {
                                                     AutoZoom
                                                                    on
      BlockType
                            Constant
                                                     Block {
      Name
                     "UCL3"
                                                       BlockType
                                                                      Inport
      Position
                       [310, 269, 335,
                                                       Name
                                                                      "Inl"
2911
                                                                      [35, 78, 65, 92]
                                                       Position
      BackgroundColor
                             "red"
                                                       BackgroundColor
                                                                          "cyan"
                     *90*
      Value
                                                       Port
                                                                      -1-
                                                       PortWidth
                                                                      -1-
    Block {
                                                       SampleTime
      BlockType
                            Constant
                                                       DataType
                                                                      "auto"
                     "UCL4"
      Name
                                                       SignalType
                                                                         "auto"
      Position
                       [310, 359, 335,
                                                       Interpolate
                                                                          on
381 I
      BackgroundColor
                             "red"
                                                     Block {
      Value
                                                       BlockType
                                                                      Inport
                                                       Name
                                                                      "In3"
    Block {
                                                       Position
                                                                      [595, 298, 625, 312]
      BlockType
                            Constant
                                                       BackgroundColor
                                                                         "cyan"
      Name
                     "UCL5"
                                                       Port
      Position
                       [315, 449, 340,
                                                       PortWidth
4711
                                                                         --1
                                                       SampleTime
      BackgroundColor
                             "red"
                                                       DataType
                                                                      "auto"
                    *90*
      Value
                                                       SignalType
                                                                        "auto"
                                                       Interpolate
                                                                          OIL
    Block {
```

Block { BlockType	Tonore	Position	[75, 93,
Name	Inport "In4"	105, 107]  BackgroundColor	2 cm ro m 2
Position	[690, 298, 720, 312]		"cyan"
BackgroundCol		PortWidth	*-1*
Port	*3*	SampleTime	*-1*
PortWidth	*-1 <b>*</b>	DataType	"auto"
SampleTime	*-1*	SignalType	"auto"
DataType	"auto"	Interpolate	on
SignalType	"auto"	}	
Interpolate	on	Block {	<u> </u>
} Block {		BlockType Name	Constant **
BlockType	Inport	Position	[80, 134,
Name	"In5"	110, 1561	[80, 134,
Position	[750, 298, 780, 312]	BackgroundColor	"red"
BackgroundCol	or "cyan"		"160"
Port	<b>-4-</b>	}	
PortWidth	"-1"	Block (	
SampleTime	"-1"	BlockType	
DataType	"auto"	DataStoreMemory	
SignalType Interpolate	"auto"		*Data
interpolate	on	Store\nMemory" Position	[430 35
Block {		462. 651	[430, 35,
BlockType	Abs	BackgroundColor	"orange"
Name	"Abs"	DataStoreName	"AGC1"
Position	[100, 70, 130, 100]	InitialValue	•0•
BackgroundCol	lor "red"	}	
}		Block (	
Block (	C	BlockType	
BlockType Name	Constant "Constant"	DataStoreRead	
Position	[595, 195, 625, 225]	Name Store\nRead"	"Data
BackgroundCol		Position	[210, 155,
Value	*1*	240, 1851	[210, 133,
}		BackgroundColor	"orange"
Block (		DataStoreName	"AGC1"
BlockType	Constant	SampleTime	"1/Fs"
Name Position	"Constant1"	}	
BackgroundCol	[795, 350, 825, 380] lor "green"	Block (	
Value	*330*	BlockType DataStoreWrite	
}		Name	"Data
Block {		Store\nWrite*	
BlockType	SubSystem	Position	[435, 175,
Name			
_	"FastMoving"	465, 205]	
Ports	[1, 1, 0, 0, 0]	465, 205] BackgroundColor	
Position	[1, 1, 0, 0, 0] [155, 57, 185, 113]	BackgroundColor DataStoreName	"orange" "AGC1"
Position BackgroundCol	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange"	BackgroundColor DataStoreName SampleTime	"orange"
Position	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on	BackgroundColor DataStoreName SampleTime }	"orange" "AGC1"
Position BackgroundCol DropShadow	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on	BackgroundColor DataStoreName SampleTime } Block {	"orange" "AGC1"
Position BackgroundCol DropShadow ShowPortLabel	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on	BackgroundColor DataStoreName SampleTime }	"orange" "AGC1"
Position BackgroundCol DropShadow ShowPortLabel System ( Name Location	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on ls off	BackgroundColor DataStoreName SampleTime } Block { BlockType	"orange" "AGC1"
Position BackgroundCol DropShadow ShowPortLabel System ( Name Location	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on ls off "FastMoving" [65, 141, 853,	BackgroundColor DataStoreName SampleTime } Block { BlockType Reference	"orange"
Position BackgroundCol DropShadow ShowPortLabel System ( Name Location 482] Open	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on ls off  "FastMoving" [65, 141, 853,	BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position	"orange" "AGC1" "1/Fs" "Integer Delay"
Position BackgroundCol DropShadow ShowPortLabel System ( Name Location 482] Open ModelBrowse	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on ls off  "FastMoving" [65, 141, 853, off erVisibility off	BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103]	"orange"
Position BackgroundCol DropShadow ShowPortLabel System ( Name Location 482] Open ModelBrowse	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on ls off  "FastMoving" [65, 141, 853,  off erVisibility off erWidth 200	BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor	"orange"     "AGC1"     "1/Fs"  "Integer Delay" [1, 1, 0, 0, 0]     [200, 67,
Position BackgroundCol DropShadow ShowPortLabel System ( Name Location  482]  Open ModelBrowse ModelBrowse ScreenColor	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on ls off  "FastMoving" [65, 141, 853,  off erVisibility off erWidth 200	BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock	"orange"
Position BackgroundCol DropShadow ShowPortLabel System ( Name Location  482] Open ModelBrowse ModelBrowse ScreenColor	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on ls off  "FastMoving" [65, 141, 853,  off erVisibility off erWidth 200	BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay"	"orange" "AGC1" "1/Fs"  "Integer Delay" [1, 1, 0, 0, 0] [200, 67, "red"
Position BackgroundCol DropShadow ShowPortLabel System ( Name Location  482]  Open ModelBrowse ModelBrowse ScreenColor	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on ls off  "FastMoving" [65, 141, 853,  off erVisibility off erWidth 200	BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType	"orange"
Position BackgroundCol DropShadow ShowPortLabel System ( Name Location 482] Open ModelBrowse ModelBrowse ScreenColor "lightBlue" PaperOrient "landscape" PaperPositi	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on ls off  "FastMoving" [65, 141, 853,  off erVisibility off erWidth 200 ctation	BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay"	"orange" "AGC1" "1/Fs"  "Integer Delay" [1, 1, 0, 0, 0] [200, 67, "red"  "Integer
Position BackgroundCol DropShadow ShowPortLabel System ( Name Location 482] Open ModelBrowse ModelBrowse ScreenColor "lightBlue" PaperOrient "landscape" PaperPositi PaperType	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on ls off  "FastMoving" [65, 141, 853,  off erVisibility off erWidth 200 ctation ionMode "auto" "usletter"	BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType	"orange" "AGC1" "1/Fs"  "Integer Delay" [1, 1, 0, 0, 0] [200, 67, "red"
Position BackgroundCol DropShadow ShowPortLabel System ( Name Location 482] Open ModelBrowse ModelBrowse ScreenColor "lightBlue" PaperOrient "landscape" PaperPositi PaperType PaperUnits	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on ls off  "FastMoving" [65, 141, 853,  off erVisibility off erWidth 200 r tation ionMode "auto" "usletter" "inches"	BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay" delay ic	"orange" "AGC1" "1/Fs"  "Integer Delay" [1, 1, 0, 0, 0] [200, 67, "red"  "Integer
Position BackgroundCol DropShadow ShowPortLabel System { Name Location  482] Open ModelBrowse ModelBrowse ScreenColor "lightBlue" PaperOrient "landscape" PaperPositi PaperType PaperUnits ZoomFactor	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on ls off  "FastMoving" [65, 141, 853,  off erVisibility off erWidth 200 r tation ionMode "auto" "usletter" "inches" "100"	BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay" delay ic frame df	"orange"     "AGC1"     "1/Fs"  "Integer Delay" [1, 1, 0, 0, 0]     [200, 67,     "red"  "Integer  "160" "0" off
Position BackgroundCol DropShadow ShowPortLabel System ( Name Location  482] Open ModelBrowse ModelBrowse ScreenColor "lightBlue" PaperOrient "landscape" PaperPositi PaperType PaperUnits ZoomFactor AutoZoom	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on ls off  "FastMoving" [65, 141, 853,  off erVisibility off erWidth 200 r tation ionMode "auto" "usletter" "inches"	BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay" delay ic frame df numChans	"orange"
Position BackgroundCol DropShadow ShowPortLabel System ( Name Location  482] Open ModelBrowse ModelBrowse ScreenColor "lightBlue" PaperOrient "landscape" PaperPositi PaperType PaperUnits ZoomFactor AutoZoom Block {	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on ls off  "FastMoving" [65, 141, 853,  off erVisibility off erWidth 200 r tation ionMode "auto" "usletter" "inches" "100" on	BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay" delay ic frame df numChans }	"orange"     "AGC1"     "1/Fs"  "Integer Delay" [1, 1, 0, 0, 0]     [200, 67,     "red"  "Integer  "160" "0" off
Position BackgroundCol DropShadow ShowPortLabel System ( Name Location  482] Open ModelBrowse ModelBrowse ScreenColor "lightBlue" PaperOrient "landscape" PaperPositi PaperType PaperUnits ZoomFactor AutoZoom	[1, 1, 0, 0, 0] [155, 57, 185, 113] lor "orange" on ls off  "FastMoving" [65, 141, 853,  off erVisibility off erWidth 200 ctation ionMode "auto" "usletter" "inches" "100" on	BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay" delay ic frame df numChans	"orange"     "AGC1"     "1/Fs"  "Integer Delay" [1, 1, 0, 0, 0]     [200, 67,     "red"  "Integer  "160" "0" off

```
Name
                         "Product"
                         [2, 1, 0, 0, 0]
          Ports
                                                         Line (
          Position
                            [145, 92,
                                                           SrcBlock
                                                                              "Suml"
175, 123]
                                                           SrcPort
                                                                              7
                            "green"
          BackgroundColor
                                                           Points
                                                                              [45. 0]
          Inputs
                                                           DstBlock
                                                                               "Sum"
          SaturateOnIntegerOverflow on
                                                           DstPort
       Block (
                                                         Line {
          BlockType
                                Sum
                                                           SrcBlock
                                                                              "Product"
          Name
                         "Sum"
                                                           SrcPort
                                                                              1
                         [2, 1, 0, 0, 0]
          Ports
                                                           Points
                                                                              [5, 0]
          Position
                             [375, 121,
                                                           Branch {
405, 1541
                                                         Points
                                                                        [0, 0]
         BackgroundColor
                                 "green"
                                                         DstBlock
                                                                        "Integer Delay"
          DropShadow
                             on
                                                         DstPort
          IconShape
"rectangular"
                                                           Branch (
         Inputs
                                                                        [0, 35]
                                                         Points
          SaturateOnIntegerOverflow on
                                                         DstBlock
                                                                        "Sum"
                                                         DstPort
                                                                        2
        Block (
                                                           }
          BlockType
                                Sum
                         "Sumi"
[2, 1, 0, 0, 0]
          Name
                                                         Line (
          Ports
                                                           SrcBlock
                                                                               "Sum"
          Position
                            [280, 77,
                                                           SrcPort
310, 108]
                                                           Points
                                                                               [10, 0]
          BackgroundColor
                                "green"
                                                           Branch {
          DropShadow
                             on
                                                         DstBlock
                                                                         *Data
          IconShape
                                                  Store\nWrite"
"rectangular"
                                                         DstPort
                                                                        1
          Inputs
                                                           }
          SaturateOnIntegerOverflow on
                                                           Branch (
                                                         DstBlock
                                                                         "Out1"
        Block (
                                                         DstPort
          BlockType
                                Outport
                                                           3
                         "Out1"
          Name
                                                         }
          Position
                            [490, 133,
                                                       }
520, 147]
          BackgroundColor
                                 "cyan"
                                                     Block {
          Port
                                                       BlockType
                                                                       Fcn
          OutputWhenDisabled
                                  "held"
                                                       Name
                                                                       "Fen"
          InitialOutput
                                 *0*
                                                       Position
                                                                      [720, 130, 780, 160]
                                                        BackgroundColor "yellow"
        Line {
                                                       Expr
                                                                      "power(10,((u/20)-
                             *Constant*
          SrcBlock
                                                  5.5))*
          SrcPort
          Points
                             [15, 0]
                                                     Block {
          DstBlock
                             "Product"
                                                       BlockType
                                                                       Fcn
          DstPort
                                                       Name
                                                                       "Fcn1"
                                                        Position
                                                                      [625, 110, 685, 140]
        Line {
                                                       BackgroundColor "yellow"
          SrcBlock
                             "Inl"
                                                                       "power(10,((u/20)-
                                                       Expr
          SrcPort
                                                  5.5))*
          DstBlock
                             "Product"
          DstPort
                                                      Block (
                                                       BlockType
                                                                       Logic
        Line {
                                                        Name
                                                                       "Logical\nOperator2"
          SrcBlock
                             "Data
                                                       Ports
                                                                       [1, 1, 0, 0, 0]
Store\nRead"
                                                       Position
                                                                       [450, 144, 480, 176]
                                                       BackgroundColor "yellow"
         SrcPort
          Points
                             [20. 0]
                                                       Operator
                                                                       "NOT"
          DstBlock
                             "Sum1"
                                                       Inputs
                                                                       *1*
          DstPort
                                                     Block {
        Line {
                                                       BlockType
                                                                       Math
          SrcBlock
                             "Integer
                                                                       "Math\nFunction"
                                                        Name
Delay*
                                                                      [1, 1, 0, 0, 0]
[960, 75, 990, 105]
                                                       Ports
          SrcPort
                                                       Position
          DstBlock
                                                       BackgroundColor "red"
ShowName off
                             "Sum1"
          DstPort
```

```
"log"
                                                         Ports [2, 1, 0, 0, 0]
Position [500, 217, 530, 248]
      Operator
      OutputSignalType "auto"
                                                         BackgroundColor "green"
Inputs "2"
   Block {
                                                         Inputs
      BlockType
                     Math
                                                         SaturateOnIntegerOverflow on
                      "Math\nFunction1"
      Name
      Ports
                      [1, 1, 0, 0, 0]
                                                       Block (
                                                         BlockType
                    [1110, 85, 1140,
      Position
                                                                       Product
                                                         Name
1151
                                                                        "Product2"
      BackgroundColor "red"
ShowName off
Operator "exp"
                                                         Ports
                                                                       [2, 1, 0, 0, 0]
[1060, 82, 1090,
                                                         Position
                                                   113]
      OutputSignalType "auto"
                                                         BackgroundColor "yellow"
                                                         Inputs
    Block {
                                                         SaturateOnIntegerOverflow on
      BlockType Product
                     "Product"
      Name
                                                       Block {
      Ports [2, 1, 0, 0, 0]
Position [800, 72, 830, 103]
                                                         BlockType Product
                                                         Name
                                                                        "Product3"
      BackgroundColor "yellow"
Inputs "*/"
                                                         Ports
                                                                        [2, 1, 0, 0, 0]
[1175, 77, 1205,
                                                         Position
      SaturateOnIntegerOverflow on
                                                   108]
                                                         BackgroundColor "yellow"
Inputs "**"
    Block {
                                                         Inputs
      BlockType Product
                                                         SaturateOnIntegerOverflow on
      Name
                     "Product1"
      Ports [2, 1, 0, 0, 0]
Position [880, 252, 910, 283]
                                                       Block {
                                                         BlockType
                                                                       Product
                                                         Name
      BackgroundColor "yellow"
Inputs "*/"
                                                                        "Product4"
      Inputs
                                                         Ports [2, 1, 0, 0, 0]
Position [905, 322, 935, 353]
      SaturateOnIntegerOverflow on
                                                         BackgroundColor "yellow"
    Block {
                                                         Inputs **/*
      BlockType
                    Product
                                                         SaturateOnIntegerOverflow on
      Name
Ports
                     *Product10*
                     [2, 1, 0, 0, 0]
                                                       Block {
      Ports [2, 1, 0, 0, 0]
Position [500, 67, 530, 98]
                                                         BlockType
                                                                      RelationalOperator
      BackgroundColor "green"
Inputs "2"
                                                         Name
      Inputs
                                                    "Relational\nOperator3"
      SaturateOnIntegerOverflow on
                                                         Position [395, 142, 425, 173]
                                                         BackgroundColor "yellow"
Operator ">="
    Block {
                                                         Operator
      BlockType
                    Product
      Name
                     "Product11"
                                                       Block {
      Ports [2, 1, 0, 0, 0]
Position [390, 257, 420, 288]
                                                         BlockType
                                                                        SubSystem
                                                         Name
                                                                         "SlowMoving"
      BackgroundColor "green"
Inputs "2"
                                                         Ports [1, 1, 0, 0, 0]
Position [155, 137, 185, 193]
                                                         Ports
      SaturateOnIntegerOverflow on
                                                         BackgroundColor "orange"
                                                         DropShadow
                                                                            on
    Block {
                                                         ShowPortLabels
                                                                            off
      BlockType
                     Product
                                                         System (
      Name
                      "Product12"
                                                           Name
                                                                           "SlowMoving"
      Ports [2, 1, 0, 0, 0]
Position [390, 212, 420, 243]
                                                           Location
                                                                              [65, 141, 853,
                                                   4821
      BackgroundColor "green" Inputs "2"
                                                           Open
                                                                           off
                                                           ModelBrowserVisibility off
      SaturateOnIntegerOverflow on
                                                           ModelBrowserWidth
                                                           ScreenColor
    Block {
                                                    "lightBlue"
      BlockType
                    Product
                                                           PaperOrientation
                      "Product13"
                                                    "landscape"
                      [2, 1, 0, 0, 0]
                                                           PaperPositionMode
      Ports
                                                                                 "auto"
      Position [490, 311, 520, 344]
                                                           PaperType "usletter"
PaperUnits "inches"
      BackgroundColor "green"
      Inputs **/*
                                                                              -100-
                                                           ZoomFactor
      SaturateOnIntegerOverflow on
                                                           AutoZoom
                                                                               OIL
                                                           Block {
    Block {
                                                             BlockType
                                                                                     Import
                                                                           "Inl"
      BlockType
                     Product
                                                             Name
      Name
                      "Product14"
```

```
[75, 93,
         Position
                                                           Name
                                                                           "Product"
                                                                         [2, 1, 0, 0, 0]
[145, 92,
105, 107]
                                                           Ports
         BackgroundColor
                                "cyan"
                                                           Position
                        -1-
         Port
                                                 175, 123]
                                                                              *green*
          PortWidth
                                                           BackgroundColor
         SampleTime
                             -1-
                                                           Inputs
                            "auto"
         DataType
                                                           SaturateOnIntegerOverflow on
          SignalType
                             "auto"
         Interpolate
                             on
                                                         Block (
                                                           BlockType
                                                                                  Sum
        Block {
                                                                           "Sum"
                                                           Name
                                                                          [2, 1, 0, 0, 0]
[375, 121,
          BlockType
                                Constant
                                                           Ports
          Name
                         "Constant"
                                                           Position
          Position
                            [80, 134,
                                                 405, 154]
110, 156]
                                                           BackgroundColor
                                                                                  "green"
         BackgroundColor
                                 "red"
                                                           DropShadow
                                                                              on
                         *3520*
         Value
                                                           IconShape
                                                  "rectangular"
        Block (
                                                           Inputs
          BlockType
                                                           SaturateOnIntegerOverflow on
DataStoreMemory
                         "Data
         Name
                                                         Block {
Store\nMemory*
                                                           BlockType
                                                                                  Sum
          Position
                             [430, 35,
                                                           Name
                                                                           "Sum1"
                                                                           [2, 1, 0, 0, 0]
[280, 77,
462, 65]
                                                           Ports
          BackgroundColor
                                 "orange"
                                                           Position
          DataStoreName
                                "AGCS1"
                                                 310, 108]
                             -0-
          InitialValue
                                                           BackgroundColor
                                                                                  "green"
                                                           DropShadow
                                                                              on
        Block {
                                                           IconShape
          BlockType
                                                  "rectangular"
DataStoreRead
                                                           Inputs
         Name
                         "Data
                                                           SaturateOnIntegerOverflow on
Store\nRead"
         Position
                             [210, 155,
                                                         Block (
240, 185]
                                                           BlockType
                                                                                  Outport
          BackgroundColor
                                                                           "Outl"
                                 "orange"
                                                           Name
          DataStoreName
                                 "AGCS1"
                                                           Position
                                                                             [490, 133,
                            "1/Fs"
          SampleTime
                                                  520, 147]
                                                           BackgroundColor
                                                                                   "cyan"
        Block {
                                                           Port
          BlockType
                                                            OutputWhenDisabled
                                                                                   "held"
DataStoreWrite
                                                           InitialOutput
          Name
                         "Data
Store\nWrite*
                                                         Line {
                             [435, 175,
                                                           SrcBlock
                                                                               "Constant"
465, 205]
                                                           SrcPort
          BackgroundColor
                                 "orange"
                                                           Points
                                                                               [15, 0]
          DataStoreName
                                "AGCS1"
                                                           DstBlock
                                                                               "Product"
          SampleTime
                             "1/Fs"
                                                           DstPort
                                                          }
        Block (
                                                         Line (
          BlockType
                                                                               "Inl"
                                                           SrcBlock
Reference
                                                           SrcPort
          Name
                          "Integer Delay"
                                                           DstBlock
                                                                               *Product*
                         [1, 1, 0, 0, 0]
[200, 67,
          Ports
                                                           DstPort
                                                                               1
          Position
245, 103]
                                                         Line {
          BackgroundColor
                                 "red"
                                                           SrcBlock
                                                                               "Data
          SourceBlock
                                                  Store\nRead*
"dspbdsp2/Integer Delay"
                                                           SrcPort
          SourceType
                             "Integer
                                                            Points
                                                                               [20, 0]
Delay*
                                                           DstBlock
                                                                               "Suml"
          delay
                         *3520*
                                                            DstPort
                         -0-
          ic
                                                          }
                         off
          frame
                                                         Line (
          đ£
                                                            SrcBlock
                                                                               "Integer
          numChans
                             -1-
                                                  Delay*
                                                            SrcPort
        Block {
                                                           DstBlock
                                                                               "Suml"
          BlockType
                                 Product
                                                           DstPort
```

```
Block {
                                                       BlockType
       Line {
                                                                       Sum
                             "Suml"
         SrcBlock
                                                       Name
                                                                       "Sum13"
                                                                       [2, 1, 0, 0, 0]
[440, 252, 470, 283]
         SrcPort
                                                       Ports
         Points
                             [45, 0]
                                                       Position
         DstBlock
                             "Sum"
                                                       BackgroundColor *green*
         DstPort
                                                       IconShape "rectangular"
                                                       Inputs
       Line {
                                                        SaturateOnIntegerOverflow on
                             "Product"
         SrcBlock
                             1
         SrcPort
                                                     Block {
         Points
                                                       BlockType
                             [5, 0]
                                                                       Sum
         Branch {
                                                       Name
                                                                       "Sum14"
                                                                      [2, 1, 0, 0, 0]
[395, 317, 425, 348]
       Points
                       [0, 0]
                                                       Ports
       DstBlock
                       "Integer Delay"
                                                        Position
                                                        BackgroundColor "green"
       DstPort
                                                                       "rectangular"
         }
                                                        IconShape
         Branch (
                                                        Inputs
       Points
                       [0, 35]
                                                        SaturateOnIntegerOverflow on
       DstBlock
                       "Sum"
                       2
       DstPort
                                                      Block (
                                                        BlockType
         }
                                                                       Sum
                                                        Name
                                                                       "Sum2 "
       Line (
                                                                       [2, 1, 0, 0, 0]
                                                        Ports
         SrcBlock
                             "Sum"
                                                        Position
                                                                       [1015, 213, 1035,
         SrcPort
                                                  242]
         Points
                             [10, 0]
                                                        BackgroundColor
                                                                           "orange"
         Branch {
                                                        ShowName
                                                                    off
       DstBlock
                       "Data
                                                        IconShape
                                                                        "rectangular"
Store\nWrite"
                                                        Inputs
                                                                       *+-*
       DstPort
                       1
                                                        SaturateOnIntegerOverflow on
         Branch {
                                                      Block {
       DstBlock
                       "Outl"
                                                        BlockType
                                                                       Sum
       DstPort
                                                        Name
                                                                        "Sum3"
                                                                       [2, 1, 0, 0, 0]
[960, 293, 980, 322]
        }
                                                        Ports
       }
                                                        Position
     }
                                                        BackgroundColor
                                                                          "orange"
                                                                   off
                                                        ShowName
   Block {
                                                        IconShape
                                                                        "rectangular"
     BlockType
                     Sum
                                                        Inputs
     Name
                     "Sum"
                                                        SaturateOnIntegerOverflow on
                     [2, 1, 0, 0, 0]
[820, 258, 840, 287]
      Ports
     Position
                                                      Block {
     BackgroundColor "orange"
                                                        BlockType
                                                                        Sum
     ShowName off
                                                        Name
                                                                        "Sum8 "
     IconShape
                     "rectangular"
                                                                        [2, 1, 0, 0, 0]
                                                        Ports
      Inputs
                                                        Position
                                                                        [560, 107, 590, 138]
     SaturateOnIntegerOverflow on
                                                        BackgroundColor "green"
                                                        IconShape
                                                                        "rectangular"
    Block {
                                                        Inputs
     BlockType
                     Sum
                                                        SaturateOnIntegerOverflow on
      Name
                     "Sum1"
     Ports
                     [2, 1, 0, 0, 0]
                                                      Block {
                     [940, 203, 960, 232]
      Position
                                                        BlockType
                                                                        Switch
                        *orange*
     BackgroundColor
                                                        Name
                                                                        "Switch"
      ShowName
                   off
                                                                        [885, 75, 915, 105]
                                                        Position
      IconShape
                     "rectangular"
                                                        BackgroundColor "yellow"
      Inputs
                                                        NamePlacement
                                                                                "alternate"
      SaturateOnIntegerOverflow on
                                                        ShowName
                                                                        off
                                                                        *10.^-8*
                                                        Threshold
   Block {
     BlockType
                     Sum
                                                      Block {
     Name
                     "Sum12"
                                                        BlockType
                                                                        SubSystem
                     [2, 1, 0, 0, 0]
[335, 262, 365, 293]
      Ports
                                                        Name
                                                                        "dB Conv"
     Position
                                                        Ports
                                                                        [1, 1, 0, 0, 0]
     BackgroundColor "green"
                                                                        [210, 63, 235, 97]
                                                        Position
      IconShape
                     "rectangular"
                                                        BackgroundColor "darkGreen"
      Inputs
                     --+
                                                        DropShadow
     SaturateOnIntegerOverflow on
                                                        ShowPortLabels
                                                                           off
    ŀ
                                                        System {
```

```
"dB Conv"
      Location
                                                      Position
                                                                       [280, 70,
                     [12, 74, 478, 310, 100]
3991
                                                      BackgroundColor
                                                                           "orange"
                     off
                                                      Threshold
       ModelBrowserVisibility off
ModelBrowserWidth 200
                                                     Block (
                                                                    Outport
                                                      BlockType
       ScreenColor
"lightBlue"
                                                      Name
       PaperOrientation
                                                      Position
                                                                     [360, 78,
"landscape"
                                             390, 92]
       PaperPositionMode "auto"
                                                      BackgroundColor "cyan"
Port "1"
       PaperType "usletter"
PaperUnits "inches"
ZoomFactor "100"
                                                      Port
                                                      OutputWnenDisabled "held" InitialOutput "[]"
       AutoZoom
                       on
       Block {
                       Inport
                                                     Line {
         BlockType
                                                                        "Fcn"
                                                      SrcBlock
                                                      SrcPort
         Name
         Position
                        [25, 68, 55,
                                                      Points
                                                                        [15. 0]
82]
                                                      DstBlock
                                                                        "Switch"
         BackgroundColor
Port "1"
                            "cyan"
                                                      DstPort
         PortWidth
                                                     Line {
                          -1-
         SampleTime
                                                      SrcBlock
                                                                        "Inl"
         DataType
                          "auto"
                                                      SrcPort
                                                                        1
         SignalType
                          "auto"
                                                      Points
                                                                        [10, 0]
         Interpolate
                          on
                                                      Branch {
                                                    Points
DstBlock
                                                                 [0, -45; 195, 0]
       Block {
                                                                   "Switch"
                     Constant
         BlockType
                                                   DstPort
                     *Constant1*
                                                     }
Branch {
         Name
         Name
Position
                         [100, 80,
120, 1001
                                                    DstBlock
         BackgroundColor
                                                 "Relational\nOperator"
"darkGreen"
                                                    DstPort 1
        Value
                                                     }
Branch {
       Block {
                                                                  [0, 110]
                                                     Points
                                                     DstBlock
         BlockType
                              Fcn
                                                                  "Sum"
                       "Fcn"
         Name
                                                     DstPort
                                                                   2
         Position
                        [185, 165,
                                                      }
245, 195]
         BackgroundColor
                              "vellow"
                                                     Line (
         Expr
                                                      SrcBlock
                                                                        "Constant1"
"20"log10(u/(3.1623"power(10,-6)))"
                                                      SrcPort
                                                      DstBlock
       Block {
                                              "Relational\nOperator"
         BlockType
                                                     DstPort
                                                                        2
RelationalOperator
         Name
                                                     Line {
"Relational\nOperator"
                                                      SrcBlock
        Position
                           [145, 67,
                                              "Relational\nOperator"
175, 98]
                                                      SrcPort
                           "yellow"
         BackgroundColor
                                                      Points
                                                                       [30, 0]
         Operator
                                                      Branch {
                                                     DstBlock
                                                                  "Switch"
       Block {
                                                     DstPort
         BlockType
                              Sum
                                                      }
         Name
                       "Sum"
                                                      Branch {
                       [2, 1, 0, 0, 0]
         Ports
                                                     Points
                                                                  [0, 50; -105, 0]
         Position
                          [120, 162,
                                                     DstBlock
                                                                   "Sum"
150, 193]
                                                     DstPort
                                                                   1
         BackgroundColor
                            *green*
                                                      ŀ
         IconShape
"rectangular"
                                                     Line {
         Inputs
                                                     SrcBlock
                                                                        "Sum"
         SaturateOnIntegerOverflow on
                                                      SrcPort
                                                      DstBlock
                                                                        "Fcn"
       Block {
                                                      DstPort
         BlockType
                             Switch
         Name
                       "Switch"
                                                     Line {
```

```
SrcBlock
                           "Switch"
                                                       Block (
         SrcPort
                           1
         DstBlock
                           "Outl"
                                                        BlockType
                                                                              Sum
                                                                       "Sum"
         DstPort
                                                        Name
       }
                                                        Ports
                                                                       [2, 1, 0, 0, 0]
     }
                                                                          [120, 162,
                                                        Position
   ł
                                               150, 1931
   Block {
                                                        BackgroundColor
                                                                              "green"
     BlockType
                    SubSystem
                                                        IconShape
     Name
                    "dB Conv.-LF"
                                               "rectangular"
     Ports
                   [1, 1, 0, 0, 0]
                                                        Inputs
                   [210, 158, 235, 192]
     Position
                                                        SaturateOnIntegerOverflow on
     BackgroundColor "darkGreen"
     DropShadow
                                                       Block {
     ShowPortLabels
                     off
                                                        BlockType
                                                                              Switch
     System {
                                                                       "Switch"
                                                        Name
       Name
                      "dB Conv.-LF"
                                                        Position
                                                                          [280, 70,
       Location
                        [154, 318,
                                               310, 100]
620, 643]
                                                        BackgroundColor
                                                                              "orange"
       Open
                     off
                                                        Threshold
       ModelBrowserVisibility off
       ModelBrowserWidth 200
                                                       Block {
       ScreenColor
                                                         BlockType
                                                                              Outport
                                                                       "Outl"
"lightBlue"
                                                         Name
       PaperOrientation
                                                         Position
                                                                          [360, 78,
"landscape"
                                               390, 921
                            "auto"
       PaperPositionMode
                                                         BackgroundColor
                  "usletter"
       PaperType
                                                         Port
                                                         OutputWhenDisabled
       PaperUnits
                         "inches"
                                                                               "held"
                         *100*
       ZoomFactor
                                                         InitialOutput
                                                                              -[]-
       AutoZoom
                         on
       Block (
                                                       Line {
                        Inport
         BlockType
                                                        SrcBlock
                                                                           "Fcn"
         Name
                                                        SrcPort
         Position
                          [25, 68, 55,
                                                        Points
                                                                           [15, 0]
821
                                                        DstBlock
                                                                           "Switch"
         BackgroundColor
                               "cyan"
                                                        DstPort
                                                                           3
         Port
         PortWidth
                                                       Line (
         SampleTime
                                                                           "Inl"
                                                        SrcBlock
         DataType
                            "auto"
                                                        SrcPort
         SignalType
                            "auto"
                                                        Points
                                                                           [10, 0]
         Interpolate
                            on
                                                        Branch (
                                                                     [0, -45; 195, 0]
                                                       Points
       Block {
                                                       DstBlock
                                                                     "Switch"
         BlockType
                              Constant
                                                       DstPort
         Name
                        *Constantl*
                                                        }
         Position
                            [100, 80,
                                                         Branch {
120, 100]
                                                       DstBlock
         BackgroundColor
                                                   "Relational\nOperator"
"darkGreen"
                                                       DstPort
         Value
                                                        }
                                                         Branch {
       Block {
                                                       Points
                                                                     [0, 110]
         BlockType
                               Fcn
                                                       DstBlock
                                                                     "Sum"
         Name
                        "Fcn"
                                                       DstPort
         Position
                           [185, 165,
                                                        ŀ
245, 1951
         Back_roundColor
                               "yellow"
                                                       Line {
         Expr
                                                         SrcBlock
                                                                           *Constantl*
"20"log10(u/(3.1623"power(10,-6)))"
                                                         SrcPort
                                                        DstBlock
       Block {
                                               "Relational\nOperator"
         BlockType
                                                         DstPort
RelationalOperator
         Name
                                                       Line {
"Relational\nOperator"
                                                         SrcBlock
         Position
                            [145, 67,
                                               "Relational\nOperator"
175, 981
                            "yellow"
                                                         SrcPort
         BackgroundColor
                                                         Points
                                                                           [30, 0]
         Operator
                                                         Branch {
```

```
DstBlock
                     "Switch"
                                                     DstBlock
                                                                    "Sum"
       DstPort
                                                     DstPort
                                                                    2
         }
         Branch {
                                                   Line {
       Points
                     [0, 50; -105, 0]
                                                                    "Sum"
                                                     SrcBlock
       DstBlock
                      "Sum"
                                                     SrcPort
                                                                    1
       DstPort
                                                     DstBlock
                                                                    *Product1*
                                                                    2
        }
                                                     DstPort
       Line {
                                                   Line {
         SrcBlock
                            "Sum"
                                                     SrcBlock
                                                                    "In3"
         SrcPort
                                                     SrcPort
         DstBlock
                            "Fcn"
                                                                    [15, 0; 0, -65; 205,
                                                     Points
        DstPort
                                                0; 0, 20]
                                                     DstBlock
                                                                    *Product1*
       Line {
                                                     DstPort
         SrcBlock
                            "Switch"
         SrcPort
                                                   Line (
         DstBlock
                            "Outl"
                                                     SrcBlock
                                                                    "Suml"
         DstPort
                                                     SrcPort
                                                                    1
       }
                                                      DstBlock
                                                                    "Sum2"
     }
                                                     DstPort
                                                                    1
   Block {
                                                    Line {
     BlockType
                   Constant
                                                      SrcBlock
                                                                    "Constant"
     Name
                    "effect"
                                                      SrcPort
                [255, 210, 275, 230]
     Position
                                                      Points
                                                                    [105. 0]
     BackgroundColor "red"
Value "6"
                                                      Branch (
     Value
                                                       DstBlock
                                                                          "Suml"
                                                       DstPort
                                                                      1
   Block (
     BlockType
                    Outport
                                                      Branch (
     Name
                    "Out1"
                                                       Points
                                                                      [0, -20; 130, 0]
     Position
                    [1230, 88, 1260,
                                                       Branch {
102]
                                                         Points
                                                                            [120, 0; 0,
     BackgroundColor "cyan"
Port "1"
                                                45]
                                                                            "Sum2"
                                                         DstBlock
     OutputWhenDisabled
                            "held"
                                                         DstPort
     InitialOutput
                            -0-
                                                        Branch (
   Line {
                                                         Points
                                                                            [0, -90]
                    "Inl"
     SrcBlock
                                                          DstBlock
                                                                            "Switch"
     SrcPort
                                                         DstPort
     Points
                    [5, 0]
     Branch {
                                                      }
      DstBlock
                          "Abs"
       DstPort
                     1
                                                    Line {
                                                                     "Sum2"
                                                      SrcBlock
     Branch {
                                                      SrcPort
                                                                    1
                      [0, -80; 1085, 0]
      Points
                                                                     [5, 0]
                                                      Points
       DstBlock
                          "Product3"
                                                      DstBlock
                                                                     "Product2"
       DstPort
                                                      DstPort
                                                    Line {
   Line {
                                                      SrcBlock
                                                                     "Math\nFunction"
                    "Abs"
     SrcBlock
                                                      SrcPort
     SrcPort
                    1
                                                      DstBlock
                                                                     "Product2"
     Points
                    [5. 0]
                                                      DstPort
                                                                     1
     Branch {
      DstBlock
                          "FastMoving"
                                                    Line (
       DstPort
                      1
                                                      SrcBlock
                                                                     "Product2"
                                                      SrcPort
                                                                     1
     Branch {
                                                      DstBlock
                                                                     "Math\nFunction1"
       DstBlock
                          "SlowMoving"
                                                      DstPort
                                                                     1
       DstPort
                      1
     ł
                                                    Line {
                                                      SrcBlock
                                                                     "Math\nFunction1"
   Line {
                                                      SrcPort
                                                                    1
     SrcBlock
                    "In5"
                                                      DstBlock
                                                                     *Product3*
     SrcPort
                                                     DstPort
     Points
                    [20, 0]
```

```
DstBlock
                                                                  "Suml"
Line {
  SrcBlock
                 "Product3"
                                                   DstPort
  SrcPort
                 1
 DstBlock
                 "Outl"
                                                 Line {
 DstPort
                                                   SrcBlock
                                                                  "Logical\nOperator2"
                 1
                                                   SrcPort
                                                                  1
Line {
                                                   DstBlock
                                                                  "Product14"
  SrcBlock
                                                   DstPort
                 *Product*
  SrcPort
  Points
                 [25, 0]
                                                 Line {
  Branch {
                                                   SrcBlock
   DstBlock
                      "Switch"
                                             "Relational\nOperator3"
                                                   SrcPort
   DstPort
                                                   Points
                                                                  [5, 0]
  Branch {
                                                   Branch (
   Points
                   [0, -10]
                                                     Points
                                                                    [0. -70]
    DstBlock
                       "Switch"
                                                     DstBlock
                                                                        *Product10*
    DstPort
                                                    DstPort
  }
                                                   Branch {
Line {
                                                    DstBlock
  SrcBlock
                 "Switch"
                                              "Logical\nOperator2"
  SrcPort
                                                    DstPort
  DstBlock
                 "Math\nFunction"
  DstPort
                 1
                                                 Line {
Line (
                                                   SrcBlock
                                                                   "Product11"
  SrcBlock
                 "In4"
                                                   SrcPort
                                                                   1
  SrcPort
                                                   DstBlock
                                                                   "Sum13"
  Points
                 [0. -40]
                                                   DstPort
  Branch (
   DstBlock
                       " Sum "
                                                 Line {
   DstPort
                                                                   "Product12"
                                                   SrcBlock
                                                   SrcPort
  Branch (
                                                    DstBlock
                                                                   "Suml3"
    Points
                   [-20, 0]
                                                   DstPort
                                                                   1
    DstBlock
                      "Fcn"
    DstPort
                                                 Line {
  }
                                                    SrcBlock
                                                                   "Sum13"
}
                                                    SrcPort
Line {
                                                    DstBlock
                                                                   "Product13"
  SrcBlock
                 "Fcn"
                                                    DstPort
  SrcPort
                 1
  DstBlock
                 "Product"
                                                 Line (
  DstPort
                 2
                                                    SrcBlock
                                                                   "Product10"
                                                    SrcPort
                                                                   1
Line {
                                                    Points
                                                                   [10, 0]
                 "Product4"
  SrcBlock
                                                    DstBlock
                                                                   "Sum8"
  SrcPort
                                                    DstPort
  Points
                 [5, 0]
  DstBlock
                 "Sum3"
                                                  Line {
  DstPort
                                                    SrcBlcck
                                                                   *Product14*
                                                    SrcPort
Line {
                                                    Points
                                                                   [10, 0]
  SrcBlock
                 "Constant1"
                                                    DstBlock
                                                                   "Sum8"
  SrcPort
                 1
                                                    DstPort
  Points
                 [60, 0]
  DstBlock
                 "Product4"
                                                  Line {
  DstPort
                                                    SrcBlock
                                                                   "Sum12"
                                                    SrcPort
Line {
                                                    Points
                                                                   [0, 0]
  SrcBlock
                 "Product1"
                                                    Branch {
  SrcPort
                 1
                                                     DstBlock
                                                                         "Productll"
  Points
                 [20, 0; 0, 30]
                                                      DstPort
                                                                     2
  DstBlock
                 "Sum3 "
  DstPort
                                                    Branch {
                                                      Points
                                                                     [0, 45]
Line {
                                                      DstBlock
                                                                         "Sum14"
  SrcBlock
                 "Sum3"
                                                      DstPort
  SrcPort
                                                   ŀ
  Points
                 [0, -65; -60, 0]
                                                  }
```

```
Line {
                                                        Branch {
     SrcBlock
                    *effect*
                                                          Points
                                                                             [-85, 0; 0,
                                                551
     SrcPort
                    1
     Points
                    [0, 0]
                                                          DstBlock
                                                                             "Sum12"
     Branch {
                                                          DstPort
       DstBlock
                          *Product12*
       DstPort
                                                        Branch {
                                                          DstBlock
                                                                             "Product11"
     Branch {
                                                          DstPort
                                                                             1
       Points
                      [0, 120]
       DstBlock
                          "Sum14"
                                                      }
       DstPort
                                                    }
     }
                                                    Line {
                                                      SrcBlock
                                                                     "FastMoving"
   Line {
                                                      SrcPort
                                                                     1
                    "Sum14"
     SrcBlock
                                                      Points
                                                                      [5, 0]
     SrcPort
                                                      DstBlock
                                                                      "dB Conv"
     DstBlock
                    *Product13*
                                                      DstPort
                                                                      1
     DstPort
                                                    Line {
   Line {
                                                      SrcBlock
                                                                      "SlowMoving"
     SrcBlock
                     "Product13"
                                                      SrcPort
                                                                      1
                                                                      [5, 0]
     SrcPort
                                                      Points
     Points
                     [0, -65; -40, 0]
                                                      DstBlock
                                                                      "dB Conv.-LF"
     DstBlock
                     *Product14*
                                                      DstPort
                                                                      1
     DstPort
                                                     Line {
   Line {
                                                       SrcBlock
                                                                      "Fcnl"
                     "dB Conv"
     SrcBlock
                                                       SrcPort
     SrcPort
                                                                      [25, 0; 0, -45]
                                                      Points
     Points
                    [45, 0; 0, 20; 40,
                                                      DstBlock
                                                                      *Product*
0!
                                                      DstPort
     Branch (
       Points
                       [0, -25]
                                                     Line (
       DstBlock
                           "Product10"
                                                       SrcBlock
                                                                      "Sum8"
       DstPort
                                                       SrcPort
                                                                      1
                                                       Points
                                                                      [10, 0]
     Branch (
                                                       Branch {
       Points
                       [5, 0]
                                                        DstBlock
                                                                            "Fcnl"
       Branch {
                                                        DstPort
         Points
                           [-10, 0; 0,
135]
                                                       Branch (
         Branch {
                                                                        [0, 35; -40, 0; 0,
                                                         Points
       DstBlock
                       "Sum12"
                                                 170]
       DstPort
                                                         DstBlock
                                                                            *Product4*
         }
                                                         DstPort
                                                                        1
         Branch {
       DstBlock
                       *Product12*
                                                     }
       DstPort
        }
                                                     Block {
       Branch (
                                                       BlockType
                                                                             SubSystem
         Points
                             [50, 0]
                                                       Name
         DstBlock
                                                 "homomorphic\nmultiplicative AGC2"
"Relational\nOperator3"
                                                       Ports [4, 1, 0, 0, 0]
Position [440, 139, 470,
        DstPort
                             1
       }
                                                 1961
     }
                                                       BackgroundColor
                                                                              "orange"
                                                       DropShadow
                                                                         on
                                                       ShowPortLabels
                                                                              off
                     *dB Conv.-LF*
     SrcBlock
                                                       System (
     SrcPort
                                                     Name
     Points
                    [0, 5; 35, 0; 0, -
                                                     "homomorphic\nmultiplicative AGC2"
15; 100, 0]
                                                     Location [97, 88, 873, 465]
     Branch {
                                                     Open
                                                                    off
       DstBlock
                                                     ModelBrowserVisibility off
"Relational\nOperator3"
                                                     ModelBrowserWidth 200
      DstPort
                                                     ScreenColor "lightBlue"
                                                     PaperOrientation "landscape"
PaperPositionMode "auto"
     Branch {
        Points
                       [0, 65]
                                                                   "usletter"
                                                     PaperType
```

```
PaperUnits
               "inches"
                                                Block {
                                                  BlockType
               -100-
ZoomFactor
                                                                SubSystem
                                                                 "FastMoving"
[1, 1, 0, 0, 0]
[270, 57, 300, 113]
AutoZoom
               on
                                                  Name
Block {
                                                  Ports
 BlockType
                Inport
                                                  Position
                                                  BackgroundColor "orange"
                 "Inl"
 Name
                 [150, 78, 180, 92]
 Position
                , /8,
c "cyan"
"1"
                                                  DropShadow
                                                                     on
 BackgroundColor
                                                  ShowPortLabels
                                                                    off
 Port
                                                  System (
                 --1-
 PortWidth
                                                    Name
                                                                    "FastMoving"
                   --1-
 SampleTime
                                                                       [65, 141, 853,
                                                     Location
 DataType
                 "auto"
                                             4821
 SignalType
                    "auto"
                                                                    off
                                                     ModelBrowserVisibility off
 Interpolate
                    on
                                                     ModelBrowserWidth
Block {
                                                     ScreenColor
 BlockType
                 Inport
                                             "lightBlue"
 Name
                 "In3"
                                                     PaperOrientation
                 [710, 298, 740, 312]
                                             "landscape"
  Position
                 "2"
  BackgroundColor
                                                     PaperPositionMode
                                                                           "auto"
                                                                       "usletter"
  Port
                                                     PaperType
  PortWidth
                 --1-
                                                     PaperUnits
                                                                       "inches"
                    --1-
  SampleTime
                                                     ZoomFactor
                                                                       "100"
  DataType
                 "auto"
                                                     AutoZoom
                                                                       on
  SignalType
                    "auto"
                                                     Block (
                                                                      Inport
  Interpolate
                     on
                                                       BlockType
                                                       Name
Block {
                                                       Position
                                                                       [75, 93,
  BlockType
                 Inport
                                             105, 107]
  Name
                 "In4"
                                                       BackgroundColor
                                                                             "cyan"
  Position
                 [805, 298, 835, 312]
                 , ∠98,
"cyan"
"3"
                                                       Port
  BackgroundColor
                                                       PortWidth
  Port
                                                       SampleTime
                                                                          --1-
  PortWidth
                 --1-
                                                                          "auto"
                                                       DataType
                   --1-
  SampleTime
                                                       SignalType
                                                                          "auto"
  DataType
                 "auto"
                                                       Interpolate
                                                                          on
  SignalType
                  "auto"
  Interpolate
                     on
                                                     Block (
                                                       BlockType
                                                                            Constant
Block (
                                                       Name
                                                                      *Constant*
  BlockType
                 Inport
                                                       Position
                                                                        [80, 134.
  Name
                 "In5"
                                             110, 156]
                 [865, 298, 895, 312]
  Position
                                                       BackgroundColor
                                                                              "red"
  BackgroundColor
                    "cyan"
                                                                      -160-
                                                       Value
  Port
  PortWidth
                 -1-
                                                     Block (
                    *-1*
  SampleTime
                                                       BlockType
  DataType
                 "auto"
                                             DataStoreMemory
  SignalType
                   "auto"
                                                       Name
                                                                      "Data
  Interpolate
                     on
                                             Store\nMemory"
                                                       Position
                                                                          [430, 35,
Block {
                                              462, 65]
  BlockType
                 Abs
                                                       BackgroundColor
                                                                              "orange"
                 "Abs"
  Name
                                                       DataStoreName
                                                                              "AGC2 "
  Position
                 [215, 70, 245, 100]
                                                       InitialValue
  BackgroundColor "red"
                                                     Block {
Block {
                                                       BlockType
  BlockType
                 Constant
                                             DataStoreRead
  Name
                 "Constant"
                                                       Name
                                                                      "Data
  Position
                 [710, 195, 740, 225]
                                             Store\nRead*
                 . "green"
  BackgroundColor
                                                       Position
                                                                          [210, 155,
  Value
                                             240, 1851
                                                       BackgroundColor
                                                                              "orange"
Block {
                                                       DataStoreName
                                                                             *AGC2
  BlockType
                 Constant
                                                       SampleTime
                                                                          "1/Fs"
  Name
                 "Constant1"
  Position
                 [910, 350, 940, 380]
                                                     Block {
  BackgroundColor *green*
                                                       BlockType
                 *330*
  Value
                                             DataStoreWrite
}
```

```
Name
                         "Data
Store\nWrite*
                                                          Line {
          Position
                             [435, 175,
                                                            SrcBlock
                                                                                "Constant"
465, 2051
                                                            SrcPort
                                                                               1
          BackgroundColor
                                 "orange"
                                                            Points
                                                                                [15, 0]
          DataStoreName
                                 "AGC2"
                                                            DstBlock
                                                                                "Product"
          SampleTime
                              "1/Fs"
                                                            DstPort
        Block {
                                                          Line {
          BlockType
                                                            SrcBlock
                                                                                "Inl"
Reference
                                                            SrcPort
                                                                                1
                         "Integer Delay"
                                                            DstBlock
                                                                                "Product"
                         [1, 1, 0, 0, 0]
[200, 67,
          Ports
                                                            DstPort
          Position
245, 103]
                                                          Line {
          BackgroundColor
                                "red"
                                                            SrcBlock
                                                                                *Data
          SourceBlock
                                                  Store\nRead*
"dspbdsp2/Integer Delay"
                                                            SrcPort
          SourceType
                             "Integer
                                                            Points
                                                                                [20, 0]
Delay*
                                                            DstBlock
                                                                                "Suml"
          delay
                         "160"
                                                            DstPort
                         -0-
          ic
                         off
          frame
                                                          Line {
          df
                         on
                                                            SrcBlock
                                                                                *Integer
          numChans
                             *1*
                                                  Delay*
                                                            SrcPort
        Block {
                                                            DstBlock
                                                                                "Suml"
          BlockType
                                Product
                                                            DstPort
                          *Product*
          Name
                          [2, 1, 0, 0, 0]
          Ports
                                                          Line {
                              [145, 92,
          Position
                                                            SrcBlock
                                                                                "Suml"
175, 123]
                                                            SrcPort
          BackgroundColor
                                "green"
                                                            Points
                                                                                [45. 0]
          Inputs
                                                            DstBlock
                                                                                "Sum"
          SaturateOnIntegerOverflow on
                                                            DstPort
        Block {
                                                          Line {
          BlockType
                                 Sum
                                                            SrcBlock
                                                                                "Product"
                          "Sum"
          Name
                                                            SrcPort
                         [2, 1, 0, 0, 0]
[375, 121,
          Ports
                                                            Points
                                                                                [5, 0]
          Position
                                                            Branch (
405, 154]
                                                          Points
                                                                          [0, 0]
          BackgroundColor
                                 "green"
                                                          DstBlock
                                                                          "Integer Delay"
          DropShadow
                              on
                                                          DstPort
          IconShape
                                                            }
"rectangular"
                                                            Branch {
          Inputs
                                                          Paints
                                                                          [0, 35]
          SaturateOnIntegerOverflow on
                                                          DstBlock
                                                                          "Sum"
                                                          DstPort
        Block {
                                                            }
          BlockType
                                 Sum
                         "Sum1"
[2, 1, 0, 0, 0]
[280, 77,
          Name
                                                           Line (
          Ports
                                                             SrcBlock
                                                                                "Sum"
          Position
                                                             SrcPort
310, 108]
                                                            Points
                                                                                [10. 0]
          BackgroundColor
                                  "green"
                                                            Branch {
          DropShadow
                              on
                                                          DstBlock
                                                                          "Data
          IconShape
                                                   Store\nWrite*
"rectangular"
                                                          DstPort
                                                                          1
          Inputs
          SaturateOnIntegerOverflow on
                                                            Branch {
                                                          DstBlock
                                                                          "Outl"
        Block {
                                                          DstPort
                          Outport
          BlockType
                                                             ł
          Name
                                                           }
          Position
                             [490, 133,
                                                        }
520, 147]
          BackgroundColor
                                 "cyan"
                                                      Block {
          Port
                                                        BlockType
                                                                        Fcn
          OutputWhenDisabled
                                  "held"
                                                        Name
                                                                        "Fcn"
          InitialOutput
                                 -0-
                                                        Position
                                                                        [835, 130, 895, 160]
```

```
BackgroundColor "yellow"
                                                    Block {
                   "power(10,((u/20)-
     Expr
                                                     BlockType
                                                                   Product
5.5))*
                                                     Name
                                                                     *Product11*
                                                                     [2, 1, 0, 0, 0]
   }
                                                     Ports
   Block {
                                                      Position
                                                                    [505, 257, 535, 288]
                                                     Position
BackgroundColor
"2"
     BlockType
                    Fcn
                                                                        "green"
                    "Fcnl"
     Name
                                                      Inputs
     Position [740, 110, 800, 140]
                                                      SaturateOnIntegerOverflow on
     BackgroundColor "yellow"
     Expr
                   "power(10,((u/20)-
                                                    Block {
5.5))*
                                                      BlockType
                                                                   Product
                                                      Name
                                                                    *Product12*
                                                                   [2, 1, 0, 0, 0]
   Block {
                                                      Ports
     BlockType
                    Logic
                                                                    [505, 212, 535, 243]
                                                      Position
                                                                    r "green"
"2"
                    "Logical\nOperator2"
     Name
                                                      BackgroundColor
                    [1, 1, 0, 0, 0]
[565, 144, 595, 176]
     Ports
                                                      Inputs
     Position
                                                      SaturateOnIntegerOverflow on
     Operator *NOT*
                                                    Block {
                    -1-
     Inputs
                                                      BlockType
                                                                   Product
                                                      Name
                                                                     *Product13*
   Block {
                                                                [2, 1, 0, 0, 0]
[605, 311, 635, 344]
                                                      Ports
     BlockType
                   Math
                                                      Position
                    "Math\nFunction"
                                                      Ports
                    [1, 1, 0, 0, 0]
[1075, 75, 1105,
     Position
                                                      SaturateOnIntegerOverflow on
105]
     BackgroundColor "red"
                                                    Block {
               off
"log"
     ShowName
                                                      BlockType
                                                                   Product
     Operator
                                                      Name
Ports
                                                                     "Product14"
     OutputSignalType "auto"
                                                                     [2, 1, 0, 0, 0]
                                                      Position
                                                                   [615, 217, 645, 248]
                                                      BackgroundColor "green"
Inputs "2"
   Block {
     BlockType
                    "Math\nFunction1"
     Name
                                                      SaturateOnIntegerOverflow on
     Ports [1, 1, 0, 0, 0]
Position [1260, 85, 1290,
                                                    Block {
1151
                                                      BlockType
                                                                   Product
     BackgroundColor
                        "red"
                                                      Name
                                                                    "Product2"
     ShowName off
                                                                     [2, 1, 0, 0, 0]
[1175, 82, 1205,
                                                      Ports
     Operator
                    exp"
                                                      Position
     OutputSignalType *auto*
                                                1131
                                                      BackgroundColor "yellow"
    Block {
                                                      Inputs
     BlockType
                    Product
                                                      SaturateOnIntegerOverflow on
                    "Product"
     Name
     Ports [2, 1, 0, 0, 0]
Position [915, 72, 945, 103]
                                                    Block (
                                                      BlockType
                                                                    Product
     BackgroundColor "yellow"
Inputs "*/"
                                                      Name
                                                                    "Product3"
      Inputs
                                                                    [2, 1, 0, 0, 0]
[1350, 77, 1380,
                                                      Ports
     SaturateOnIntegerOverflow on
                                                      Position
                                                 1081
    Block {
                                                      BackgroundColor "yellow"
      BlockType
                   Product
                                                      Inputs
      Name
                    *Product1*
                                                      SaturateOnIntegerOverflow on
      Ports
                     [2, 1, 0, 0, 0]
                  [995, 252, 1025,
      Position
                                                    Block {
2831
                   or "yellow"
                                                      BlockType
                                                                   Product
      BackgroundColor
                                                      Name
                                                                    "Product4"
     Inputs
                                                      Ports
                                                                     [2, 1, 0, 0, 0]
[1020, 322, 1050,
      SaturateOnIntegerOverflow on
                                                      Position
                                                 3531
    Block {
                                                      BackgroundColor "yellow"
     BlockType
                    Product
                                                      Inputs
     Name
                     "Product10"
                                                      SaturateOnIntegerOverflow on
     Ports
                    [2, 1, 0, 0, 0]
[615, 67, 645, 98]
     Position
                                                    Block {
     BackgroundColor *green*
Inputs *2*
                                                      BlockType
                                                                    RelationalOperator
                                                      Name
     SaturateOnIntegerOverflow on
                                                 "Relational\nOperator3"
                                                      Position [510, 142, 540, 173]
```

```
BackgroundColor "yellow"
                                                           BlockType
     Operator
                                                 DataStoreWrite
   }
                                                                          "Data
                                                           Name
   Block {
                                                 Store\nWrite"
     BlockType
                    SubSystem
                                                           Position
                                                                              [435, 175,
                     "SlowMoving"
     Name
                                                 465, 2051
                     [1, 1, 0, \bar{0}, 0]
     Ports
                                                           BackgroundColor
                                                                                  "orange"
                    [270, 137, 300, 193]
                                                                                  "AGCS2"
     Position
                                                           DataStoreName
     BackgroundColor
                        "orange"
                                                           SampleTime
                                                                              "1/Fs"
     DropShadow
                        on
     ShowPortLabels
                        off
                                                         Block {
     System {
                                                           BlockType
       Name
                       "SlowMoving"
                                                 Reference
                         [67, 139, 855,
       Location
                                                           Name
                                                                          "Integer Delay"
480]
                                                                          [1, 1, 0, 0, 0]
                                                           Ports
        Open
                       off
                                                           Position
                                                                              [200, 67,
       ModelBrowserVisibility off
                                                 245, 103]
        ModelBrowserWidth
                                                           BackgroundColor
                                                                                  "red"
        ScreenColor
                                                           SourceBlock
"lightBlue"
                                                 "dspbdsp2/Integer Delay"
       PaperOrientation
                                                           SourceType
                                                                              *Integer
"landscape"
                                                 Delay"
        PaperPositionMode
                            "auto"
                                                           delay
                                                                          *3520*
                          "usletter"
        PaperType
                                                           ic
                                                                          -0-
        PaperUnits
                          "inches"
                                                           frame
                                                                          off
                           "100"
        ZoomFactor
                                                           đf
                                                                          on
        AutoZoom
                           on
                                                           numChans
                                                                              -1-
        Block (
          BlockType
                                Inport
                                                         Block {
                         "Inl"
          Name
                                                           BlockType
                                                                                  Product
                                                                           "Product"
[2, 1, 0, 0, 0]
          Position
                           [75, 93,
                                                           Name
105, 1071
                                                           Ports
          BackgroundColor
                                "cyan"
                                                           Position
                                                                              [145, 92,
          Port
                                                 175, 123]
                                                                              "green"
          PortWidth
                                -1-
                                                           BackgroundColor
          SampleTime
                             -1-
                                                           Inputs
          DataType
                             "auto"
                                                           SaturateOnIntegerOverflow on
          SignalType
                             "auto"
          Interpolate
                             on
                                                         Block {
                                                           BlockType
                                                                                  Sum
        Block {
                                                           Name
                                                                           "Sum"
          BlockType
                                                                           [2, 1, 0, 0, 0]
                                Constant
                                                           Ports
          Name
                         "Constant"
                                                           Position
                                                                              [375, 121,
          Position
                            (80, 134,
                                                 405, 1541
110, 156]
                                                           BackgroundColor
                                                                                  "green"
          BackgroundColor
                                 "red"
                                                           DropShadow
                         -3520-
          Value
                                                           IconShape
                                                  "rectangular"
        Block {
                                                           Inputs
          BlockType
                                                           SaturateOnIntegerOverflow on
DataStoreMemory
         Name
                         "Data
                                                         Block {
Store\nMemory"
                                                           BlockType
         Position
                             [430, 35,
                                                                           "Sum1"
[2, 1, 0, 0, 0]
                                                           Name
462, 65]
                                                           Ports
          BackgroundColor
                                 "orange"
                                                           Position
                                                                              [280, 77,
          DataStoreName
                                 "AGCS2"
                                                 310, 1081
                             -0-
          InitialValue
                                                           BackgroundColor
                                                                                  "green"
                                                           DropShadow
                                                                              on
        Block {
                                                           IconShape
          BlockType
                                                  "rectangular"
DataStoreRead
                                                           Inputs
          Name
                         *Data
                                                           SaturateOnIntegerOverflow on
Store\nRead*
          Position
                             [210, 155,
                                                         Block {
240, 1851
                                                           BlockType
                                                                                  Outport
          BackgroundColor
                                 "orange"
                                                                           "Outl"
                                                           Name
          DataStoreName
                                 *AGCS2*
                                                           Position
                                                                            [490, 133,
          SampleTime
                             "1/Fs"
                                                 520, 147]
                                                           BackgroundColor
                                                                                  "cyan"
        Block {
                                                           Port
```

```
OutputWhenDisabled
                                   "held"
                                                                        "Sum"
                                                        Name
         InitialOutput
                                 -0-
                                                        Ports
                                                                        [2, 1, 0, 0, 0]
                                                                       [935, 258, 955, 287]
                                                        Position
       Line {
                                                        BackgroundColor
                                                                           "orange"
          SrcBlock
                             "Constant"
                                                                     off
                                                        ShowName
          SrcPort
                                                        IconShape
                                                                        "rectangular"
         Points
                             [15, 0]
                                                        Inputs
         DstBlock
                             "Product"
                                                        SaturateOnIntegerOverflow on
         DstPort
                                                      Block {
       Line {
                                                        BlockType
                                                                        Sum
                             "Inl"
          SrcBlock
                                                        Name
                                                                        "Suml"
                                                                        [2, 1, 0, 0, 0]
[1055, 203, 1075,
          SrcPort
                                                        Ports
          DstBlock
                              "Product"
                                                        Position
          DstPort
                                                  2321
                                                        BackgroundColor
                                                                           "orange"
       Line {
                                                        ShowName
                                                                      off
          SrcBlock
                             "Data
                                                        IconShape
                                                                        "rectangular"
Store\nRead*
                                                                        *+-*
                                                        Inputs
          SrcPort
                                                        SaturateOnIntegerOverflow on
          Points
                             [20, 0]
          DstBlock
                              "Suml"
                                                      Block {
          DstPort
                              2
                                                        BlockType
                                                                        Sum
                                                                        *Sum12*
                                                        Name
                                                                        [2, 1, 0, 0, 0]
[450, 262, 480, 293]
       Line {
                                                         Ports
          SrcBlock
                              *Integer
                                                         Position
Delay*
                                                        BackgroundColor "green"
                                                         IconShape
          SrcPort
                                                                        "rectangular"
          DstBlock
                              "Sum1 "
                                                         Inputs
          DstPort
                              1
                                                         SaturateOnIntegerOverflow on
        Line {
                                                      Block {
          SrcBlock
                              "Suml"
                                                        BlockType
                                                                        Sum
          SrcPort
                                                                         "Sum13"
                                                        Name
          Points
                              [45, 0]
                                                         Ports
                                                                         [2, 1, 0, 0, 0]
          DstBlock
                              "Sum"
                                                         Position
                                                                        [555, 252, 585, 283]
          DstPort
                              1
                                                         BackgroundColor *green*
                                                         IconShape
                                                                        "rectangular"
        Line {
                                                         Inputs
                              *Product*
          SrcBlock
                                                         SaturateOnIntegerOverflow on
          SrcPort
          Points
                              [5, 0]
                                                       Block {
          Branch (
                                                         BlockType
                                                                        Sum
        Points
                       [0, 0]
                                                                         "Sum14"
                                                         Name
        DstBlock
                                                                        [2, 1, 0, 0, 0]
[510, 317, 540, 348]
                       "Integer Delay"
                                                         Ports
        DstPort
                                                         Position
          }
                                                         BackgroundColor "green"
          Branch {
                                                         IconShape
                                                                        "rectangular"
                        [0, 35]
        Points
                                                         Inputs
                                                                        *++*
        DstBlock
                        "Sum"
                                                         SaturateOnIntegerOverflow on
        DstPort
                       2
         }
                                                       Block {
                                                         BlockType
                                                                        Sum
        Line {
                                                         Name
                                                                         "Sum2 "
          SrcBlock
                              "Sum"
                                                         Ports
                                                                         [2, 1, 0, 0, 0]
          SrcPort
                                                         Position
                                                                         [1130, 213, 1150,
          Points
                              [10, 0]
                                                   2421
          Branch {
                                                         BackgroundColor
                                                                            "orange"
       DstBlock
                        "Data
                                                                       off
                                                         ShowName
Store\nWrite*
                                                         IconShape
                                                                        "rectangular"
       DstPort
                                                         Inputs
                                                         SaturateOnIntegerOverflow on
          Branch {
       DstBlock
                        "Outl"
                                                       Block {
       DstPort
                       1
                                                         BlockType
                                                                        Sum
          1
                                                         Name
                                                                         *Sum3 *
                                                                        [2, 1, 0, 0, 0]
[1075, 293, 1095,
        }
                                                         Ports
      }
                                                         Position
                                                   3221
    Block {
                                                         BackgroundColor
                                                                           "orange"
      BlockType
                      Sum
                                                         ShowName
                                                                        off
```

```
IconShape
               ***
                   "rectangular"
                                                        BlockType
                                                                              Fcn
                                                                       "Fcn"
     Inputs
                                                        Name
     SaturateOnIntegerOverflow on
                                                                         [185, 165,
                                                        Position
                                               245, 195]
   Block {
                                                        BackgroundColor
                                                                              "yellow"
     BlockType
                   Sum
                                                        Expr
     Name
                    "Sum8"
                                               *20*log10(u/(3.1623*power(10,-6)))*
                   [2, 1, 0, 0, 0]
     Ports
                 [2, 1, 0, 0, 0, [675, 107, 705, 138]
     Position
                                                      Block {
     BackgroundColor "green"
                                                        BlockType
                "rectangular"
     IconShape
                                               RelationalOperator
                   *++*
     Inputs
                                                        Name
     SaturateOnIntegerOverflow on
                                               "Relational\nOperator"
                                                        Position
                                                                          [145, 67,
   Block {
                                               175, 98]
                                                                           "yellow"
     BlockType
                   Switch
                                                        BackgroundColor
     Name
                   "Switch"
                                                        Operator
     Position
                  [1000, 75, 1030,
1051
                                                       Block {
     BackgroundColor "yellow"
                                                         BlockType
                   "alternate"
                                                                              Sum
     NamePlacement
                                                                       "Sum"
                                                        Name
     ShowName
                                                                       [2, 1, 0, 0, 0]
                                                         Ports
     Threshold
                   "10.^-8"
                                                        Position
                                                                          [120, 162,
                                               150, 193]
   Block {
                                                         BackgroundColor
                                                                              "green"
     BlockType
                    SubSystem
                                                         IconShape
     Name
                    "dB Conv"
                                               "rectangular"
                    [1, 1, 0, 0, 0]
     Ports
                                                        Inputs
     Position
                    [325, 63, 350, 97]
                                                         SaturateOnIntegerOverflow on
     BackgroundColor "darkGreen"
     DropShadow
                       on
                                                       Block {
                                                         BlockType
     ShowPortLabels
                     off
                                                                             Switch
     System {
                                                                       "Switch"
                                                         Name
                      *dB Conv*
       Name
                                                         Position
                                                                         [280, 70,
       Location
                       [8, 74, 474,
                                               310, 100]
399]
                                                         BackgroundColor
                                                                               "orange"
       Open
                      off
                                                         Threshold
                                                                               •1•
       ModelBrowserVisibility off ModelBrowserWidth 200
       ModelBrowserWidth
                                                       Block {
                                                         BlockType
       ScreenColor
                                                                              Outport
"lightBlue"
                                                                        "Outl"
                                                         Name
       PaperOrientation
                                                         Position
                                                                         [360, 78,
"landscape"
                                               390, 92]
       PaperPositionMode
                            "auto"
                                                         BackgroundColor
                                                                             "cyan"
                    "usletter"
       PaperType
                                                         Port
       PaperUnits
                         "inches"
                                                                              "held"
                                                         OutputWhenDisabled
                         -100-
       ZoomFactor
                                                         InitialOutput
                                                                               •[] •
       AutoZoom
                         on
       Block {
                                                       Line {
                        Inport
         BlockType
                                                         SrcBlock
                                                                           "Fcn"
         Name
                                                         SrcPort
         Position
                          [25, 68, 55,
                                                         Points
                                                                           [15. 0]
82]
                                                         DstBlock
                                                                           "Switch"
                              "cyan"
         BackgroundColor
                                                         DstPort
         Port
         PortWidth
                              --1-
                                                       Line {
         SampleTime
                            -1-
                                                         SrcBlock
                                                                           "Inl"
         DataType
                            "auto"
                                                         SrcPort
         SignalType
                            "auto"
                                                         Points
                                                                           [10, 0]
         Interpolate
                            on
                                                         Branch {
                                                       Points
                                                                     [0, -45; 195, 0]
       Block {
                                                      DstBlock
                                                                     "Switch"
         BlockType
                              Constant
                                                       DstPort
                        "Constant1"
         Name
                                                         ŀ
         Position
                           [100, 80,
                                                        Branch {
120, 1001
                                                       DstBlock
         BackgroundColor
                                                   "Relational\nOperator"
"darkGreen"
                                                      DstPort
                        -0-
         Value
                                                        ŀ
       ŀ
                                                         Branch {
       Block {
                                                       Points
                                                                     [0, 110]
```

```
DstBlock
                     "Sum"
                                                       PortWidth
                                                                         -1-
      DstPort
                     2
                                                       SampleTime
        }
                                                       DataType
                                                                         "auto"
                                                       SignalType
                                                                         "auto"
      Line {
                                                       Interpolate
                                                                          on
        SrcBlock
                           "Constantl"
         SrcPort
                                                      Block {
        DstBlock
                                                       BlockType
                                                                             Constant
"Relational\nOperator"
                                                       Name
                                                                      *Constant1*
        DstPort
                                                       Position
                                                                         [100, 80,
                                              120, 100]
       Line {
                                                       BackgroundColor
        SrcBlock
                                              "darkGreen"
"Relational\nOperator"
                                                      Value
        SrcPort
         Points
                          [30. 0]
                                                      Block {
        Branch (
                                                       BlockType
                                                                             Fcn
      DstBlock
                     "Switch"
                                                        Name
                                                                      "Fcn"
       DstPort
                                                        Position
                                                                        [185, 165,
        }
                                              245, 195]
                                                       BackgroundColor
        Branch (
                                                                              "yellow"
                     [0, 50; -105, 0]
       Points
                                                        Expr
       DstBlock
                     "Sum"
                                               "20*log10(u/(3.1623*power(10,-6)))"
       DstPort
                     1
        }
                                                      Block {
                                                       BlockType
       Line (
                                              RelationalOperator
         SrcBlock
                           "Sum"
                                                       Name
         SrcPort
                           1
                                               "Relational\nOperator"
        DstBlock
                           "Fcn"
                                                                          [145, 67.
                                                        Position
        DstPort
                           1
                                               175, 98]
                                                        BackgroundColor
                                                                             "yellow"
       Line (
                                                        Operator
         SrcBlock
                           "Switch"
         SrcPort
                                                      Block {
         DstBlock
                           "Outl"
                                                        BlockType
                                                                              Sum
         DstPort
                                                        Name
Ports
                                                                      "Sum"
       }
                                                                      [2, 1, 0, 0, 0]
     ł
                                                                          [120, 162,
                                                        Position
   }
                                               150, 1931
   Block (
                                                        BackgroundColor
                                                                             "green"
     BlockType
                  SubSystem
                                                        IconShape
                   "dB Conv.-LF"
                                               "rectangular"
     Ports
                  [1, 1, 0, 0, 0]
                                                        Inputs
                   [325, 158, 350, 192]
     Position
                                                        SaturateOnIntegerOverflow on
     BackgroundColor "darkGreen"
     DropShadow
                     on
                                                      Block {
     ShowPortLabels
                     off
                                                        BlockType
                                                                             Switch
     System {
                                                        Name
                                                                      "Switch"
       Name
                     "dB Conv.-LF"
                                                                         [280, 70.
                                                        Position
       Location
                       [152, 320,
                                               310, 100]
618, 645]
                                                        BackgroundColor
                                                                              "orange"
                     off
                                                        Threshold
                                                                              -1-
       ModelBrowserVisibility off
       ModelBrowserWidth 200
                                                      Block {
       ScreenColor
                                                        BlockType
                                                                              Outport
"lightBlue"
                                                                       "Out1"
                                                        Name
      PaperOrientation
                                                        Position
                                                                        [360, 78,
"landscape"
                                               390, 921
       PaperPositionMode
                            "auto"
                                                        BackgroundColor
                                                                              "cyan"
                  "usletter"
       PaperType
                                                        Port
       PaperUnits
                         "inches"
                                                        OutputWhenDisabled
                                                                              "held"
                         *100*
       ZoomFactor
                                                        InitialOutput
                                                                             -[]-
       AutoZoom
                         on
       Block {
                       Import
                                                      Line {
         BlockType
                                                        SrcBlock
                                                                          "Fcn"
         Name
                                                        SrcPort
         Position
                          [25, 68, 55,
                                                       Points
                                                                          [15, 0]
82]
                                                       DstBlock
                                                                          "Switch"
         BackgroundColor
                               "cyan"
                                                       DstPort
                       *1*
         Port
                                                      }
```

```
Line {
                                                     InitialOutput
                                                                         "0"
         SrcBlock
                           Inl
         SrcPort
                                                   Line {
        Points
                          [10, 0]
                                                                   "Inl"
                                                     SrcBlock
        Branch {
                                                     SrcPort
                                                                    1
       Points
                     [0, -45; 195, 0]
                                                     Points
                                                                    [5, 0]
      DstBlock
                     "Switch"
                                                     Branch {
       DstPort
                                                      DstBlock
                                                                          "Abs"
        }
                                                      DstPort
                                                                     1
        Branch {
       DstBlock
                                                     Branch {
   "Relational\nOperator"
                                                       Points
                                                                     [0, -80; 1145, 0]
      DstPort
                                                       DstBlock
                                                                          "Product3"
        }
                                                       DstPort
        Branch {
       Points
                     [0, 110]
       DstBlock
                     "Sum"
                                                   Line {
       DstPort
                     2
                                                     SrcBlock
                                                                    "Abs"
        }
                                                     SrcPort
                                                                    1
                                                     Points
                                                                    [5, 0]
       Line {
                                                     Branch {
         SrcBlock
                            "Constant1"
                                                       DstBlock
                                                                          "FastMoving"
         SrcPort
                                                       DstPort
                                                                      1
        DstBlock
"Relational\nOperator"
                                                     Branch {
        DstPort
                            2
                                                       DstBlock
                                                                          "SlowMoving"
                                                       DstPort
       Line (
         SrcBlock
"Relational\nOperator"
                                                   Line {
        SrcPort
                                                     SrcBlock
                                                                    "In5"
         Points
                            [30, 0]
                                                     SrcPort
                                                                    1
        Branch {
                                                     Points
                                                                    [20, 0]
       DstBlock
                      "Switch"
                                                     DstBlock
                                                                    "Sum"
       DstPort
                      2
                                                     DstPort
         }
         Branch (
                                                   Line {
       Points
                     [0, 50; -105, 0]
                                                     SrcBlock
                                                                    "Sum"
       DstBlock
                      "Sum"
                                                     SrcPort
                                                                    1
       DstPort
                                                     DstBlock
                                                                    "Product1"
         }
                                                     DstPort
       Line {
                                                   Line {
         SrcBlock
                            "Sum"
                                                     SrcBlock
                                                                    "In3"
         SrcPort
                            1
                                                     SrcPort
         DstBlock
                            "Fcn"
                                                     Points
                                                                    [15, 0; 0, -65; 205,
        DstPort
                                                0; 0, 20]
                            1
                                                     DstBlock
                                                                    *Product1*
       Line (
                                                     DstPort
         SrcBlock
                            "Switch"
         SrcPort
                                                    Line {
         DstBlock
                            "Outl"
                                                     SrcBlock
                                                                    "Sum1"
         DstPort
                                                      SrcPort
       }
                                                     DstBlock
                                                                     "Sum2"
     }
                                                     DstPort
   1
   Block {
                                                   Line {
     BlockType
                    Constant
                                                     SrcBlock
                                                                    "Constant"
     Name
                    "effect"
                                                     SrcPort
     Position
                    [370, 210, 390, 230]
                                                     Points
                                                                    [105, 0]
     BackgroundColor "red"
Value "6"
                                                     Branch {
     Value
                                                       DstBlock
                                                                          "Suml"
                                                       DstPort
                                                                      1
   Block {
     BlockType
                    Outport
                                                     Branch {
                    "Outl"
[1415, 88, 1445,
     Name
                                                       Points
                                                                      [0, -20; 130, 0]
     Position
                                                       Branch {
102]
                                                         Points
                                                                            [120, 0; 0,
     BackgroundColor "cyan"
                                                45]
     Port
                                                         DstBlock
                                                                            *Sum2*
     OutputWhenDisabled "held"
                                                         DstPort
```

```
}
   Branch {
     Points
                         [0, -90]
                                                 Line {
     DstBlock
                         "Switch"
                                                   SrcBlock
                                                                   "Fcn"
     DstPort
                                                   SrcPort
                                                                   1
   }
                                                   DstBlock
                                                                   "Product"
 }
                                                   DstPort
3
Line {
                                                 Line {
 SrcBlock
                 "Sum2"
                                                   SrcBlock
                                                                   "Product4"
 SrcPort
                                                   SrcPort
 Points
                 [5, 0]
                                                   Points
                                                                   [5, 0]
 DstBlock
                 "Product2"
                                                   DstBlock
                                                                   " Sum3 "
 DstPort
                                                   DstPort
Line {
                                                 Line {
  SrcBlock
                 "Math\nFunction"
                                                   SrcBlock
                                                                   "Constant1"
  SrcPort
                                                   SrcPort
  DstBlock
                 *Product2*
                                                   Points
                                                                   [60, 0]
  DstPort
                                                   DstBlock
                                                                   "Product4"
                                                   DstPort
                                                                   2
Line {
  SrcBlock
                 "Product2"
                                                 Line {
  SrcPort
                 1
                                                    SrcBlock
                                                                   "Product1"
  DstBlock
                 "Math\nFunction1"
                                                    SrcPort
 DstPort
                 1
                                                    Points
                                                                   [20, 0; 0, 30]
                                                    DstBlock
                                                                   "Sum3 "
Line {
                                                   DstPort
                                                                   1
  SrcBlock
                 "Math\nFunction1"
  SrcPort
                 1
                                                  Line {
  DstBlock
                 "Product3"
                                                    SrcBlock
                                                                   "Sum3"
  DstPort
                 2
                                                    SrcPort
                                                    Points
                                                                   [0, -65; -60, 0]
Line (
                                                    DstBlock
                                                                   "Suml"
  SrcBlock
                 "Product3"
                                                   DstPort
  SrcPort
                 1
  DstBlock
                 "Outl"
                                                  Line {
  DstPort
                                                    SrcBlock
                                                                   "Logical\nOperator2"
                                                    SrcPort
Line {
                                                    DstBlock
                                                                   "Product14"
  SrcBlock
                 "Product"
                                                    DstPort
  SrcPort
                 1
  Points
                 [25, 0]
                                                  Line {
  Branch {
                                                    SrcBlock
   DstBlock
                       "Switch"
                                              "Relational\nOperator3"
   DstPort
                                                    SrcPort
                                                    Points
                                                                   [5, 0]
  Branch {
                                                    Branch (
    Points
                   [0, -10]
                                                      Points
                                                                     [0, -70]
    DstBlock
                       "Switch"
                                                      DstBlock
                                                                         *Product10*
    DstPort
                                                     DstPort
  }
                                                    Branch {
Line {
                                                     DstBlock
  SrcBlock
                 "Switch"
                                              "Logical\nOperator2"
  SrcPort
                 1
                                                     DstPort
  DstBlock
                 "Math\nFunction"
                                                    }
  DstPort
                                                  Line {
Line [
                                                    SrcBlock
                                                                   "Product11"
  SrcBlock
                 "In4"
                                                    SrcPort
                                                                   1
  SrcPort
                                                   DstBlock
                                                                   "Sum13"
  Points
                 [0, -40]
                                                   DstPort
  Branch (
   DstBlock
                       "Sum"
                                                  Line {
   DstPort
                                                    SrcBlock
                                                                   "Product12"
                                                    SrcPort
  Branch (
                                                    DstBlock
                                                                   "Sum13"
    Points
                   [-20.0]
                                                    DstPort
                                                                   1
    DstBlock
                       "Fcn"
    DstPort
                                                  Line {
```

```
SrcBlock
                    "Sum13"
                                                     Branch {
     SrcPort
                                                                    [5, 0]
                                                      Points
     DstBlock
                    *Product13*
                                                       Branch {
     DstPort
                    1
                                                        Points
                                                                          [-10, 0; 0,
                                               1351
   Line {
                                                        Branch {
     SrcBlock
                    "Product10"
                                                       DstBlock
                                                                      "Sum12"
     SrcPort
                                                       DstPort
     Points
                    [10, 0]
     DstBlock
                    "Sum8"
                                                         Branch {
     DstPort
                    1
                                                       DstBlock
                                                                      "Product12"
                                                       DstPort
                                                                      2
   Line {
                                                        }
     SrcBlock
                    "Product14"
     SrcPort
                                                       Branch {
     Points
                    [10, 0]
                                                         Points
                                                                           [50, 0]
     DstBlock
                    "Sum8"
                                                         DstBlock
     DstPort
                                                "Relational\nOperator3"
                                                        DstPort
   Line {
                                                       1
     SrcBlock
                    "Sum12"
                                                     }
     SrcPort
     Points
                    [0, 0]
                                                   Line {
     Branch {
                                                     SrcBlock
                                                                    "dB Conv.-LF"
      Points
                     [0, 0]
                                                     SrcPort
                                                                    1
       DstBlock
                          "Product11"
                                                     Points
                                                                    [0, 5; 35, 0; 0, -
      DstPort
                                                15; 100, 0]
                                                     Branch {
     Branch (
                                                       Points
                                                                     [0, 0]
       Points
                      [0, 45]
                                                       DstBlock
       DstBlock
                          "Sum14"
                                                "Relational\nOperator3"
       DstPort
                                                      DstPort
     }
                                                     Branch (
   Line {
                                                       Points
                                                                      [0, 65]
     SrcBlock
                    "effect"
                                                       Branch {
     SrcPort
                                                         Points
                                                                            [-85, 0; 0,
     Points
                    [0, 0]
                                                551
     Branch {
                                                         DstBlock
                                                                            "Sum12"
      DstBlock
                          "Product12"
                                                         DstPort
       DstPort
                                                       Branch {
     Branch {
                                                         DstBlock
                                                                            "Product11"
      Points
                      [0, 120]
                                                         DstPort
       DstBlock
                          "Sum14"
       DstPort
                                                     ŀ
     }
   3
                                                    Line {
   Line {
                                                     SrcBlock
                                                                    "FastMoving"
                    "Sum14"
     SrcBlock
                                                      SrcPort
                                                                    1
     SrcPort
                                                                    [5, 0]
                                                     Points
     DstBlock
                     "Product13"
                                                     DstBlock
                                                                    "dB Conv"
     DstPort
                                                     DstPort
                                                                    1
   Line {
                                                   Line (
     SrcBlock
                     *Product13*
                                                      SrcBlock
                                                                    "SlowMoving"
     SrcPort
                                                      SrcPort
                                                                    1
     Points
                    [0, -65; -40, 0]
                                                                    [5, 0]
                                                     Points
     DstBlock
                     "Product14"
                                                     DstBlock
                                                                    *dB Conv.-LF*
     DstPort
                    2
                                                     DstPort
   Line (
                                                    Line {
     SrcBlock
                    "dB Conv"
                                                     SrcBlock
                                                                    "Fcnl"
     SrcPort
                                                     SrcPort
     Points
                    [45, 0; 0, 20; 40,
                                                     Points
                                                                    [25, 0; 0, -45]
QΙ
                                                     DstBlock
                                                                    "Product"
     Branch {
                                                     DstPort
                                                                    1
                      [0, -25]
      Points
       DstBlock
                          *Product10*
                                                   Line {
       DstPort
                                                     SrcBlock
                                                                    *Sum8*
     }
                                                     SrcPort
                                                                    7
```

```
SignalType
                    [10, 0]
                                                                          "auto"
     Points
     Branch {
                                                       Interpolate
       DstBlock
                           "Fcnl"
                     1
       DstPort
                                                     Block {
                                                       BlockType
                                                                      Inport
                                                                      "In5"
[865, 298, 895, 312]
     Branch {
                                                       Name
       Points
                       [0, 35; -40, 0; 0,
                                                       Position
                                                       BackgroundColor "cyan"
1701
       DstBlock
                           "Product4"
                                                       Port
       DstPort
                       1
                                                       PortWidth
                                                                      --1-
                                                       SampleTime
   }
                                                       DataType
                                                                      "auto"
      }
                                                       SignalType
                                                                         "auto"
                                                       Interpolate
                                                                          on
    Block {
      BlockType
                             SubSystem
                                                     Block {
      Name
                                                       BlockType
                                                                      Abs
"homomorphic\nmultiplicative AGC3"
                                                       Name
                                                                      "Abs"
      Ports [4, 1, 0, 0, 0]
Position [440, 229, 470,
                                                                      [215, 70, 245, 100]
                                                       Position
                                                       BackgroundColor "red"
2861
      BackgroundColor
                                                     Block (
                             "orange"
      DropShadow
                         on
                                                       BlockType
                                                                      Constant
      ShowPortLabels
                             off
                                                       Name
                                                                       "Constant"
      System {
                                                       Position
                                                                      [710, 195, 740, 225]
                                                       BackgroundColor "green"
Value "1"
    Name
    "homomorphic\nmultiplicative AGC3"
    Location [97, 88, 873, 465]
                  off
                                                     Block {
    ModelBrowserVisibility off
                                                       BlockType
                                                                      Constant
    ModelBrowserWidth 200
                                                                       "Constantl"
                                                       Name
    ScreenColor "lightBlue"
                                                       Position
                                                                    [910, 350, 940, 380]
    PaperOrientation "landscape"
PaperPositionMode "auto"
                                                       BackgroundColor "green"
Value "330"
    PaperType
                   "usletter"
    PaperUnits
                   "inches"
                                                     Block {
                  *100*
    ZoomFactor
                                                       BlockType
                                                                      SubSystem
    AutoZoom
                   on
                                                       Name
                                                                       "FastMoving"
    Block {
                                                                      [1, 1, 0, 0, 0]
[270, 57, 300, 113]
                                                       Ports
      BlockType
                    Inport
                                                       Position
                 "Inl"
[150, 78, 180, 92]
      Name
                                                       BackgroundColor "orange"
      Position
                                                       DropShadow
      BackgroundColor "cyan"
Port "1"
                                                       ShowPortLabels
                                                                        off
                                                       System (
                     -1-
      PortWidth
                                                         Name
                                                                         "FastMoving"
                        --1-
      SampleTime
                                                         Location
                                                                            [67, 139, 855,
      DataType
                     "auto"
                                                  480]
      SignalType
                         "auto"
                                                                        off
      Interpolate
                                                         ModelBrowserVisibility off
                         on
                                                         ModelBrowserWidth 200
    Block {
                                                         ScreenColor
      BlockType
                     Inport
                                                  "lightBlue"
      Name
                      "In3"
                                                         PaperOrientation
                     [710, 298, 740, 312]
                                                  "landscape"
      BackgroundColor
                       "cyan"
                                                         PaperPositionMode
                                                                                "auto"
      Port
                                                                            "usletter"
                                                          PaperType
      PortWidth
                                                          PaperUnits
                                                                             "inches"
                        --1-
      SampleTime
                                                         ZoomFactor
                                                                            -100-
      DataType
                     "auto"
                                                          AutoZoom
                                                                             on
      SignalType
                         "auto"
                                                          Block {
                                                                           Inport
      Interpolate
                         on
                                                           BlockType
                                                            Name
    Block {
                                                            Position
                                                                             [75, 93,
      BlockType
                     Inport
                                                  105, 107]
      Name
                     "In4"
                                                            BackgroundColor
                                                                                  "cyan"
      Position
                     [805, 298, 835, 312]
                                                                           -1-
                                                            Port
      BackgroundColor "cyan"
                                                            PortWidth
      Port
                                                                              --1-
                                                            SampleTime
      PortWidth
                     -1-
                                                            DataType
                                                                               "auto"
      SampleTime
                                                            SignalType
                                                                               "auto"
      DataType
                     "auto"
                                                            Interpolate
                                                                               on
```

```
BlockType
                                                                                   Sum
        Block {
                                                            Name
                                                                            "Sum"
         BlockType
                                 Constant
                                                            Ports
                                                                           [2, 1, 0, 0, 0]
                         "Constant"
          Name
                                                            Position
                                                                               [375, 121,
          Position
                            [80, 134,
                                                  405, 154]
110, 156]
                                                            BackgroundColor
                                                                                   "green"
          BackgroundColor
                                 "red"
                                                            DropShadow
                                                                               on
          Value
                         "160"
                                                            IconShape
                                                  "rectangular"
        Block (
                                                            Inputs
          BlockType
                                                            SaturateOnIntegerOverflow on
DataStoreMemory
          Name
                         *Data
                                                          Block {
Store\nMemory"
                                                            BlockType
                                                                            "Sum1"
[2, 1, 0, 0, 0]
          Position
                             [430, 35,
                                                            Name
462, 65]
                                                            Ports
          BackgroundColor
                                 "orange"
                                                                               [280, 77,
                                                            Position
          DataStoreName
                                 "AGC3 "
                                                  310, 108]
          InitialValue
                                                            BackgroundColor
                                                                                    "green"
                                                            DropShadow
                                                                               on
        Block {
                                                            IconShape
          BlockType
                                                  "rectangular"
DataStoreRead
                                                            Inputs
          Name
                          "Data
                                                            SaturateOnIntegerOverflow on
Store\nRead*
          Position
                             [210, 155,
                                                          Block (
240, 185]
                                                            BlockType
                                                                                   Outport
          BackgroundColor
                                 "orange"
                                                            Name
                                                                            "Out1"
          DataStoreName
                                 "AGC3"
                                                            Position
                                                                              [490, 133,
          SampleTime
                             "1/Ps"
                                                  520, 147]
                                                            BackgroundColor
                                                                                    "cyan"
        Block {
                                                            Port
          BlockType
                                                            OutputWhenDisabled
                                                                                     "held"
DataStoreWrite
                                                            InitialOutput
                                                                                    -0-
          Name
                          "Data
Store\nWrite*
                                                          Line {
          Position
                             [435, 175,
                                                            SrcBlock
                                                                                "Constant"
465, 205]
                                                            SrcPort
                                                                                1
          BackgroundColor
                                 "orange"
                                                            Points
                                                                                [15. 0]
          DataStoreName
                                 "AGC3"
                                                            DstBlock
                                                                                "Product"
          SampleTime
                             "1/Fs"
                                                            DstPort
                                                                                2
        Block {
                                                          Line (
          BlockType
                                                            SrcBlock
                                                                                "Inl"
Reference
                                                            SrcPort
          Name
                          "Integer Delay"
                                                            DstBlock
                                                                                "Product"
          Ports
                          [1, 1, 0, 0, 0]
[200, 67,
                                                            DstPort
          Position
245, 1031
                                                          Line {
          BackgroundColor
                                 "red"
                                                            SrcBlock
                                                                                "Data
          SourceBlock
                                                   Store\nRead*
"dspbdsp2/Integer Delay"
                                                            SrcPort
          SourceType
                             *Integer
                                                            Points
                                                                                [20, 0]
Delay*
                                                            DstBlock
                                                                                "Sum1"
          delav
                          -160-
                                                            DstPort
                          -0-
          ic
          frame
                          off
                                                          Line {
          đf
                          on
                                                            SrcBlock
                                                                                "Integer
                              -1-
          numChans
                                                  Delay"
                                                            SrcPort
        Block {
                                                            DstBlock
                                                                                "Sum1"
          BlockType
                                 Product
                                                            DstPort
                                                                                1
          Name
                          "Product"
          Ports
                          [2, 1, 0, 0, 0]
                                                          Line (
                              [145, 92,
          Position
                                                            SrcBlock
                                                                                "Suml"
175, 1231
                                                            SrcPort
          BackgroundColor
                                 "green"
                                                            Points
                                                                                [45, 0]
          Inputs
                                                            DstBlock
                                                                                "Sum"
          SaturateOnIntegerOverflow on
                                                            DstPort
                                                                                1
        Block {
                                                          Line {
```

```
SrcBlock
                             "Product"
                                                         Position
                                                                        [1260, 85, 1290,
          SrcPort
                                                   1151
                             7
                                                        BackgroundColor "red"
ShowName off
Operator "exp"
          Points
                             [5, 0]
         Branch {
       Points
                       [0, 0]
       DstBlock
                       "Integer Delay"
                                                         OutputSignalType "auto"
       DstPort
                                                       Block {
         Branch (
                                                         BlockType
                                                                       Product
       Points
                       [0, 35]
                                                         Name
                                                                         "Product"
                                                                       [2, 1, 0, 0, 0]
[915, 72, 945, 103]
       DstBlock
                       "Sum"
                                                         Ports
       DstPort
                       2
                                                         Position
                                                         BackgroundColor "yellow"
Inputs "*/"
         }
        Line {
                                                         SaturateOnIntegerOverflow on
          SrcBlock
                              "Sum"
          SrcPort
                             1
                                                       Block {
         Points
                              [10, 0]
                                                         BlockType
                                                                       Product
         Branch {
                                                         Name
                                                                         "Product1"
       DstBlock
                       "Data
                                                                         [2, 1, 0, 0, 0]
[995, 252, 1025,
                                                         Ports
Store\nWrite"
                                                         Position
       DstPort
                       1
                                                   2831
                                                         BackgroundColor "yellow"
Thous "*/"
         }
         Branch {
       DstBlock
                       "Outl"
                                                         SaturateOnIntegerOverflow on
       DstPort
                       1
         }
                                                       Block {
        }
                                                         BlockType
                                                                        Product
      }
                                                         Name
                                                                         "Product10"
                                                         Ports
                                                                         [2, 1, 0, 0, 0]
   Block {
                                                                         [615, 67, 645, 98]
                                                         Position
                                                         BackgroundColor "green" Inputs "2"
      BlockType
                      Fcn
                      "Fcn"
      Name
                 [835, 130, 895, 160]
                                                         SaturateOnIntegerOverflow on
      BackgroundColor "yellow"
      Expr
                     "power(10,((u/20)-
                                                       Block {
5.5))*
                                                         BlockType
                                                                        Product
                                                          Name
                                                                         "Product11"
   Block (
                                                          Ports
                                                                        [2, 1, 0, 0, 0]
[505, 257, 535, 288]
      BlockType
                     Fcn
                                                         Position
                                                                         , 437,
r "green"
"2"
      Name
                     "Fcn1"
                                                         BackgroundColor
                  [740, 110, 800, 140]
      Position
                                                         Inputs
      BackgroundColor "yellow"
                                                         SaturateOnIntegerOverflow on
                      *power(10,((u/20)-
      Expr
5.5))~
                                                       Block {
                                                         BlockType
                                                                        Product
    Block (
                                                         Name
                                                                         "Product12"
      BlockType
                                                                    [2, 1, 0, 0, 0]
[505, 212, 535, 243]
                      Logic
                                                          Ports
      Name
                      "Logical\nOperator2"
                                                         Position
                      [1, 1, 0, 0, 0]
                                                         BackgroundColor "green"
Inputs "2"
      Position
                     [565, 144, 595, 176]
      BackgroundColor "yellow"
Operator "NOT"
                                                         SaturateOnIntegerOverflow on
      Inputs
                      -1-
                                                       Block {
                                                          BlockType
                                                                        Product
                                                         Name
Ports
    Block {
                                                                         "Product13"
      BlockType
                      Math
                                                                         [2, 1, 0, 0, 0]
      Name
                                                          Position [605, 311, 635, 344]
                      "Math\nFunction"
                                                         BackgroundColor "green"
Tomits "*/"
                     [1, 1, 0, 0, 0]
[1075, 75, 1105,
      Ports
      Position
1051
                off
                                                         SaturateOnIntegerOverflow on
      BackgroundColor
      ShowName
                                                       Block {
      Operator
                                                          BlockType
                                                                         Product
      OutputSignalType "auto"
                                                         Name
                                                                         "Product14"
                                                                         [2, 1, 0, 0, 0]
                                                          Ports
    Block {
                                                                         [615, 217, 645, 248]
                                                          Position
      BlockType
                      Mach
                                                         BackgroundColor "green"
Innuts "2"
      Name
                      "Math\nFunction1"
                                                         Inputs
                     [1, 1, 0, 0, 0]
      Ports
                                                         SaturateOnIntegerOverflow on
```

Plack (	Do to Bross	
Block (	DataType	"auto"
BlockType Product Name *Product2*	SignalType	"auto"
Ports [2, 1, 0, 0, 0]	Interpolate	on
* * * * *	) D1 == 'e (	
Position [1175, 82, 1205, 113]	Block {	
BackgroundColor "yellow"	BlockType	Constant
Inputs ****		Constant*
SaturateOnIntegerOverflow on	Position	[80, 134,
}	110, 156]	a 3 a
Block (	BackgroundColor Value *:	
BlockType Product	}	3520*
Name "Product3"	Block {	
Ports [2, 1, 0, 0, 0]	BlockType	
Position [1350, 77, 1380,	DataStoreMemory	
1081	<del>-</del>	Data
BackgroundColor "yellow"	Store\nMemory*	Data
Inputs ****	Position	[430, 35,
SaturateOnIntegerOverflow on	462, 65]	[430, 33,
}	BackgroundColor	"orange"
Block (	DataStoreName	*AGCS3*
BlockType Product	InitialValue	•0•
Name "Product4"	}	•
Ports [2, 1, 0, 0, 0]	Block {	
Position [1020, 322, 1050.	BlockType	
353]	DataStoreRead	
BackgroundColor "yellow"		Data
Inputs "*/"	Store\nRead*	
SaturateOnIntegerOverflow on	Position	[210, 155,
}	240, 185]	(===, ===,
Block {	BackgroundColor	"orange"
BlockType RelationalOperator	DataStoreName	"AGCS3"
Name	SampleTime	"1/Fs"
"Relational\nOperator3"	}	
Position [510, 142, 540, 173]	Block (	
BackgroundColor "yellow"		
	BlockType	
Operator ">="	BlockType DataStoreWrite	
Operator ">="	DataStoreWrite	Data
Operator ">=" } Block {	DataStoreWrite	Data
Operator ">=" } Block {    BlockType SubSystem	DataStoreWrite Name * Store\nWrite* Position	Data [435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving"	DataStoreWrite Name Store\nWrite*	
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0]	DataStoreWrite Name Store\nWrite* Position 465, 205] BackgroundColor	
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193]	DataStoreWrite Name Store\nWrite* Position 465, 205] BackgroundColor DataStoreName	[435, 175, "orange" "AGCS3"
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange"	DataStoreWrite Name Store\nWrite* Position 465, 205] BackgroundColor DataStoreName SampleTime	(435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on	DataStoreWrite Name Store\nWrite* Position 465, 205] BackgroundColor DataStoreName SampleTime }	[435, 175, "orange" "AGCS3"
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off	DataStoreWrite Name Store\nWrite* Position 465, 205; BackgroundColor DataStoreName SampleTime } Block {	[435, 175, "orange" "AGCS3"
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System {	DataStoreWrite Name Store\nWrite* Position 465, 205; BackgroundColor DataStoreName SampleTime } Block { BlockType	[435, 175, "orange" "AGCS3"
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving"	DataStoreWrite Name Store\nWrite* Position 465, 205] BackgroundColor DataStoreName SampleTime } Block { BlockType Reference	[435, 175, "orange" "AGCS3" "1/Fs"
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857,	DataStoreWrite Name Store\nWrite* Position 465, 205] BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name **	[435, 175, "orange" "AGCS3" "1/Fs"
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478]	DataStoreWrite Name Store\nWrite* Position 465, 205] BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports [	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478] Open off	DataStoreWrite Name Store\nWrite* Position 465, 205] BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position    SampleTime	[435, 175, "orange" "AGCS3" "1/Fs"
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478] Open off ModelBrowserVisibility off	DataStoreWrite Name Store\nWrite* Position 465, 205] BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103]	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478]  Open off ModelBrowserVisibility off ModelBrowserWidth 200	DataStoreWrite Name Store\nWrite* Position 465, 205]  BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor	DataStoreWrite Name Store\nWrite* Position 465, 205] BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue"	DataStoreWrite Name Store\nWrite* Position 465, 205] BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock *dspbdsp2/Integer Delay*	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor	DataStoreWrite Name Store\nWrite* Position 465, 205] BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape"	DataStoreWrite Name Store\nWrite* Position 465, 205]  BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103]  BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay"	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor *lightBlue" PaperOrientation *landscape"	DataStoreWrite Name Store\nWrite* Position 465, 205] BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay" delay  **  **  **  **  **  **  **  **  **	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478] Open off ModelBrowserVisibility off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto"	DataStoreWrite Name Store\nWrite* Position 465, 205]  BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay* delay ic	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter"	DataStoreWrite Name Store\nWrite* Position 465, 205]  BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay*  delay ic frame	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478] Open off ModelBrowserVisibility off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches"	DataStoreWrite Name Store\nWrite* Position 465, 205]  BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay*  delay ic frame off	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478] Open off ModelBrowserVisibility off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100"	DataStoreWrite Name Store\nWrite* Position 465, 205]  BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay"  delay ic frame off onumChans	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478]  Open off ModelBrowserVisibility off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on Block {	DataStoreWrite Name Store\nWrite* Position 465, 205]  BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay"  delay ic frame of frame of numChans }	[435, 175,
Operator ">="" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478]  Open off ModelBrowserVisibility off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on Block (	DataStoreWrite Name Store\nWrite* Position 465, 205]  BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position 245, 103] BackgroundColor SourceBlock *dspbdsp2/Integer Delay* SourceType Delay*  delay ic frame off numChans } Block {	[435, 175,
Operator ">="" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478]  Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape"  PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on Block { BlockType Import	DataStoreWrite Name Store\nWrite* Position  465, 205]  BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position  245, 103]  BackgroundColor SourceBlock *dspbdsp2/Integer Delay* SourceType Delay*  delay ic frame off numChans } Block { BlockType	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857,  478] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on Block { BlockType Import Name "In1"	DataStoreWrite Name Store\nWrite* Position  465, 205]  BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position  245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay*  delay ic frame of frame of mumChans } Block { BlockType Name "	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478] Open off ModelBrowserVisibility off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on Block { BlockType Import Name "In1" Position [75, 93,	DataStoreWrite Name Store\nWrite* Position  465, 205]  BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position  245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay*  delay ic frame of frame of frame of Block { BlockType Name Ports [ BlockType Name Ports ]  Block { BlockType Name Ports [ BlockType Name Ports	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on Block { BlockType Import Name "In1" Position [75, 93,	DataStoreWrite Name Store\nWrite* Position  465, 205]  BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position  245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType Delay*  delay ic frame of frame of mumChans } Block { BlockType Name "	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on Block { BlockType Import Name "In1" Position [75, 93, 105, 107] BackgroundColor "cyan"	DataStoreWrite Name Store\nWrite* Position  465, 205]  BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position  245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType  Delay*  delay ic frame of of numChans } Block { BlockType Name Ports Position  175, 123]	[435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [69, 137, 857, 478] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor *lightBlue" PaperOrientation *landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on Block { BlockType Import Name "In1" Position [75, 93, 105, 107] BackgroundColor "cyan" Port "1"	DataStoreWrite Name Store\nWrite* Position  465, 205]  BackgroundColor DataStoreName SampleTime } Block { BlockType Reference Name Ports Position  245, 103] BackgroundColor SourceBlock "dspbdsp2/Integer Delay" SourceType  Delay*  delay ic frame odf omumChans } Block { BlockType Name Ports Frame Ports Position  I BlockType Name Ports Position	[435, 175,

```
SaturateOnIntegerOverflow on
                                                             DstPort
                                                                                 1
        Block {
                                                           Line {
          BlockType
                                  Sum
                                                             SrcBlock
                                                                                 "Product"
          Name
                          "Sum"
                                                             SrcPort
                          [2, 1, 0, 0, 0]
          Ports
                                                             Points
                                                                                 [5. 0]
          Position
                             [375, 121,
                                                             Branch {
405, 1541
                                                           Points
                                                                           [0, 0]
          BackgroundColor
                                  "green"
                                                           DstBlock
                                                                           "Integer Delay"
          DropShadow
                              on
                                                           DstPort
                                                                           1
          IconShape
                                                             }
"rectangular"
                                                             Branch {
          Inputs
                                                           Points
                                                                           [0, 35]
          SaturateOnIntegerOverflow on
                                                           DstBlock
                                                                           "Sum"
                                                           DstPort
        Block {
                                                             }
          BlockType
                                  Sum
                          "Sum1"
[2, 1, 0, 0, 0]
[280, 77,
          Name
                                                           Line {
          Ports
                                                                                 "Sum"
                                                             SrcBlock
          Position
                                                             SrcPort
310, 108]
                                                             Points
                                                                                 [10, 0]
          BackgroundColor
                                  "green"
                                                             Branch (
          DropShadow
                              on
                                                           DstBlock
                                                                           "Data
          IconShape
                                                   Store\nWrite"
"rectangular"
                                                           DstPort
          Inputs
                                                             }
          SaturateOnIntegerOverflow on
                                                             Branch {
                                                           DstBlock
                                                                           "Outl"
        Block {
                                                           DstPort
                                                                           1
          BlockType
                                  Outport
                                                             }
                          "Outl"
          Name
                                                           }
          Position
                             [490, 133,
                                                         ŀ
520, 147]
          BackgroundColor
                                  "cyan"
                                                       Block {
          Port
                                                         BlockType
          OutputWhenDisabled
                                   "held"
                                                                          "Sum"
                                                         Name
          InitialOutput
                                  -0-
                                                                         [2, 1, 0, 0, 0]
[935, 258, 955, 287]
                                                         Ports
                                                          Position
        Line {
                                                          BackgroundColor
                                                                            "orange"
          SrcBlock
                              "Constant"
                                                          ShowName
                                                                        off
          SrcPort
                              1
                                                         IconShape
                                                                          "rectangular"
          Points
                              [15, 0]
                                                          Inputs
          DstBlock
                               "Product"
                                                          SaturateOnIntegerOverflow on
          DstPort
                              2
                                                       Block {
        Line {
                                                         BlockType
                                                                         Sum
          SrcBlock
                              "Inl"
                                                          Name
                                                                          "Sum1"
          SrcPort
                              1
                                                          Ports
                                                                          [2, 1, 0, 0, 0]
          DstBlock
                               "Product"
                                                          Position
                                                                         [1055, 203, 1075,
          DstPort
                              1
                                                    2321
                                                          BackgroundColor
                                                                             "orange"
        Line {
                                                          ShowName
                                                                        off
          SrcBlock
                              "Data
                                                          IconShape
                                                                          "rectangular"
Store\nRead*
                                                          Inputs
                                                                          *+-*
          SrcPort
                                                          SaturateOnIntegerOverflow on
                              1
          Points
                               [20, 0]
          DstBlock
                               "Sum1 "
                                                       Block {
          DstPort
                              2
                                                          BlockType
                                                                         Sum
                                                          Name
                                                                          "Sum12"
        Line {
                                                                         [2, 1, 0, 0, 0]
[450, 262, 480, 293]
                                                          Ports
          SrcBlock
                              *Integer
                                                          Position
Delay*
                                                          BackgroundColor *green*
          SrcPort
                                                          IconShape
                                                                         "rectangular"
          DstBlock
                              "Sum1"
                                                          Inputs
          DstPort
                                                          SaturateOnIntegerOverflow on
                              1
        Line {
                                                       Block {
          SrcBlock
                              "Sum1"
                                                         BlockType
                                                                         Sum
          SrcPort
                              1
                                                          Name
                                                                         "Sum13"
          Points
                              [45, 0]
                                                                         [2, 1, 0, 0, 0]
[555, 252, 585, 283]
                                                          Ports
          DstBlock
                               "Sum"
                                                          Position
```

```
BackgroundColor "green"
                                                                       off
     IconShape "rectangular"
Inputs "++"
                                                        ModelBrowserVisibility off
                                                        ModelBrowserWidth
     SaturateOnIntegerOverflow on
                                                        ScreenColor
                                                "lightBlue"
   Block (
                                                        PaperOrientation
     BlockType
                                                "landscape"
                    Sum
                    "Sum14"
     Name
                                                                             "auto"
                                                        PaperPositionMode
     Ports
                    [2, 1, 0, 0, 0]
                                                        PaperType "usletter"
     Position
                    [510, 317, 540, 348]
                                                        PaperUnits
                                                                          "inches"
     BackgroundColor "green"
                                                        ZoomFactor
                                                                          *100*
                  "rectangular"
     IconShape
                                                        AutoZoom
                                                                          on
     Inputs
                                                        Block {
                                                                         Inport
     SaturateOnIntegerOverflow on
                                                          BlockType
                                                          Name
   Block {
                                                          Position
                                                                           [25, 68, 55,
     BlockType
                                                821
     Name
                    "Sum2 "
                                                          BackgroundColor
                                                                                "cyan"
                    [2, 1, 0, 0, 0]
[1130, 213, 1150,
     Ports
                                                          Port
     Position
                                                          PortWidth
                                                                                --1-
2421
                                                          SampleTime
                                                                             --1-
     BackgroundColor
                       "orange"
                                                          DataType
                                                                             "auto"
                 off
     ShowName
                                                          SignalType
                                                                            "auto"
     IconShape
                    "rectangular"
                                                          Interpolate
                                                                             on
     Inputs
                    "+-"
     SaturateOnIntegerOverflow on
                                                        Block {
                                                          BlockType
                                                                               Constant
   Block {
                                                                         "Constant1"
                                                          Name
     BlockType
                    Sum
                                                          Position
                                                                           [100, 80,
     Name
                     "Sum3 "
                                                120, 100]
     Ports
                     [2, 1, 0, 0, 0]
                                                          BackgroundColor
                    [1075, 293, 1095,
     Position
                                                "darkGreen"
322]
                                                          Value
                                                                         *0*
     BackgroundColor
                        "orange"
                 off
     ShowName
                                                        Block (
      IconShape
                     "rectangular"
                                                          BlockType
                                                                               Fcn
                     *++*
      Inputs
                                                          Name
                                                                         "Fcn"
     SaturateOnIntegerOverflow on
                                                          Position
                                                                           [185, 165,
                                                245, 1951
   Block {
                                                          BackgroundColor
                                                                                 "yellow"
     BlockType
                    Sum
                                                          Expr
     Name
                     "Sum8"
                                                 *20*log10(u/(3.1623*power(10,-6)))*
                    [2, 1, 0, 0, 0]
[675, 107, 705, 138]
      Ports
      Position
                                                        Block {
      BackgroundColor *green*
                                                          BlockType
      IconShape "rectangular"
                                                RelationalOperator
      Inputs
                                                          Name
      SaturateOnIntegerOverflow on
                                                 "Relational\nOperator"
                                                          Position
                                                                             [145, 67,
   Block {
                                                 175, 98]
                                                                             "yellow"
      BlockType
                    Switch
                                                          BackgroundColor
      Name
                     "Switch"
                                                          Operator
      Position
                    [1000, 75, 1030,
                                                        }
105]
                                                        Block {
      BackgroundColor "yellow"
                                                          BlockType
                                                                                Sum
                         "alternate"
      NamePlacement
                                                          Name
                                                                         "Sum"
     ShowName
                     off
                                                          Ports
                                                                         [2, 1, 0, 0, 0]
     Threshold
                     "10.^-8"
                                                          Position
                                                                            [120, 162,
                                                 150, 193]
    Block {
                                                          BackgroundColor
                                                                                 "green"
      BlockType
                     SubSystem
                                                          IconShape
      Name
                     "dB Conv"
                                                 "rectangular"
                     [1, 1, 0, 0, 0]
[325, 63, 350, 97]
      Ports
                                                          Inputs
                                                                             -++
      Position
                                                          SaturateOnIntegerOverflow on
      BackgroundColor "darkGreen"
      DropShadow
                        on
                                                        Block {
      ShowPortLabels
                       off
                                                          BlockType
                                                                                Switch
     System {
                                                          Name
                                                                         "Switch"
       Name
                      "dB Conv"
                                                          Position
                                                                           [280, 70,
       Location
                          [8, 74, 474,
                                                310, 1001
3991
                                                          BackgroundColor
                                                                                "orange"
```

```
DstPort
         Threshold
                               -1-
                                                                          1
                                                     }
       Block {
                                                    }
         BlockType
                               Outport
                        "Outl"
         Name
                                                  Block {
         Position
                          [360, 78,
                                                    BlockType
                                                                   SubSystem
390, 921
                                                    Name
                                                                   *dB Conv.-LF*
                               "cyan"
         BackgroundColor
                                                    Ports
                                                                   [1, 1, 0, 0, 0]
                                                                [325, 158, 350, 192]
         Port
                                                    Position
                              "held"
         OutputWhenDisabled
                                                    BackgroundColor "darkGreen"
         InitialOutput
                               •[]•
                                                    DropShadow
                                                                      on
                                                    ShowPortLabels
                                                                     off
       Line {
                                                    System {
                           "Fcn"
         SrcBlock
                                                      Name
                                                                     "dB Conv.-LF"
         SrcPort
                                                      Location
                                                                       [152, 320,
         Points
                           [15, 0]
                                               618, 645]
         DstBlock
                            "Switch"
                                                      Open
                                                                     off
         DstPort
                                                      ModelBrowserVisibility off
                                                      ModelBrowserWidth 200
       Line {
                                                       ScreenColor
                           "Inl"
         SrcBlock
                                               "lightBlue"
         SrcPort
                           1
                                                      PaperOrientation
         Points
                           [10, 0]
                                               "landscape"
         Branch {
                                                       PaperPositionMode
                                                       PaperType
       Points
                      [0, -45; 195, 0]
                                                                        "usletter"
       DstBlock
                      "Switch"
                                                                        "inches"
                                                       PaperUnits
       DstPort
                                                       ZoomFactor
                                                                        -100-
         }
                                                       AutoZoom
                                                                        on
         Branch (
                                                       Block {
                                                                       Inport
                                                        BlockType
       DstBlock
    "Relational\nOperator"
                                                        Name
       DstPort
                      1
                                                         Position
                                                                         [25, 68, 55,
         }
                                               821
         Branch (
                                                        BackgroundColor
                                                                              "cyan"
                      [0. 110]
       Points
                                                         Port
       DstBlock
                      "Sum"
                                                         PortWidth
                      2
                                                                          --1-
       DstPort
                                                         SampleTime
        }
                                                                          "auto"
                                                         DataType
                                                         SignalType
                                                                          "auto"
        Line {
                                                        Interpolate
         SrcBlock
                            "Constant1"
          SrcPort
                            1
                                                       Block {
         DstBlock
                                                         BlockType
                                                                              Constant
"Relational\nOperator"
                                                                       "Constant1"
                                                        Name
         DstPort
                            7
                                                        Position
                                                                          [100, 80,
                                               120. 1001
        Line {
                                                        BackgroundColor
         SrcBlock
                                                "darkGreen"
"Relational\nOperator"
                                                        Value
                                                                       -0-
         SrcPort
          Points
                            [30, 0]
                                                       Block (
         Branch (
                                                         BlockType
                                                                             Fcn
                      "Switch"
        DstBlock
                                                         Name
                                                                       "Fcn"
        DstPort
                      2
                                                         Position
                                                                         [185, 165,
         1
                                               245, 195]
         Branch {
                                                         BackgroundColor
                                                                               "yellow"
        Points
                      [0, 50; -105, 0]
                                                         Expr
        DstBlock
                      "Sum"
                                                *20*log10(u/(3.1623*power(10,-6)))*
        DstPort
                      1
         }
                                                       Block {
                                                        BlockType
        Line {
                                               RelationalOperator
         SrcBlock
                            "Sum"
                                                        Name
          SrcPort
                            1
                                                "Relational\nOperator"
         DstBlock
                            "Fcn"
                                                         Position
                                                                           [145, 67,
         DstPort
                                               175, 98]
                            1
                                                        BackgroundColor
                                                                              "yellow"
        Line {
                                                        Operator
          SrcBlock
                            "Switch"
          SrcPort
                                                       Block {
          DstBlock
                            "Outl"
                                                        BlockType
                                                                               Sum
```

```
Name
                       "Sum"
                                                      Branch (
        Name
Ports
                    [2, 1, 0, 0, 0]
                                                    Points [0, 50; -105, 0]
                                                    DstBlock
        Position
                         [120, 162,
                                                                 "Sum"
                                                    DstPort
        BackgroundColor
                             "green"
                                                     }
        IconShape
"rectangular"
                                                    Line (
                                                                       "Sum"
        Inputs
                                                    SrcBlock
         SaturateOnIntegerOverflow on
                                                      SrcPort
                                                                      1
                                                      DstBlock
                                                                       "Fcn"
       Block {
                                                      DstPort
         BlockType
                             Switch
                       "Switch"
         Name
                                                    Line {
                        [280, 70,
         Position
                                                     SrcBlock
                                                                        "Switch"
310, 100]
                                                      SrcPort
         BackgroundColor
                             "orange"
                                                     DstBlock
                                                                        "Outl"
         Threshold
                              -1-
                                                      DstPort
                                                    }
       Block {
                                                  }
         BlockType
                             Outport
                       "Outl"
         Name
                                                 Block (
                        [360, 78,
                                                  BlockType
         Position
                                                               Constant
390, 92]
                                                        "effect"
ion [370, 210, 390, 230]
                                                   Name
         BackgroundColor
Port "1"
                             "cyan"
                                                   Position
         Port
OutputWhenDisabled *he *[]*
                                                   BackgroundColor "red"
Value "6"
                             "held"
                                                   Value
         InitialOutput
                                                 Block (
                                                   BlockType
       Line (
                                                               Outport
         SrcBlock
                           "Fcn"
                                                   Name
                                                                "Out1"
                                                            [1415, 88, 1445,
         SrcPort
                          1
                                                   Position
                         [15, 0]
         Points
                                             102]
         DstBlock
                                                   BackgroundColor "cyan"
Port "1"
                           "Switch"
         DstPort
                                                   Port
                                                   OutputWhenDisabled
                                                                        "held"
       Line {
                                                   InitialOutput
                                                                      -0-
         SrcBlock
                          "Inl"
         SrcPort
                          1
                                                 Line {
                                                   SrcBlock "In1"
SrcPort 1
Points [5, 0]
        Points
                          [10, 0]
        Branch {
       Points
                   [0, -45; 195, 0]
       DstBlock
                                                   Branch (
                    "Switch"
       DstPort
                                                    DstBlock
                                                                      "Abs"
                                                                  1
        }
                                                    DstPort
        Branch (
       DstBlock
                                                   Branch {
    "Relational\nOperator"
                                                    Points
                                                                  [0, -80; 1145, 0]
       DstPort
                                                    DstBlock
                                                                      *Product3*
        }
                                                    DstPort
        Branch {
                                                   ŀ
       Points
                    [0, 110]
       DstBlock
                     "Sum"
                                                 Line {
       DstPort
                                                                "Abs"
                                                   SrcBlock
        }
                                                   SrcPort
                                                   Points
                                                                 [5, 0]
       Line {
                                                   Branch {
         SrcBlock
                           "Constant1"
                                                    DstBlock
                                                                      "FastMoving"
         SrcPort
                           1
                                                    DstPort
                                                                   1
        DstBlock
"Relational\nOperator"
                                                   Branch {
       DstPort
                           2
                                                    DstBlock
                                                                      "SlowMoving"
                                                    DstPort
                                                                   1
       Line (
                                                   }
         SrcBlock
"Relational\nOperator"
                                                 Line {
        SrcPort
                                                                 *In5*
                                                   SrcBlock
         Points
                           [30, 0]
                                                   SrcPort
                                                                 1
        Branch {
                                                   Points
                                                                 [20, 0]
       DstBlock
                     "Switch"
                                                  DstBlock
                                                                 "Sum"
       DstPort
                     2
                                                  DstPort
         }
```

```
Line {
                                                      DstBlock
                                                                     "Outl"
     SrcBlock
                    "Sum"
                                                     DstPort
                                                                     1
     SrcPort
                    1
     DstBlock
                    *Product1*
                                                    Line {
     DstPort
                    2
                                                                     "Product"
                                                      SrcBlock
                                                      SrcPort
   Line {
                                                      Points
                                                                     [25, 0]
                    "In3"
     SrcBlock
                                                      Branch (
     SrcPort
                                                                          "Switch"
                                                      DstBlock
                    [15, 0; 0, -65; 205,
     Points
                                                       DstPort
                                                                      2
0; 0, 20]
     DstBlock
                    "Product1"
                                                      Branch {
     DstPort
                    1
                                                       Points
                                                                      [0, -10]
                                                        DstBlock
                                                                          "Switch"
   Line {
                                                       DstPort
     SrcBlock
                    "Sum1"
     SrcPort
     DstBlock
                     "Sum2"
                                                    Line {
     DstPort
                    1
                                                      SrcBlock
                                                                     "Switch"
                                                      SrcPort
   Line {
                                                      DstBlock
                                                                     "Math\nFunction"
     SrcBlock
                    "Constant"
                                                      DstPort
     SrcPort
                    1
     Points
                    [105, 0]
                                                    Line {
     Branch {
                                                      SrcBlock
                                                                     "In4"
       DstBlock
                          "Suml"
                                                      SrcPort
                                                                     1
       DstPort
                                                      Points
                                                                     [0, -40]
                                                      Branch {
     Branch (
                                                       DstBlock
                                                                           "Sum"
       Points
                      [0, -20; 130, 0]
                                                        DstPort
                                                                       1
       Branch {
         Points
                            [120, 0; 0,
                                                      Branch (
45]
                                                        Points
                                                                       [-20, 0]
         DstBlock
                            "Sum2"
                                                        DstBlock
                                                                          "Fcn"
         DstPort
                                                        DstPort
       Branch {
         Points
                            [0, -90]
                                                    Line {
         DstBlock
                             "Switch"
                                                      SrcBlock
                                                                     "Fen"
         DstPort
                                                      SrcPort
       }
                                                      DstBlock
                                                                     "Product"
     }
                                                      DstPort
   Line {
                                                    Line {
     SrcBlock
                     "Sum2"
                                                      SrcBlock
                                                                     "Product4"
     SrcPort
                     1
                                                      SrcPort
     Points
                     [5, 0]
                                                      Points
                                                                     [5, 0]
     DstBlock
                     "Product2"
                                                      DstBlock
                                                                     "Sum3 "
     DstPort
                                                      DstPort
   Line {
                                                    Line {
     SrcBlock
                     "Math\nFunction"
                                                      SrcBlock
                                                                     "Constant1"
      SrcPort
                                                      SrcPort
                                                                     1
     DstBlock
                     *Product2*
                                                      Points
                                                                     [60, 0]
     DstPort
                                                      DstBlock
                                                                     *Product4*
                                                      DstPort
   Line {
     SrcBlock
                     *Product2*
                                                    Line {
     SrcPort
                     7
                                                      SrcBlock
                                                                     "Product1"
     DstBlock
                     "Math\nFunction1"
                                                      SrcPort
     DstPort
                                                      Points
                                                                     [20, 0; 0, 30]
                                                      DstBlock
                                                                     "Sum3 "
   Line {
                                                      DstPort
     SrcBlock
                     "Math\nFunction1"
     SrcPort
                                                    Line {
     DstBlock
                     *Product3*
                                                      SrcBlock
                                                                     *Sum3 *
     DstPort
                                                      SrcPort
                                                      Points
                                                                     [0, -65; -60, 0]
   Line {
                                                      DstBlock
                                                                     "Suml"
     SrcBlock
                     "Product3"
                                                      DstPort
     SrcPort
                     1
                                                    ł
```

```
Line (
                                                    SrcPort
     SrcBlock
                   "Logical\nOperator2"
                                                    Points
                                                                   [0, 0]
     SrcPort
                                                    Branch (
     DstBlock
                    *Product14*
                                                      DstBlock
                                                                         *Product12*
     DstPort
                                                      DstPort
   Line {
                                                    Branch (
    SrcBlock
                                                      Points
                                                                     [0, 120]
"Relational\nOperator3"
                                                                      "Suml4"
                                                      DstBlock
     SrcPort 1
                                                      DstPort
     Points
                   [5, 0]
     Branch {
      Points
                     [0, -70]
                                                  Line {
       DstBlock
                      "Product10"
                                                    SrcBlock
                                                                   "Sum14"
      DstPort
                                                    SrcPort
                                                                   1
                                                    DstBlock
                                                                   "Product13"
     Branch {
                                                    DstPort
      DstBlock
"Logical\nOperator2"
                                                   Line (
      DstPort
                     1
                                                     SrcBlock
                                                                   "Product13"
                                                     SrcPort
                                                     Points
                                                                   [0, -65; -40, 0]
   Line {
                                                    DstBlock
                                                                    *Product14*
     SrcBlock
                    *Product11*
                                                    DstPort
     SrcPort
     DstBlock
                    "Sum13"
                                                   Line {
     DstPort
                                                     SrcBlock
                                                                   "dB Conv"
                                                     SrcPort
   Line {
                                                     Points
                                                                   [45, 0; 0, 20; 40,
     SrcBlock
                    *Product12*
                                               01
     SrcPort
                                                     Branch (
     DstBlock
                    "Sum13"
                                                       Points
                                                                    [0, -25]
     DstPort
                                                       DstBlock
                                                                         *Product10*
                                                      DstPort
   Line {
     SrcBlock
                    "Sum13"
                                                     Branch {
     SrcPort
                                                      Points
                                                                     [5, 0]
     DstBlock
                    "Product13"
                                                       Branch {
     DstPort
                                                        Points
                                                                         [-10, 0; 0,
                                               1351
   Line {
                                                        Branch {
                    "Product10"
     SrcBlock
                                                       DstBlock
                                                                     "Sum12"
     SrcPort
                                                       DstPort
     Points
                    [10, 0]
                                                         }
     DstBlock
                    "Sum8"
                                                         Branch {
     DstPort
                                                       DstBlock
                                                                     *Product12*
                                                       DstPort
   Line {
                                                        }
     SrcBlock
                    *Product14*
     SrcPort
                                                       Branch {
     Points
                    [10, 0]
                                                        Points
                                                                           [50, 0]
     DstBlock
                    *Sum8*
                                                         DstBlock
     DstPort
                                                "Relational\nOperator3"
                                                        DstPort
   Line {
                                                       }
     SrcBlock
                    "Sum12"
                                                     }
     SrcPort
     Points
                    [0, 0]
                                                   Line {
     Branch {
                                                     SrcBlock
                                                                   *dB Conv.-LF*
      Points
                      [0, 0]
                                                     SrcPort
                                                                   1
       DstBlock
                       *Product11*
                                                     Points
                                                                    [0, 5; 35, 0; 0, -
      DstPort
                                               15; 100, 01
                                                     Branch {
     Branch {
                                                       Points
                                                                     [0, 0]
       Points
                      [0, 45]
                                                      DstBlock
       DstBlock
                          "Sum14"
                                               "Relational\nOperator3"
       DstPort
                                                      DstPort
                                                     Branch {
   Line {
                                                       Points
                                                                      [0, 65]
                    "effect"
     SrcBlock
                                                       Branch {
```

```
[-85, 0; 0,
                                                     ZoomFactor
                                                                     -100-
         Points
551
                                                     AutoZoom
                                                                     on
         DstBlock
                             "Sum12"
                                                     Block {
                                                       BlockType
         DstPort
                                                                       Inport
                                                       Name
                                                                       "Inl"
       Branch (
                                                                       [150, 78, 180, 92]
                                                       Position
                                                                       .d,
"cyan"
"1"
          DstBlock
                             "Product11"
                                                        BackgroundColor
          DstPort
                                                        Port
                                                        PortWidth
                                                                       --<u>1</u>-
     }
                                                        SampleTime
                                                        DataType
                                                                       "auto"
    Line {
                                                        SignalType
                                                                          "auto"
      SrcBlock
                     "FastMoving"
                                                        Interpolate
                                                                           on
      SrcPort
                     [5. 0]
     Points
                                                      Block {
      DstBlock
                     "dB Conv"
                                                        BlockType
                                                                       Inport
      DstPort
                                                        Name
                                                                       "In3"
                                                                       [710, 298, 740, 312]
                                                        Position
    Line {
                                                        BackgroundColor "cyan"
Port "2"
      SrcBlock
                     "SlowMoving"
                                                        Port
      SrcPort
                                                                        --1-
                                                        PortWidth
                     [5, 0]
                                                                          --1-
      Points
                                                        SampleTime
      DstBlock
                     "dB Conv.-LF"
                                                        DataType
                                                                       "auto"
      DstPort
                                                        SignalType
                                                                           "auto"
                                                        Interpolate
    Line {
      SrcBlock
                     "Fcnl"
                                                      Block {
      SrcPort
                                                        BlockType
                                                                       Inport
      Points
                     [25, 0; 0, -45]
                                                        Name
                                                                        "In4"
      DstBlock
                     "Product"
                                                        Position
                                                                        [805, 298, 835, 312]
                                                                       , 298,
"cyan"
"3"
      DstPort
                                                        BackgroundColor
                                                        Port
    Line {
                                                        PortWidth
                                                                        --1-
      SrcBlock
                     *Sum8 *
                                                                           --1-
                                                        SampleTime
      SrcPort
                                                        DataType
                                                                        "auto"
      Points
                     [10, 0]
                                                        SignalType
                                                                           "auto"
      Branch {
                                                        Interpolate
        DstBlock
                           "Fcn1"
        DstPort
                                                      Block {
                                                        BlockType
                                                                       Inport
      Branch (
                                                        Name
                                                                        *In5*
       Points
                       [0, 35; -40, 0; 0,
                                                        Position
                                                                        [865, 298, 895, 312]
1701
                                                        BackgroundColor
                                                                          "cyan"
        DstBlock
                            "Product4"
                                                        Port
        DstPort
                       1
                                                        PortWidth
                                                                        -1-
      }
                                                                           --1-
                                                        SampleTime
    }
                                                        DataType
                                                                        "auto"
      }
                                                        SignalType
                                                                           "auto"
                                                        Interpolate
                                                                            on
    Block {
      BlockType
                             SubSystem
                                                      Block {
      Name
                                                        BlockType
                                                                        Abs
"homomorphic\nmultiplicative AGC4"
                                                        Name
                                                                        "Abs"
                 [4, 1, 0, 0, 0]
[440, 319, 470,
      Ports
                                                        Position
                                                                        [215, 70, 245, 100]
      Position
                                                        BackgroundColor "red"
3761
      BackgroundColor
                              "orange"
                                                      Block {
      DropShadow
                         on
                                                        BlockType
                                                                        Constant
      ShowPortLabels
                             off
                                                        Name
                                                                        "Constant"
      System {
                                                                        [710, 195, 740, 225]
                                                        Position
    Name
                                                        BackgroundColor "green"
Value "1"
    "homomorphic\nmultiplicative AGC4"
    Location [101, 84, 877, 461]
    Open
                   off
                                                      Block {
    ModelBrowserVisibility off
                                                        BlockType
                                                                       Constant
    ModelBrowserWidth 200
                                                        Name
                                                                        "Constant1"
    ScreenColor *lightBlue*
                                                        Position
                                                                       [910, 350, 940, 380]
    PaperOrientation "landscape"
PaperPositionMode "auto"
                                                        BackgroundColor *green*
                                                                       *330*
                                                        Value
                   "usletter"
    PaperType
                                                      1
    PaperUnits
                   "inches"
                                                      Block {
```

```
BlockType
                    SubSystem
                                                           Position
                                                                              [435, 175.
                                                 465, 2051
     Name
                     "FastMoving"
                     [1, 1, 0, 0, 0]
     Ports
                                                           BackgroundColor
                                                                                  "orange"
     Position
                    [270, 57, 300, 113]
                                                           DataStoreName
                                                                                  "AGC4"
     BackgroundColor
                        "orange"
                                                           SampleTime
                                                                              *1/Fs*
     DropShadow
                        on
     ShowPortLabels
                        off
                                                         Block {
     System (
                                                           BlockType
       Name
                       "FastMoving"
                                                 Reference
       Location
                         [71, 135, 859,
                                                           Name
                                                                          "Integer Delay"
4761
                                                                          [1, 1, 0, 0, 0]
                                                           Ports
                                                           Position
                                                                              [200, 67,
       ModelBrowserVisibility off
                                                 245, 103]
       ModelBrowserWidth
                              200
                                                           BackgroundColor
                                                                                  "red"
       ScreenColor
                                                           SourceBlock
"lightBlue"
                                                 "dspbdsp2/Integer Delay"
       PaperOrientation
                                                           SourceType
                                                                              *Integer
"landscape"
                                                 Delay*
       PaperPositionMode
                              "auto"
                                                           delay
                                                                          *160*
        PaperType
                          "usletter"
                                                           ic
                                                                           -0-
        PaperUnits
                          "inches"
                                                           frame
                                                                          off
        ZoomFactor
                          -100-
                                                           đf
                                                                          on
        AutoZoom
                           on
                                                           numChans
        Block {
          BlockType
                                Inport
                                                         Block {
                         "Inl"
          Name
                                                           BlockType
                                                                                 Product
          Position
                            [75, 93,
                                                                          "Product"
                                                           Name
105, 107]
                                                           Ports
                                                                           [2, 1, 0, 0, 0]
          BackgroundColor
                                 "cyan"
                                                           Position
                                                                              [145, 92,
          Port
                                                 175, 123]
          PortWidth
                                --1-
                                                           BackgroundColor
                                                                                  "green"
                             --1-
          SampleTime
                                                           Inputs
          DataType
                             "auto"
                                                           SaturateOnIntegerOverflow on
                             "auto"
          SignalType
          Interpolate
                             on
                                                         Block (
                                                           BlockType
                                                                                  Sum
        Block {
                                                                           "Sum"
                                                           Name
          BlockType
                                Constant
                                                           Ports
                                                                           [2, 1, 0, 0, 0]
                         "Constant"
          Name
                                                           Position
                                                                              [375, 121,
          Position
                            [80, 134,
                                                 405, 1541
110, 156]
                                                           {\tt BackgroundColor}
                                                                                  "green"
          BackgroundColor
                                 "red"
                                                           DropShadow
                                                                              OΠ
                         *160*
          Value
                                                           IconShape
                                                  "rectangular"
        Block {
                                                           Inputs
          BlockType
                                                           SaturateOnIntegerOverflow on
DataStoreMemory
         Name
                         *Data
                                                         Block {
Store\nMemory"
                                                           BlockType
                                                                                  Sum
          Position
                             [430, 35,
                                                                           "Suml"
                                                           Name
                                                                           [2, 1, 0, 0, 0]
462, 651
                                                           Ports
          BackgroundColor
                                 "orange"
                                                           Position
                                                                              [280, 77,
          DataStoreName
                                 "AGC4"
                                                 310, 108]
          InitialValue
                                                           BackgroundColor
                                                                                  "green"
                                                           DropShadow
                                                                              on
        Block {
                                                           IconShape
          BlockType
                                                  "rectangular"
DataStoreRead
                                                           Inputs
         Name
                         *Data
                                                           SaturateOnIntegerOverflow on
Store\nRead*
          Position
                             [210, 155,
                                                         Block {
240, 185]
                                                           BlockType
                                                                                  Outport
          BackgroundColor
                                 "orange"
                                                                           "Outl"
                                                           Name
                                 "AGC4"
          DataStoreName
                                                           Position
                                                                             [490, 133,
                             *1/Fs*
          SampleTime
                                                 520, 147]
                                                           BackgroundColor
                                                                                  "cyan"
        Block {
                                                           Port
         BlockType
                                                           OutputWhenDisabled
                                                                                   "held"
DataStoreWrite
                                                           InitialOutput
                                                                                  -0-
         Name
                         *Data
Store\nWrite"
                                                         Line {
```

```
SrcBlock
                             "Constant"
                                                        Expr
                                                                        "power(10,((u/20)-
          SrcPort
                             1
                                                   5.5))*
          Points
                             [15, 0]
                                                      }
          DstBlock
                             *Product*
                                                       Block {
          DstPort
                             2
                                                        BlockType
                                                                        Fcn
                                                         Name
                                                                        "Fcnl"
                                                                        [740, 110, 800, 140]
        Line (
                                                         Position
                                                         BackgroundColor "yellow"
          SrcBlock
                             "Inl"
          SrcPort
                             1
                                                        Expr
                                                                        *power(10,((u/20)-
          DstBlock
                             "Product"
                                                   5.5))-
          DstPort
                             1
                                                       Block {
                                                         BlockType
        Line [
                                                                        Logic
         SrcBlock
                             "Data
                                                         Name
                                                                         "Logical\nOperator2"
Store\nRead*
                                                         Ports
                                                                        [1, 1, 0, 0, 0]
[565, 144, 595, 176]
         SrcPort
                                                         Position
          Points
                             [20, 0]
                                                         BackgroundColor "yellow" Operator "NOT"
          DstBlock
                              "Suml"
          DstPort
                                                                         -1-
                                                         Inputs
        Line {
                                                       Block {
          SrcBlock
                                                         BlockType
                              "Integer
                                                                        Math
Delay*
                                                         Name
                                                                         "Math\nFunction"
          SrcPort
                                                         Ports
                                                                         [1, 1, 0, 0, 0]
          DstBlock
                              "Suml"
                                                         Position
                                                                        [1075, 75, 1105,
          DstPort
                                                   1051
                                                         BackgroundColor
        Line {
                                                                   off
                                                         ShowName
          SrcBlock
                              "Suml"
                                                         Operator
                                                                        "log"
          SrcPort
                              1
                                                         OutputSignalType "auto"
          Points
                              [45. 0]
          DstBlock
                              "Sum"
                                                       Block (
         DstPort
                              1
                                                         BlockType
                                                                        Math
                                                         Name
                                                                         "Math\nFunction1"
        Line {
                                                                        [1, 1, 0, 0, 0]
[1260, 85, 1290,
                                                         Ports
          SrcBlock
                              *Product*
                                                         Position
          SrcPort
                                                   1151
          Points
                              [5, 0]
                                                         BackgroundColor
                                                                            "red"
         Branch {
                                                         ShowName off
        Points
                        [0. 0]
                                                         Operator
                                                                        "exp"
        DstBlock
                        "Integer Delay"
                                                         OutputSignalType "auto"
        DstPort
         }
                                                       Block {
          Branch {
                                                         BlockType
                                                                         Product
        Points
                        [0, 35]
                                                         Name
                                                                         "Product"
        DstBlock
                        "Sum"
                                                         Ports
                                                                         [2, 1, 0, 0, 0]
[915, 72, 945, 103]
        DstPort
                                                         Position
          ŀ
                                                         BackgroundColor "yellow"
Inputs "*/"
                                                         Inputs
        Line {
                                                         SaturateOnIntegerOverflow on
          SrcBlock
                              "Sum"
          SrcPort
                                                       Block {
          Points
                              [10, 0]
                                                         BlockType
                                                                         Product
         Branch {
                                                         Name
                                                                         "Product1"
        DstBlock
                        "Data
                                                                        [2, 1, 0, 0, 0]
[995, 252, 1025,
                                                         Ports
Store\nWrite*
                                                         Position
        DstPort
                                                   2831
                                                                        r "yellow"
         }
                                                         BackgroundColor
         Branch (
                                                         Inputs
        DstBlock
                        "Outl"
                                                         SaturateOnIntegerOverflow on
        DstPort
                        1
          }
                                                       Block {
        }
                                                         BlockType
                                                                         Product
      }
                                                         Name
                                                                         "Product10"
    ŀ
                                                         Ports
                                                                         [2, 1, 0, 0, 0]
    Block {
                                                         Position
                                                                         [615, 67, 645, 98]
      BlockType
                                                         BackgroundColor *green*
Inouts *2*
                      Fcn
      Name
                      "Fcn"
                                                         Inputs
      Position
                     [835, 130, 895, 160]
                                                         SaturateOnIntegerOverflow on
      BackgroundColor "yellow"
                                                       Block {
```

```
BlockType Product
Name Product11*
Ports [2, 1, 0, 0, 0]
Position [505, 257, 535, 288]
                                                          BackgroundColor "yellow"
                                                          Operator
                                                       Block {
     BackgroundColor *green* Inputs *2*
                                                          BlockType
                                                                        SubSystem
                                                                          "SlowMoving"
                                                          Name
                                                          Ports [1, 1, 0, 0, 0]
Position [270, 137, 300, 193]
      SaturateOnIntegerOverflow on
                                                          BackgroundColor "orange"
DropShadow on
ShowPortLabels off
   Block (
      BlockType
                   Product
     Name "Product12"
Ports [2, 1, 0, 0, 0]
Position [505, 212, 535, 243]
                                                          System (
                                                                          "SlowMoving"
                                                            Name
                                                            Location
     BackgroundColor "green" Inputs "2"
                                                                               [73, 133, 861,
                                                    474]
      SaturateOnIntegerOverflow on
                                                            Open
                                                                            off
                                                            ModelBrowserVisibility off
   Block {
                                                            ModelBrowserWidth 200
     BlockType
                   Product
                                                            ScreenColor
      Name
                     "Product13"
                                                    "lightBlue"
      Ports [2, 1, 0, 0, 0]
Position [605, 311, 635, 344]
                                                           PaperOrientation
                                                    "landscape"
                                                            Paper?ositionMode "auto"
PaperType "usletter"
PaperUnits "inches"
ZoomFactor "100"
      BackgroundColor "green"
Inputs "*/"
      SaturateOnIntegerOverflow on
                                                            ZoomFactor
   Block {
                                                            AutoZoom
                                                                                on
      BlockType
                    Product
                                                            Block (
                                                                              Inport
     Ports
                                                              BlockType Inpor
Name *In1*
Position [75, 93,
                      "Product14"
                     [2, 1, 0, 0, 0]
      Position [615, 217, 645, 248]
      BackgroundColor "green"
Inputs "2"
                                                    105, 107]
      Inputs
                                                              BackgroundColor
                                                                                      "cyan"
                                                                         *1*
                                                               Port
     SaturateOnIntegerOverflow on
                                                               PortWidth
                                                               SampleTime
                                                                                  -1-
    Block {
                                                               DataType
                                                                                  "auto"
      BlockType Product
Name "Product2"
Ports [2, 1, 0, 0, 0]
Position [1175, 82, 1205,
                                                               SignalType
                                                                                 "auto"
                                                              Interpolate
                                                                                 on
                                                              BlockType Constant
Name "Constant"
Position [80, 134
                                                            Block {
1131
      BackgroundColor "yellow"
      Inputs
      SaturateOnIntegerOverflow on
                                                    110, 156]
                                                              BackgroundColor
                                                                                      "red"
                                                                            *3520*
                                                              Value
      BlockType Product
      Block {
                                                              BlockType
                                                    DataStoreMemory
                                                              Name
108]
                                                                              "Data
      BackgroundColor "yellow"
                                                    Store\nMemory"
      Inputs
                                                              Position
                                                                                  [430, 35,
      SaturateOnIntegerOverflow on
                                                    462, 65]
                                                               BackgroundColor
                                                                                       "orange"
                                                              DataStoreName "AGCS4"
InitialValue "0"
      BlockType Product
      Name "Product4"
Ports [2, 1, 0, 0, 0]
Position [1020, 322, 1050,
                                                            Block {
                                                              BlockType
3531
                                                    DataStoreRead
      Name
                                                                              "Data
                                                    Store\nRead*
      SaturateOnIntegerOverflow on
                                                              Position
                                                                                   [210, 155,
                                                    240, 185]
    Block (
                                                              BackgroundColor
                                                              Background
DataStoreName *1/Fs*
                                                                                       "orange"
      BlockType
                    RelationalOperator
                                                                                      "AGCS4"
      Name
                                                              SampleTime
"Relational\nOperator3"
      Position [510, 142, 540, 173]
                                                            Block {
```

```
BlockType
                                                          OutputWhenDisabled
                                                                                 "held"
                                                                                 -0-
DataStoreWrite
                                                          InitialOutput
                        *Data
         Name
                                                        Line {
Store\nWrite"
                            [435, 175,
         Position
                                                          SrcBlock
                                                                             "Constant"
                                                          SrcPort
                                                                             1
         BackgroundColor
                                "orange"
                                                          Points
                                                                             [15, 0]
         DataStoreName
                                "AGCS4"
                                                          DstBlock
                                                                             "Product"
                            "1/Fs"
         SampleTime
                                                          DstPort
       Block {
                                                        Line (
         BlockType
                                                                             ·Inl·
                                                          SrcBlock
Reference
                                                          SrcPort
         Name
                         "Integer Delay"
                                                          DstBlock
                                                                             *Product*
                        [1, 1, 0, 0, 0]
         Ports
                                                          DstPort
                                                                             1
         Position
                            [200, 67,
245, 1031
                                                        Line {
         BackgroundColor
                                "red"
                                                          SrcBlock
                                                                             "Data
         SourceBlock
                                                Store\nRead*
"dspbdsp2/Integer Delay"
                                                          SrcPort
         SourceType
                            *Integer
                                                          Points
                                                                             [20, 0]
Delay*
                                                          DstBlock
                                                                             "Suml"
                         *3520*
         delay
                                                          DstPort
          ic
                         -0-
         frame
                        off
                                                        Line {
         đf
                         on
                                                          SrcBlock
                                                                             "Integer
         numChans
                                                 Delay"
                                                          SrcPort
        Block {
                                                          DstBlock
                                                                             "Suml"
          BlockType
                               Product
                                                          DstPort
                         *Product*
         Name
                         [2, 1, 0, 0, 0]
          Ports
                                                        Line (
          Position
                             [145, 92,
                                                          SrcBlock
                                                                             "Suml"
175, 123]
                            "green"
                                                          SrcPort
         BackgroundColor
                                                          Points
                                                                             [45, 0]
          Inputs
                                                          DstBlock
                                                                             "Sum"
          SaturateOnIntegerOverflow on
                                                          DstPort
        Block {
                                                        Line {
          BlockType
                                Sum
                                                          SrcBlock
                                                                             "Product"
                         "Sum"
          Name
                                                          SrcPort
                         [2, 1, 0, 0, 0]
          Ports
                                                         Points
                                                                             [5. 0]
          Position
                            [375, 121,
                                                         Branch {
405, 1541
                                                        Points
                                                                       [0, 0]
          BackgroundColor
                                 "green"
                                                        DstBlock
                                                                       "Integer Delay"
          DropShadow
                             on
                                                        DstPort
          IconShape
                                                          3
"rectangular"
                                                          Branch {
          Inputs
                                                        Points
                                                                       [0, 35]
          SaturateOnIntegerOverflow on
                                                        DstBlock
                                                                       "Sum"
                                                        DstPort
        Block {
                                                         }
          BlockType
                                Sum
                         "Sum1"
          Name
                                                        Line {
                         [2, 1, 0, 0, 0]
          Ports
                                                          SrcBlock
                                                                             "Sum"
          Position
                             [280, 77,
                                                          SrcPort
310, 1081
                                                          Points
                                                                             [10, 0]
          BackgroundColor
                                 "green"
                                                          Branch {
          DropShadow
                             on
                                                        DstBlock
                                                                       *Data
          IconShape
                                                 Store\nWrite"
"rectangular"
                                                        DstPort
                                                                       1
          Inputs
          SaturateOnIntegerOverflow on
                                                          Branch {
                                                        DstBlock
                                                                       "Outl"
        Block {
                                                        DstPort
                                                                       1
          BlockType
                                Outport
                                                          ł
          Name
                         *Outl*
                                                         ł
          Position
                           [490, 133,
                                                      }
520, 147]
          BackgroundColor
                                 "cyan"
                                                     Block (
          Port
                                                      BlockType
                                                                     Sum
```

```
Name
                     "Sum"
                                                       IconShape
                                                                       "rectangular"
                    [2, 1, 0, 0, 0]
[935, 258, 955, 287]
                                                                       *++
     Ports
                                                       Inputs
     Position
                                                       SaturateOnIntegerOverflow on
     BackgroundColor
                        "orange"
     ShowName off
                                                     Block (
     IconShape
                    "rectangular"
                                                       BlockType
                                                                      Sum
     Inputs
                     *+-*
                                                       Name
                                                                       "Sum8"
                                                                       [2, 1, 0, 0, 0]
     SaturateOnIntegerOverflow on
                                                       Ports
                                                                      [675, 107, 705, 138]
                                                       Position
   Block {
                                                       BackgroundColor "green"
     BlockType
                    Sum
                                                       IconShape "rectangular"
                                                                       *++*
     Name
                     "Suml"
                                                       Inputs
                     [2, 1, 0, 0, 0]
[1055, 203, 1075,
     Ports
                                                       SaturateOnIntegerOverflow on
     Position
232]
                                                     Block {
     BackgroundColor
                       "orange"
                                                       BlockType
                                                                       Switch
                 off
     ShowName
                                                       Name
                                                                       "Switch"
     IconShape
                     "rectangular"
                                                       Position
                                                                      [1000, 75, 1030,
                     *+-*
     Inputs
                                                 1051
     SaturateOnIntegerOverflow on
                                                       BackgroundColor "yellow"
                                                       NamePlacement
                                                                             "alternate"
   Block {
                                                       ShowName
                                                                       off
     BlockType
                     Sum
                                                       Threshold
                                                                       *10.^-8*
     Name
                     "Sum12"
                    [2, 1, 0, 0, 0]
[450, 262, 480, 293]
      Ports
                                                     Block (
                                                       BlockType
     Position
                                                                       SubSystem
      BackgroundColor "green"
                                                       Name
                                                                       "dB Conv"
     IconShape "rectangular"
                                                                      [1, 1, 0, 0, 0]
[325, 63, 350, 97]
                                                       Ports
      Inputs
                                                       Position
     SaturateOnIntegerOverflow on
                                                       BackgroundColor "darkGreen"
                                                        DropShadow
                                                                          on
    Block {
                                                        ShowPortLabels
                                                                          off
      BlockType
                                                        System (
                     Sum
                     "Sum13"
      Name
                                                         Name
                                                                         "dB Conv"
                    [2, 1, 0, 0, 0]
[555, 252, 585, 283]
      Ports
                                                          Location
                                                                            [8, 74, 474,
      Position
                                                  3991
      BackgroundColor *green*
                                                          Open
                                                                         off
                    "rectangular"
      IconShape
                                                          ModelBrowserVisibility off
                     *++*
      Inputs
                                                          ModelBrowserWidth
      SaturateOnIntegerOverflow on
                                                          ScreenColor
                                                  "lightBlue"
    Block (
                                                         PaperOrientation
      BlockType
                     Sum
                                                  "landscape"
                     "Sum14"
      Name
                                                          PaperPositionMode
                                                                               "auto"
                    [2, 1, 0, 0, 0]
[510, 317, 540, 348]
      Ports
                                                                            "usletter"
                                                          PaperType
      Position
                                                          PaperUnits
                                                                            "inches"
      BackgroundColor "green"
                                                          ZoomFactor
                                                                            -100-
      IconShape "rectangular"
                                                          AutoZoom
                                                                             on
                     *++
      Inputs
                                                          Block {
      SaturateOnIntegerOverflow on
                                                            BlockType
                                                                                  Inport
                                                            Name
                                                                           "Inl"
    Block {
                                                            Position
                                                                             [25, 68, 55,
      BlockType
                     Sum
                                                  82]
      Name
                     "Sum2 "
                                                            BackgroundColor
                                                                                   "cyan"
      Ports
                     [2, 1, 0, 0, 0]
                                                            Port
                                                                          -1-
                                                                               "-1"
      Position
                    [1130, 213, 1150,
                                                            PortWidth
2421
                                                            SampleTime
                         "orange"
      BackgroundColor
                                                            DataType
                                                                               "auto"
                  off
      ShowName
                                                            SignalType
                                                                               "auto"
      IconShape
                     "rectangular"
                                                            Interpolate
                                                                               on
                     ---
      Inputs
      SaturateOnIntegerOverflow on
                                                          Block {
                                                            BlockType
                                                                                  Constant
    Block {
                                                            Name
                                                                           "Constant1"
      BlockType
                     Sum
                                                            Position
                                                                              [100, 80,
      Name
                     *Sum3 *
                                                  120, 100]
      Ports
                     [2, 1, 0, 0, 0]
[1075, 293, 1095,
                                                           BackgroundColor
      Position
                                                  *darkGreen*
3221
                                                           Value
                                                                           -0-
      BackgroundColor
                        "orange"
      ShowName
                 off
                                                          Block [
```

```
Fcn
                                                     DstBlock
         BlockType
                                                                   "Sum"
                       "Fcn"
         Name
                                                     DstPort
                                                                   2
                    [185, 165,
         Position
                                                       }
245, 1951
         BackgroundColor
                             "yellow"
                                                     Line (
         Expr
                                                       SrcBlock
                                                                         "Constantl"
"20*log10(u/(3.1623*power(10,-6)))"
                                                       SrcPort
                                                       DstBlock
       Block {
                                              "Relational\nOperator"
         BlockType
                                                      DstPort
                                                                         2
RelationalOperator
        Name
                                                     Line {
"Relational\nOperator"
                                                       SrcBlock
        Position
                           [145, 67,
                                              "Relational\nOperator"
175. 981
                           "yellow"
                                                      SrcPort
         BackgroundColor
                                                       Points
                                                                        [30, 0]
         Operator
                                                      Branch {
                                                     DstBlock
                                                                   "Switch"
       Block {
                                                     DstPort
         BlockType
                              Sum
         Name
                       "Sum"
                                                       Branch {
                       [2, 1, 0, 0, 0]
[120, 162,
                                                                   [0, 50; -105, 0]
         Ports
                                                     Points
         Position
                                                     DstBlock
                                                                   "Sum"
150, 193]
                                                     DstPort
         BackgroundColor
                              "green"
                                                      }
         IconShape
"rectangular"
                                                     Line {
         Inputs
                                                     SrcBlock
                                                                         "Sum"
         SaturateOnIntegerOverflow on
                                                       SrcPort
                                                       DstBlock
                                                                         "Fcn"
       Block {
                                                      DstPort
                                                                         1
         BlockType
                              Switch
                       "Switch"
         Name
                                                     Line {
         Position
                         [280, 70,
                                                     SrcBlock
                                                                         "Switch"
310, 1001
                                                       SrcPort
         BackgroundColor
                               "orange"
                                                       DstBlock
                                                                         "Outl"
         Threshold
                                                       DstPort
                                                                         1
                                                     }
       Block {
                       Outport
                                                   }
         BlockType
         Name
                                                  Block {
         Position
                        [360, 78,
                                                   BlockType
                                                                SubSystem
390, 92]
                                                   Ports
                                                                  "dB Conv.-LF"
         BackgroundColor
                              "cyan"
                                                                 [1, 1, 0, 0, 0]
         Port
                                                               [325, 158, 350, 192]
                                                    Position
         OutputWhenDisabled
                              "held"
                                                    BackgroundColor "darkGreen"
         InitialOutput
                              -[]-
                                                    DropShadow
                                                                    on
                                                    ShowPortLabels off
       Line {
                                                    System {
         SrcBlock
                           "Fcn"
                                                     Name
                                                                   "dB Conv.-LF"
         SrcPort
                           1
                                                     Location
                                                                    [152, 320,
         Points
                           [15, 0]
                                              618, 645]
         DstBlock
                           "Switch"
                                                     Open
                                                                   off
         DstPort
                                                     ModelBrowserVisibility off
ModelBrowserWidth 200
       Line {
                                                     ScreenColor
         SrcBlock
                           "Inl"
                                              "lightBlue"
         SicPort
                           1
                                                     PaperOrientation
         Points
                           [10, 0]
                                              "landscape"
         Branch {
                                                     PaperPositionMode "auto"
PaperType "usletter"
       Points
                     [0, -45; 195, 0]
       DstBlock
                     "Switch"
                                                                       "inches"
                                                     PaperUnits
       DstPort
                     1
                                                     ZoomFactor
                                                                       *100*
         }
                                                     AutoZoom
                                                                       on
         Branch {
                                                     Block {
                                                                     Inport
       DstBlock
                                                       BlockType
    "Relational\nOperator"
                                                       Name
       DstPort
                                                       Position
                                                                        [25, 68, 55,
        }
                                              82]
                                                       BackgroundColor *1*
         Branch {
                                                                           "cyan"
       Points
                    [0, 110]
```

```
PortWidth
                                                     Line {
                                                                       "Inl"
                                                      SrcBlock
         SampleTime
                          "auto"
         DataType
                                                        SrcPort
         SignalType
                           "auto"
                                                       Points
                                                                         [10. 0]
                                                       Branch {
         Interpolate
                           on
                                                     Points
                                                                   [0, -45; 195, 0]
       Block {
                                                     DstBlock
                                                                    "Switch"
         BlockType
                              Constant
                                                     DstPort
                                                                    1
         Name
                       *Constant1*
                                                      }
         Position
                          [100, 80,
                                                        Branch {
120, 100]
                                                     DstBlock
        BackgroundColor
                                                  "Relational\nOperator"
"darkGreen"
                                                     DstPort
        Value
                                                       }
                                                       Branch (
       Block {
                                                      Points
                                                                    [0, 110]
                        Fcn
"Fcn"
         BlockType
                                                      DstBlock
                                                                    "Sum"
         Name
                                                      DstPort
         Position
                        [185, 165,
                                                      }
245, 1951
         BackgroundColor
                             "yellow"
                                                      Line (
         Expr
                                                       SrcBlock
                                                                          *Constantl*
"20"log10(u/(3.1623"power(10,-6)))"
                                                        SrcPort
                                                        DstBlock
       Block {
                                               "Relational\nOperator"
         BlockType
                                                      DstPort
RelationalOperator
        Name
                                                      Line {
"Relational\nOperator"
                                                       SrcBlock
         Position
                           [145, 67,
                                               "Relational\nOperator"
175, 98]
                           "yellow"
                                                       SrcPort
         BackgroundColor
                                                       Points
                                                                          [30, 0]
         Operator
                                                       Branch (
                                                      DstBlock
                                                                    "Switch"
       Block {
                                                      DstPort
         BlockType
                             Sum
                       "Sum"
         Name
                                                        Branch {
                       [2, 1, 0, 0, 0]
         Ports
                                                      Points
                                                                    [0, 50; -105, 0]
         Position
                           [120, 162,
                                                      DstBlock
                                                                    "Sum"
150, 193]
                                                      DstPort
         BackgroundColor
                               "green"
                                                       }
         IconShape
"rectangular"
                                                      Line {
         Inputs
                                                       SrcBlock
                                                                          "Sum"
         SaturateOnIntegerOverflow on
                                                       SrcPort
                                                                          1
                                                       DstBlock
                                                                          "Fcn"
       Block {
                                                       DstPort
                                                                          1
         BlockType
                              Switch
                        "Switch"
         Name
                                                      Line {
                          [280, 70,
         Position
                                                        SrcBlock
                                                                          "Switch"
310, 100]
                                                        SrcPort
         BackgroundColor
                               "orange"
                                                        DstBlock
                                                                          "Outl"
         Threshold
                                                        DstPort
                                                      }
       Block {
                                                    }
         BlockType
                        "Outl"
                               Outport
         Name
                                                  Block {
         Position
                          [360, 78,
                                                               Constant
"effect"
                                                    BlockType
390, 921
                                                                  "effect"
         BackgroundColor
                               "cyan"
                                                    Position
                                                                 [370, 210, 390, 230]
         Port
                                                    BackgroundColor "red"
Value "6"
                               "held"
         OutputWhenDisabled
                                                    Value
         InitialOutput
                               •[]•
                                                  Block {
       Line {
                                                    BlockType
                                                                  Outport
         SrcBlock
                           "Fcn"
                                                                   "Out1"
                                                    Name
         SrcPort
                           1
                                                    Position
                                                                  [1415, 88, 1445,
         Points
                           [15, 0]
                                               102]
         DstBlock
                                                    BackgroundColor "cyan"
Port "1"
                           "Switch"
         DstPort
                                                    OutputWhenDisabled "held"
```

```
InitialOutput
                          -0-
                                                       Branch {
   Line {
                                                         Points
                                                                            [0, -90]
                   "In1"
     SrcBlock
                                                         DstBlock
                                                                            "Switch"
     SrcPort
                    1
                                                         DstPort
     Points
                    [5, 0]
                                                       }
     Branch {
                                                     }
      DstBlock
                         "Abs"
       DstPort
                     1
                                                   Line (
                                                     SrcBlock
                                                                    "Sum2"
     Branch {
                                                     SrcPort
                                                                    1
                      [0, -80; 1145, 0]
       Points
                                                     Points
                                                                    [5, 0]
       DstBlock
                          *Product3*
                                                     DstBlock
                                                                     *Product2*
       DstPort
                                                     DstPort
     }
                                                   Line (
   Line {
                                                     SrcBlock
                                                                    "Math\nFunction"
     SrcBlock
                    "Abs"
                                                     SrcPort
     SrcPort
                    1
                                                     DstBlock
                                                                    "Product2"
     Points
                    [5, 0]
                                                     DstPort
                                                                    1
     Branch (
       DstBlock
                          "FastMoving"
                                                    Line (
      DstPort
                      1
                                                     SrcBlock
                                                                     *Product2*
                                                     SrcPort
     Branch {
                                                     DstBlock
                                                                    "Math\nFunction1"
       DstBlock
                          "SlowMoving"
                                                     DstPort
                                                                    1
       DstPort
                      1
     }
                                                    Line {
                                                      SrcBlock
                                                                     "Math\nFunction1"
   Line {
                                                      SrcPort
                                                                    1
     SrcBlock
                    "In5"
                                                      DstBlock
                                                                     "Product3"
     SrcPort
                    1
                                                      DstPort
                                                                     2
     Points
                    [20, 0]
     DstBlock
                    "Sum"
                                                    Line {
     DstPort
                                                     SrcBlock
                                                                     *Product3*
                                                      SrcPort
                                                                     1
   Line {
                                                      DstBlock
                                                                     "Out1"
     SrcBlock
                    "Sum"
                                                     DstPort
                                                                     1
     SrcPort
     DstBlock
                    "Product1"
                                                    Line {
     DstPort
                                                      SrcBlock
                                                                     "Product"
                                                      SrcPort
   Line {
                                                      Points
                                                                     [25, 0]
     SrcBlock
                    "In3"
                                                     Branch {
     SrcPort
                    1
                                                       DstBlock
                                                                           "Switch"
     Points
                    [15, 0; 0, -65; 205,
                                                       DstPort
                                                                      2
0; 0, 20]
     DstBlock
                    "Product1"
                                                      Branch {
     DstPort
                                                        Points
                                                                       [0, -10]
                                                        DstBlock
                                                                           "Switch"
   Line {
                                                       DstPort
     SrcBlock
                    "Sum1"
                                                      ł
     SrcPort
                    1
     DstBlock
                    "Sum2"
                                                    Line (
     DstPort
                                                      SrcBlock
                                                                     "Switch"
                                                      SrcPort
   Line {
                                                      DstBlock
                                                                     "Math\nFunction"
     SrcBlock
                    "Constant"
                                                      DstPort
                                                                     1
     SrcPort
                    1
     Points
                    [105, 0]
                                                    Line {
     Branch {
                                                      SrcBlock
                                                                     "In4"
       DstBlock
                          "Sum1"
                                                      SrcPort
                                                                     1
       DstPort
                                                      Points
                                                                     [0, -40]
                                                      Branch {
     Branch {
                                                       DstBlock
                                                                           "Sum"
       Points
                      [0, -20: 130, 0]
                                                       DstPort
       Branch {
         Points
                            [120, 0; 0,
                                                      Branch (
451
                                                       Points
                                                                       [-20, 0]
         DstBlock
                            "Sum2"
                                                        DstBlock
                                                                         "Fcn"
         DStPort
                                                       DstPort
```

```
}
                                                      SrcBlock
                                                                     "Sum13"
                                                      SrcPort
                                                                     1
   Line {
                                                      DstBlock
                                                                     "Product13"
     SrcBlock
                    "Fcn"
                                                      DstPort
                                                                     1
     SrcPort
                    1
     DstBlock
                    "Product"
                                                    Line {
    DstPort
                                                      SrcBlock
                                                                     "Product10"
                                                      SrcPort
   Line {
                                                                      [10, 0]
                                                      Points
                    "Product4"
     SrcBlock
                                                      DstBlock
                                                                      *Sum8 *
     SrcPort
                                                      DstPort
                                                                      1
     Points
                    [5, 0]
     DstBlock
                    "Sum3"
                                                    Line {
     DstPort
                                                                      *Product14*
                                                      SrcBlock
                                                      SrcPort
   Line {
                                                                      [10, 0]
                                                      Points
     SrcBlock
                    "Constant1"
                                                      DstBlock
                                                                      *Sum8 *
     SrcPort
                                                      DstPort
                                                                      2
     Points
                    [60, 0]
     DstBlock
                    "Product4"
                                                    Line {
     DstPort
                                                      SrcBlock
                                                                      "Sum12"
                                                      SrcPort
   Line (
                                                      Points
                                                                      [0, 0]
     SrcBlock
                    "Product1"
                                                      Branch (
     SrcPort
                                                        Points
                                                                        [0, 0]
     Points
                    [20, 0; 0, 30]
                                                        DstBlock
                                                                           "Product11"
     DstBlock
                    "Sum3 "
                                                        DstPort
     DstPort
                    1
                                                      Branch {
   Line {
                                                        Points
                                                                        [0, 45]
     SrcBlock
                    "Sum3"
                                                        DstBlock
                                                                            "Sum14"
     SrcPort
                                                        DstPort
     Points
                    [0, -65; -60, 0]
     DstBlock
                    "Suml"
     DstPort
                                                     Line {
                                                      SrcBlock
                                                                      "effect"
   Line {
                                                      SrcPort
                                                                      1
     SrcBlock
                    "Logical\nOperator2"
                                                      Points
                                                                      [0, 0]
     SrcPort
                                                      Branch (
     DstBlock
                    "Product14"
                                                        DstBlock
                                                                           "Product12"
     DstPort
                                                        DstPort
   Line (
                                                      Branch (
     SrcBlock
                                                        Points
                                                                        [0, 120]
"Relational\nOperator3"
                                                        DstBlock
                                                                            "Sum14"
     SrcPort
                                                        DstPort
     Points
                    [5, 0]
                                                      }
     Branch {
       Points
                      [0, -70]
                                                     Line {
       DstBlock
                          "Product10"
                                                       SrcBlock
                                                                      "Sum14"
       DstPort
                      2
                                                       SrcPort
                                                       DstBlock
                                                                      "Product13"
     Branch {
                                                       DstPort
       DstBlock
"Logical\nOperator2"
                                                     Line {
      DstPort
                      1
                                                       SrcBlock
                                                                      "Product13"
     ł
                                                       SrcPort
   }
                                                      Points
                                                                      [0, -65; -40, 0]
   Line {
                                                      DstBlock
                                                                      "Product14"
     SrcBlock
                     *Product11*
                                                       DstPort
                                                                      2
     SrcPort
     DstBlock
                    "Sum13"
                                                     Line {
     DstPort
                    2
                                                       SrcBlock
                                                                      "dB Conv"
                                                       SrcPort
   Line {
                                                       Points
                                                                      [45, 0; 0, 20; 40,
     SrcBlock
                    "Product12"
                                                 01
     SrcPort
                    1
                                                      Branch {
     DstBlock
                    "Sum13"
                                                        Points
                                                                        [0, -25]
     DstPort
                                                         DstBlock
                                                                            "Product10"
                                                        DstPort
   Line {
```

```
Branch (
                                                                      [10, 0]
                                                       Points
                     [5, 0]
                                                       Branch {
       Points
       Branch {
                                                         DstBlock
                                                                            "Fcnl"
        Points
                           [-10, 0; 0,
                                                                       1
                                                         DstPort
135]
         Branch {
                                                       Branch {
       DstBlock
                       "Sum12"
                                                         Points
                                                                        [0, 35; -40, 0; 0,
       DstPort
                                                 1701
                                                         DstBlock
         }
                                                                            "Product4"
         Branch {
                                                         DstPort
       DstBlock
                       "Product12"
                                                       }
       DstPort
                                                     }
         }
                                                       }
       Branch (
                                                     Block {
                                                       BlockType
         Points
                             [50, 0]
                                                                              SubSystem
         DstBlock
                                                       Name
"Relational\nOperator3"
                                                 *homomorphic\nmultiplicative AGC5*
         DstPort
                                                       Ports [4, 1, 0, 0, 0]
       }
                                                       Position
                                                                          [445, 409, 475,
     }
                                                 4661
                                                       BackgroundColor
                                                                              "orange"
   Line {
                                                       DropShadow
                                                                          on
      SrcBlock
                    "dB Conv.-LF"
                                                       ShowPortLabels
                                                                              off
      SrcPort
                     1
                                                       System {
     Points
                     [0, 5; 35, 0; 0, -
                                                     Name
15; 100, 0]
                                                     "homomorphic\nmultiplicative AGC5"
      Branch {
                                                     Location [103, 82, 879, 459]
        Points
                      [0, 0]
                                                     Open
                                                                    off
       DstBlock
                                                     ModelBrowserVisibility off
"Relational\nOperator3"
                                                     ModelBrowserWidth 200
                                                     ScreenColor "lightBlue"
       DstPort
                                                     PaperOrientation "landscape"
PaperPositionMode "auto"
      Branch {
       Points
                      [0, 65]
                                                     PaperType
                                                                     "usletter"
       Branch {
                                                     PaperUnits
                                                                     "inches"
         Points
                            [-85, 0; 0,
                                                                    -100-
                                                     ZoomFactor
55;
                                                     AutoZoom
         DstBlock
                             "Sum12"
                                                     Block {
        DstPort
                                                       BlockType
                                                                      Inport
                                                                    "Inl"
                                                       Name
        Branch {
                                                       Position
                                                                      [150, 78, 180, 92]
         DstBlock
                             *Product11*
                                                       BackgroundColor "cyan"
Port "1"
          DstPort
                             1
                                                       Port
                                                                       *-1*
                                                       PortWidth
      }
                                                       SampleTime
                                                                         --1-
                                                       DataType
                                                                       "auto"
    Line {
                                                       SignalType
                                                                         "auto"
      SrcBlock
                     "FastMoving"
                                                       Interpolate
                                                                          on
      SrcPort
                     [5, 0]
      Points
                                                     Block {
      DstBlock
                     "dB Conv"
                                                       BlockType
                                                                       Inport
      DstPort
                     1
                                                       Name
                                                                       "In3"
                                                                       [710, 298, 740, 312]
                                                       Position
                                                                       , 298,
"cyan"
"2"
    Line {
                                                       BackgroundColor
                     "SlowMoving"
      SrcBlock
                                                        Port
      SrcPort
                     1
                                                       PortWidth
                                                                       --1-
                                                                          --1-
      Points
                     [5, 0]
                                                       SampleTime
      DstBlock
                     "dB Conv.-LF"
                                                       DataType
                                                                       "auto"
      DstPort
                                                       SignalType
                                                                          "auto"
                                                       Interpolate
                                                                          on
    Line {
      SrcBlock
                     "Fcnl"
                                                     Block {
      SrcPort
                                                       BlockType
                                                                       Inport
      Points
                     [25, 0; 0, -45]
                                                       Name
                                                                       "In4"
      DstBlock
                     "Product"
                                                       Position
                                                                       [805, 298, 835, 312]
                                                                       ., 298,
"cyan"
"3"
      DstPort
                                                       BackgroundColor
                                                       Port
    Line {
                                                       PortWidth
                     "Sum8"
      SrcBlock
                                                       SampleTime
      SrcPort
                                                       DataType
                                                                       "auto"
```

```
SignalType
                         *auto*
     Interpolate
                                                          Block {
                         On
                                                            BlockType
                                                                                  Constant
   Block {
                                                                           "Constant"
                                                            Name
     BlockType
                     Inport
                                                            Position
                                                                              [80, 134,
     Name
                     •In5•
                                                  110, 156]
                     [865, 298, 895, 312]
     Position
                                                            BackgroundColor
                                                                                   "red"
                     cyan"
     BackgroundColor
                                                            Value
     Port
                     --1-
     PortWidth
                                                          Block {
                        -1-
     SampleTime
                                                            BlockType
     DataType
                     "auto"
                                                  DataStoreMemory
     SignalType
                         "auto"
                                                            Name
                                                                           "Data
     Interpolate
                         on
                                                  Store\nMemory*
                                                            Position
                                                                               [430, 35,
   Block {
                                                  462, 65]
     BlockType
                     Abs
                                                            BackgroundColor
                                                                                    "orange"
     Name
                     "Abs"
                                                            DataStoreName
                                                                                    "AGC5"
     Position
                     [215, 70, 245, 100]
                                                                               -0-
                                                            InitialValue
     BackgroundColor "red"
                                                          Block {
   Block {
                                                            BlockType
     BlockType
                     Constant
                                                  DataStoreRead
     Name
                     "Constant"
                                                            Name
                                                                           *Data
     Position
                     [710, 195, 740, 225]
                                                  Store\nRead"
     BackgroundColor "green"
Value "1"
                                                            Position
                                                                                [210, 155,
     Value
                                                  240, 185]
                                                            BackgroundColor
                                                                                    "orange"
   Block {
                                                            DataStoreName
                                                                                   "AGC5 "
     BlockType
                     Constant
                                                            SampleTime
                                                                                "1/Fs"
     Name
                     "Constant1"
     Position [910, 350, 940, 380] BackgroundColor "green"
                                                          Block (
                                                            BlockType
                     *330*
     Value
                                                  DataStoreWrite
   }
                                                            Name
                                                                            "Data
   Block {
                                                  Store\nWrite"
      BlockType
                     SubSystem
                                                            Position
                                                                                [435, 175.
      Name
                      "FastMoving"
                                                  465, 205]
      Ports
                      [1, 1, 0, 0, 0]
                                                            BackgroundColor
                                                                                    "orange"
                     [270, 57, 300, 113]
      Position
                                                            DataStoreName
                                                                                    "AGC5"
      BackgroundColor
                         "orange"
                                                            SampleTime
                                                                                *1/Fs*
      DropShadow
                         on
      ShowPortLabels
                        off
                                                          Block {
      System {
                                                            BlockType
       Name
                       "FastMoving"
                                                  Reference
       Location
                           [73, 133, 861,
                                                            Name
                                                                            "Integer Delay"
4741
                                                            Ports
                                                                            [1, 1, 0, 0, 0]
                       off
                                                            Position
                                                                                [200, 67,
        ModelBrowserVisibility off
                                                  245, 103]
        ModelBrowserWidth
                                                            BackgroundColor
                                                                                    "red"
        ScreenColor
                                                            SourceBlock
"lightBlue"
                                                  "dspbdsp2/Integer Delay"
       PaperOrientation
                                                            SourceType
                                                                                "Integer
"landscape"
                                                  Delay*
        PaperPositionMode
                               "auto"
                                                            delay
                                                                            *160*
                           "usletter"
        PaperType
                                                                            -0-
                                                            ic
        PaperUnits
                           "inches"
                                                            frame
                                                                            off
        ZoomFactor
                           *100*
                                                            đ£
                                                                            on
        AutoZoom
                           on
                                                            numChans
                                                                                -1-
        Block {
          BlockType
                                 Inport
                                                          Block {
                          "Inl"
          Name
                                                            BlockType
                                                                                   Product
          Position
                             [75, 93,
                                                            Name
                                                                            "Product"
105, 107]
                                                                            [2, 1, 0, 0, 0]
[145, 92,
                                                            Ports
          BackgroundColor
                                 "cyan"
                                                            Position
          Port
                                                  175, 123]
          PortWidth
                                                            BackgroundColor
                                                                                   "green"
                             "-I"
          SampleTime
                                                            Inputs
          DataType
                             "auto"
                                                            SaturateOnIntegerOverflow on
          SignalType
                              "auto"
          Interpolate
                             on
                                                          Block {
```

```
BlockType
                                                            SrcBlock
                                 Sum
                                                                                "Product"
                          "Sum"
          Name
                                                            SrcPort
                                                                                7
                          [2, 1, 0, 0, 0]
          Ports
                                                            Points
                                                                                [5, 0]
                             [375, 121,
          Position
                                                            Branch {
405, 154]
                                                          Points
                                                                          [0, 0]
          BackgroundColor
                                 "green"
                                                          DstBlock
                                                                          "Integer Delay"
          DropShadow
                                                          DstPort
                             on
          IconShape
                                                            }
"rectangular"
                                                            Branch {
          Inputs
                             *++*
                                                          Points
                                                                          [0, 35]
          SaturateOnIntegerOverflow
                                                          DstBlock
                                                                          "Sum"
                                                          DstPort
                                                                          2
        Block {
                                                            }
          BlockType
                                 Sum
          Name
                          "Suml"
                                                          Line {
                          [2. 1. 0. 0. 0]
          Ports
                                                            SrcBlock
                                                                                "Sum"
                             [280, 77,
          Position
                                                            SrcPort
310, 108]
                                                            Points
                                                                                [10, 0]
          BackgroundColor
                                                            Branch (
                                 "green"
          DropShadow
                                                          DstBlock
                             on
                                                                          "Data
          IconShape
                                                  Store\nWrite*
"rectangular"
                                                          DstPort
                                                                          1
          Inputs
          SaturateOnIntegerOverflow
                                                            Branch (
                                      On
                                                          DstBlock
                                                                          "Outl"
        Block (
                                                          DstPort
                                                                          1
          BlockType
                                Outport
                                                            }
                          "Outl"
          Name
          Position
                             [490, 133,
                                                        }
520, 147]
          BackgroundColor
                                 "cyan"
                                                      Block {
          Port
                                                        BlockType
                                                                        Fcn
          OutputWhenDisabled
                                   "held"
                                                        Name
                                                                        "Fcn"
          InitialOutput
                                 -0-
                                                        Position
                                                                        [835, 130, 895, 160]
                                                        BackgroundColor "yellow"
        Line (
                                                        Expr
                                                                        *power(10,((u/20)-
          SrcBlock
                              "Constant"
                                                  5.5))*
          SrcPort
          Points
                              [15, 0]
                                                      Block (
          DstBlock
                              "Product"
                                                        BlockType
                                                                        Fcn
          DstPort
                                                        Name
                                                                        "Fcnl"
                                                         Position
                                                                        [740, 110, 800, 140]
        Line {
                                                        BackgroundColor "yellow"
          SrcBlock
                              "Inl"
                                                        Expr
                                                                        "power(10,((u/20)-
          SrcPort
                                                   5.5))*
          DstBlock
                              "Product"
          DstPort
                                                      Block {
                                                        BlockType
                                                                        Logic
        Line {
                                                        Name
                                                                        "Logical\nOperator2"
                              "Data
          SrcBlock
                                                        Ports
                                                                        [1, 1, 0, 0, 0]
Store\nRead*
                                                         Position
                                                                        [565, 144, 595, 176]
          SrcPort
                                                        BackgroundColor "yellow"
          Points
                              [20, 0]
                                                        Operator
                                                                        "NOT"
          DstBlock
                              "Sum1"
                                                        Inputs
                                                                        -1-
          DstPort
                                                       Block {
        Line {
                                                         BlockType
                                                                        Math
          SrcBlock
                              *Integer
                                                         Name
                                                                        "Math\nFunction"
Delay"
                                                                        [1, 1, 0, 0, 0]
[1075, 75, 1105,
                                                         Ports
          SrcPort
                                                         Position
          DstBlock
                              "Suml"
                                                  1051
          DstPort
                              1
                                                         BackgroundColor
                                                                           "red"
                                                         ShowName
                                                                        off
        Line {
                                                        Operator
                                                                        "log"
          SrcBlock
                              "Sum1"
                                                        OutputSignalType "auto"
          SrcPort
          Points
                              [45, 0]
                                                      Block {
          DstBlock
                              "Sum"
                                                        BlockType
                                                                        Math
          DstPort
                                                        Name
                                                                        "Math\nFunction1"
                                                        Ports
                                                                        [1, 1, 0, 0, 0]
        Line {
```

```
Position
                  [1260, 85, 1290,
                                                    Block {
1151
                                                      BlockType Product
     BackgroundColor "red"
ShowName off
                                                                     "Product2"
                                                      Name
                                                      Ports
                                                                     [2, 1, 0, 0, 0]
                   "exp"
     Operator
                                                      Position
                                                                     [1175, 82, 1205,
     OutputSignalType "auto"
                                                 1131
                                                      BackgroundColor "yellow"
   Block (
                                                      Inputs
     BlockType
                    Product
                                                      SaturateOnIntegerOverflow on
                     *Product*
     Name
                   [2, 1, 0, 0, 0]
[915, 72, 945, 103]
     Ports
                                                    Block {
                                                      BlockType
     Position
                                                                    Product
     BackgroundColor "yellow"
Toputs "*/"
                                                      Name
                                                                     "Product3"
                                                                    [2, 1, 0, 0, 0]
      Inputs
                                                      Ports
     SaturateOnIntegerOverflow on
                                                      Position
                                                                    [1350, 77, 1380,
                                                 1081
   Block {
                                                      BackgroundColor "yellow"
      BlockType Product
      Name
                    "Product1"
                                                      SaturateOnIntegerOverflow on
     Forts
                    [2, 1, 0, 0, 0]
      Position
                   [995, 252, 1025,
                                                     Block {
                                                      BlockType
2831
                                                                    Product
     BackgroundColor "yellow"
Inputs "*/"
                                                      Ports
                                                                     *Product4*
                                                                    [2, 1, 0, 0, 0]
     SaturateOnIntegerOverflow on
                                                      Position
                                                                    [1020, 322, 1050,
                                                 3531
    Block {
                                                      BackgroundColor "yellow"
Inputs "*/"
      BlockType
                   Product
                                                      Inputs
                     "Product10"
                                                      SaturateOnIntegerOverflow on
      Ports
                    [2, 1, 0, 0, 0]
      Position
                   [615, 67, 645, 98]
                                                    Block {
      BackgroundColor "green"
Inputs "2"
                                                      BlockType
                                                                    RelationalOperator
                                                      Name
      SaturateOnIntegerOverflow on
                                                 "Relational\nOperator3"
                                                       Position [510, 142, 540, 173]
                                                      BackgroundColor "yellow"
Operator ">="
    Block {
      BlockType Product
                                                      Operator
      Name
                    *Product11*
      Ports [2, 1, 0, 0, 0]
Position [505, 257, 535, 288]
                                                     Block {
                                                       BlockType
                                                                     SubSystem
                    r "green"
"2"
      BackgroundColor
                                                       Name
                                                                      "SlowMoving"
      Inputs
                                                                 [1, 1, 0, 0, 0]
[270, 137, 300, 193]
                                                       Ports
      SaturateOnIntegerOverflow on
                                                       Position
                                                       BackgroundColor "orange"
    Block {
                                                       DropShadow
                                                                         on
      BlockType
                   Product
                                                       ShowPortLabels off
      Name
                    *Product12*
                                                       System {
      Ports
                    [2, 1, 0, 0, 0]
      Ports [2, 1, 0, 0, 0]
Position [505, 212, 535, 243]
                                                                        "SlowMoving"
                                                         Name
                                                         Location
                                                                        [75, 131, 863,
      BackgroundColor "green"
Inputs "2"
                                                 4721
                                                                        off
      SaturateOnIntegerOverflow on
                                                         ModelBrowserVisibility off
                                                         ModelBrowserWidth 200
    Block (
                                                         ScreenColor
      BlockType
                    Product
                                                 "lightBlue"
      Name
                     "Product13"
                                                         PaperOrientation
      Ports
                    [2, 1, 0, 0, 0]
                                                 "landscape"
      Position [605, 311, 635, 344]
                                                         PaperPositionMode "auto"
PaperType "usletter"
      BackgroundColor "green"
Inputs "*/"
      Inputs
                                                         PaperUnits
                                                                           "inches"
      SaturateOnIntegerOverflow on
                                                         ZoomFactor
                                                                           -100-
                                                         AutoZoom
                                                                           on
    Block {
                                                         Block {
      BlockType
                     Product
                                                                                 Inport
                                                           BlockType
      Name
                     "Product14"
                                                           Name
                                                                          "Inl"
      Ports
                     [2, 1, 0, 0, 0]
                                                           Position
                                                                             [75, 93,
                    [615, 217, 645, 248]
      Position
                                               105, 107]
      BackgroundColor "green"
Inputs "2"
                                                           BackgroundColor
                                                                                "cyan"
      Inputs
      SaturateOnIntegerOverflow on
                                                           PortWidth
                                                                                 --1-
    }
                                                           SampleTime
                                                                             --1-
```

```
DataType
                            "auto"
                                                           SaturateOnIntegerOverflow on
                            "auto"
         SignalType
         Interpolate
                            on
                                                         Block {
                                                           BlockType
                                                                                 Sum
                                                                          "Sum"
       Block (
                                                           Name
         BlockType
                               Constant
                                                           Ports
                                                                          [2, 1, 0, 0, 0]
         Name
                         "Constant"
                                                                              [375, 121,
                                                           Position
         Position
                            [80, 134,
                                                 405, 154]
110, 156]
                                                                                  "green"
                                                           BackgroundColor
         BackgroundColor
                                "red"
                                                           DropShadow
                                                                              on
                        *3520*
         Value
                                                           IconShape
                                                 "rectangular"
       Block (
                                                           Inputs
         BlockType
                                                           SaturateOnIntegerOverflow on
DataStoreMemory
         Name
                         "Data
                                                         Block {
Store\nMemory"
                                                           BlockType
                                                                                 Sum
                                                           Name
         Position
                             [430, 35,
                                                                          "Suml"
462, 651
                                                                          [2, 1, 0, 0, 0]
                                                           Ports
         BackgroundColor
                                "orange"
                                                           Position
                                                                              [280, 77.
         DataStoreName
                                "AGCS5"
                                                 310, 108]
         InitialValue
                                                           BackgroundColor
                                                                                  "green"
                                                           DropShadow
       Block (
                                                           IconShape
         BlockType
                                                 "rectangular"
DataStoreRead
                                                           Inputs
                                                                              *-+*
         Name
                         "Data
                                                           SaturateOnIntegerOverflow on
Store\nRead*
         Position
                            [210, 155,
                                                         Block {
                                                                          Outport
240, 1851
                                                           BlockType
         BackgroundColor
                                "orange"
                                                           Name
         DataStoreName
                                *AGCS5
                                                           Position
                                                                             (490, 133,
                             "1/Fs"
         SampleTime
                                                 520, 147]
                                                           BackgroundColor
                                                                                  "cyan"
       Block {
                                                           Port
         BlockType
                                                           OutputWhenDisabled
                                                                                   "held"
DataStoreWrite
                                                           InitialOutput
                                                                                  -0-
         Name
                         "Data
Store\nWrite*
                                                         Line {
         Position
                             [435, 175,
                                                           SrcBlock
                                                                              "Constant"
465. 2051
                                                           SrcPort
         BackgroundColor
                                "orange"
                                                           Points
                                                                               [15. 0]
         DataStoreName
                                "AGCS5"
                                                           DstBlock
                                                                              "Product"
                            "1/Fs"
         SampleTime
                                                           DstPort
       Block {
                                                         Line (
         BlockType
                                                           SrcBlock
                                                                              "Inl"
Reference
                                                           SrcPort
         Name
                         "Integer Delay"
                                                           DstBlock
                                                                              "Product"
                         [1, 1, 0, 0, 0]
         Ports
                                                           DstPort
                                                                              1
         Position
                             [200, 67,
245, 103]
                                                         Line {
         BackgroundColor
                                 "red"
                                                                              "Data
                                                           SrcBlock
         SourceBlock
                                                 Store\nRead*
"dspbdsp2/Integer Delay"
                                                           SrcPort
         SourceType
                             "Integer
                                                           Points
                                                                               [20, 0]
Delay"
                                                           DstBlock
                                                                               "Suml"
         delay
                         *3520*
                                                           DstPort
                                                                               2
          ic
                         -0-
          frame
                         off
                                                         Line {
         đf
                         on
                                                           SrcBlock
                                                                              *Integer
         numChans
                                                 Delay*
        ŀ
                                                           SrcPort
       Block {
                                                           DstBlock
                                                                               "Sum1"
          BlockType
                                Product
                                                           DstPort
                                                                              1
         Name
                         "Product"
          Ports
                         [2, 1, 0, 0, 0]
                                                         Line {
         Position
                             [145, 92,
                                                           SrcBlock
                                                                              "Sum1"
175, 1231
                                                           SrcPort
                                                                              1
         BackgroundColor
                                "green"
                                                           Points
                                                                               [45, 0]
          Inputs
                                                           DstBlock
                                                                              "Sum"
```

```
BackgroundColor "green"
         DstPort
                            1
                                                       IconShape "rectangular"
Inputs "++"
                            "Product"
         SrcBlock
                                                       SaturateOnIntegerOverflow on
         SrcPort
                            1
         Points
                            [5, 0]
                                                     Block (
         Branch {
                                                      BlockType
                                                                      Sum
                                                                      "Suml4"
       Points
                      [0, 0]
                                                       Name
                                                                      [2, 1, 0, 0, 0]
[510, 317, 540, 348]
       DstBlock
                      "Integer Delay"
                                                       Ports
       DstPort
                                                       Position
                                                       BackgroundColor "green"
         }
         Branch {
                                                                     "rectangular"
                                                       IconShape
       Points
                      [0, 35]
                                                       Inputs
       DstBlock
                      "Sum"
                                                       SaturateOnIntegerOverflow on
       DstPort
                                                     Block {
         }
                                                       BlockType
                                                                      Sum
       Line {
                                                       Name
                                                                      "Sum2"
         SrcBlock
                            "Sum"
                                                                      [2, 1, 0, 0, 0]
                                                       Ports
         SrcPort
                                                       Position
                                                                      [1130, 213, 1150,
         Points
                             [10, 0]
                                                 2421
         Branch (
                                                       BackgroundColor
                                                                         "orange"
       DstBlock
                      "Data
                                                       ShowName
                                                                  off
Store\nWrite"
                                                       IconShape
                                                                      "rectangular"
       DstPort
                                                                      *--*
                      1
                                                       Inputs
         }
                                                       SaturateOnIntegerOverflow on
         Branch (
       DstBlock
                      "Outl"
                                                     Block {
       DstPort
                      1
                                                       BlockType
                                                                      Sum
        }
                                                       Name
                                                                      "Sum3"
       }
                                                                      [2, 1, 0, 0, 0]
                                                       Ports
     }
                                                       Position
                                                                      [1075, 293, 1095.
   3
                                                 3221
   Block (
                                                       BackgroundColor
                                                                          "orange"
     BlockType
                                                                  off
                    Sum
                                                       ShowName
     Name
                     "Sயா"
                                                       IconShape
                                                                      "rectangular"
     Ports
                     [2, 1, 0, 0, 0]
                                                                      *++
                                                       Inputs
                     [935, 258, 955, 287]
     Position
                                                       SaturateOnIntegerOverflow on
     BackgroundColor
                        "orange"
     ShowName
                  off
                                                     Block {
      IconShape
                     "rectangular"
                                                       BlockType
                                                                      Sum
                     *+-*
      Inputs
                                                       Name
                                                                      "Sum8"
                                                                      [2, 1, 0, 0, 0]
[675, 107, 705, 138]
     SaturateOnIntegerOverflow on
                                                       Ports
                                                       Position
    Block {
                                                       BackgroundColor "green"
     BlockType
                     Sum
                                                       IconShape "rectangular"
      Name
                    "Suml"
                                                       Inputs
      Ports
                    [2, 1, 0, 0, 0]
                                                       SaturateOnIntegerOverflow on
      Position
                    [1055, 203, 1075,
2321
                                                     Block {
                                                       BlockType
      BackgroundColor
                        "orange"
                                                                      Switch
      ShowName
                 off
                                                       Name
                                                                      "Switch"
      IconShape
                     "rectangular"
                                                       Position
                                                                      [1000, 75, 1030,
      Inputs
                    *+-*
                                                 1051
      SaturateOnIntegerOverflow on
                                                       BackgroundColor
                                                                          "yellow"
                                                       NamePlacement
                                                                           "alternate"
    Block {
                                                       ShowName
                                                                      off
      BlockType
                     Sum
                                                       Threshold
                                                                       *10.^-8*
      Name
                     "Sum12"
                     [2, 1, 0, 0, 0]
      Ports
                                                     Block {
      Position
                    [450, 262, 480, 293]
                                                       BlockType
                                                                      SubSystem
     BackgroundColor "green"
                                                       Name
                                                                      "dB Conv"
      IconShape
                     "rectangular"
                                                       Ports
                                                                       [1, 1, 0, 0, 0]
                                                       Position
                                                                      [325, 63, 350, 97]
     SaturateOnIntegerOverflow on
                                                       BackgroundColor "darkGreen"
                                                       DropShadow
                                                                          on
    Block {
                                                       ShowPortLabels
                                                                        off
      BlockType
                     Sum
                                                       System {
      Name
                     "Sum13"
                                                         Name
                                                                        "dB Conv"
                     [2, 1, 0, 0, 0]
      Ports
                                                         Location
                                                                            [8, 74, 474,
                     [555, 252, 585, 283]
      Position
                                                 3991
```

```
Threshold
                    off
                                                                            -1-
       ModelBrowserVisibility off
       ModelBrowserWidth 200
                                                     Block {
                                                                     Outport
                                                       BlockType
      ScreenColor
"lightBlue"
                                                       Name
                                                       Position
      PaperOrientation
                                                                       [360, 78,
"landscape"
                                             390, 921
                                                       BackgroundColor "1"
      PaperPositionMode
                           "auto"
                                                                            "cyan"
                 "usletter"
       PaperType
                                                      Port
OutputWhenDisabled "he"
"[]"
                                                                           "held"
       PaperUnits
                        "100"
       ZoomFactor
       AutoZoom
                        on
       Block (
                                                     Line (
                      Inport
        BlockType
                                                      SrcBlock
                                                                        "Fcn"
        Name
                                                       SrcPort
         Position
                        [25, 68, 55,
                                                      Points
                                                                        [15, 0]
821
                                                      DstBlock
                                                                        "Switch"
         BackgroundColor
                             "cyan"
                                                      DstPort
         Port
         PortWidth
                                                     Line {
                          --1-
         SampleTime
                                                                        "Inl"
                                                      SrcBlock
                          "auto"
         DataType
                                                       SrcPort
         SignalType
                           "auto"
                                                      Points
                                                                        [10, 0]
         Interpolate
                          on
                                                      Branch (
                                                     Points
                                                                  [0, -45; 195, 0]
       Block {
                                                     DstBlock
                                                                   "Switch"
         BlockType
                             Constant
                                                     DstPort
                       "Constant1"
         Name
                                                     }
         Position
                          [100, 80,
                                                      Branch (
120, 100]
                                                     DstBlock
        BackgroundColor
                                                 "Relational\nOperator"
"darkGreen"
                                                    DstPort 1
        Value
                                                      }
                                                      Branch (
       Block (
                                                     Points
                                                                   [0, 110]
         BlockType
                             Fcn
                                                     DstBlock
                                                                   "Sum"
                       "Fcn"
         Name
                                                     DstPort
         Position
                          [185, 165,
                                                      }
245, 1951
         BackgroundColor
                              "yellow"
                                                     Line {
         Expr
                                                      SrcBlock
                                                                         *Constant1*
"20*log10(u/(3.1623*power(10,-6)))"
                                                       SrcPort
                                                       DstBlock
       Block {
                                              "Relational\nOperator"
        BlockType
                                                      DstPort
RelationalOperator
        Name
                                                     Line {
"Relational\nOperator"
                                                      SrcBlock
         Position
                           [145, 67,
                                              "Relational\nOperator"
175, 98]
                                                       SrcPort
         BackgroundColor
                              "yellow"
                                                       Points
                                                                         [30, 0]
         Operator
                                                      Branch (
                                                     DstBlock
                                                                   "Switch"
       Block {
                                                     DstPort
         BlockType
                             Sum
                                                      ł
                       "Sum"
         Name
                                                      Branch {
                       [2, 1, 0, 0, 0]
         Ports
                                                                   [0, 50; -105, 0]
                                                     Points
         Position
                          [120, 162,
                                                     DstBlock
                                                                   "Sum"
150, 1931
                                                     DstPort
         BackgroundColor
                              "green"
                                                      }
         IconShape
"rectangular"
                                                     Line {
         Inputs
                                                       SrcBlock
                                                                         "Sum"
         SaturateOnIntegerOverflow on
                                                       SrcPort
                                                      DstBlock
                                                                         "Fcn"
       Block {
                                                      DstPort
                                                                         1
         BlockType
                              Switch
         Name
                       "Switch"
                                                     Line {
         Position
                         [280, 70,
                                                       SrcBlock
                                                                         "Switch"
310, 100]
                                                       SrcPort
         BackgroundColor
                              orange*
                                                       DstBlock
                                                                         "Outl"
```

```
DstPort
                           1
                                                       Name
                                                                      "Sum"
                                                                    [2, 1, 0, 0, 0]
                                                       Ports
      }
     }
                                                       Position
                                                                        [120, 162,
                                              150, 193]
   Block {
                                                       BackgroundColor
                                                                             "green"
     BlockType
                   SubSystem
                                                       IconShape
     Name
                   "dB Conv.-LF"
                                              "rectangular"
              [1, 1, 0, 0, 0]
[325, 158, 350, 192]
     Ports
                                                       Inputs
     Position
                                                       SaturateOnIntegerOverflow on
     BackgroundColor "darkGreen"
     DropShadow
                       on
                                                      Block {
                                                       BlockType
     ShowPortLabels
                      off
                                                                            Switch
     System (
                                                       Name
                                                                      "Switch"
                     "dB Conv.-LF"
       Name
                                                                       [280, 70,
                                                       Position
                                              310, 100]
       Location
                       [152, 320,
618, 645]
                                                        BackgroundColor
                                                                             "orange"
                     off
                                                        Threshold
       ModelBrowserVisibility off
       ModelBrowserWidth
                                                      Block {
       ScreenColor
                                                        BlockType
                                                                             Outport
                                                                      "Outl"
"lightBlue"
                                                        Name
       PaperOrientation
                                                        Position
                                                                       [360, 78,
"landscape"
                                              390, 921
                                                        BackgroundColor "1"
       PaperPositionMode
                            "auto"
                                                                             "cyan"
       PaperType "usletter"
                                                       Port _
OutputWhenDisabled
                        "inches"
                                                                             "held"
       PaperUnits
                        -100-
       ZoomFactor
                                                                             •[]•
                                                        InitialOutput
       AutoZoom
                         on
       Block {
                                                      Line {
                       Inport
         BlockType
                                                        SrcBlock
                                                                          "Fcn"
         Name
                                                        SrcPort
         Position
                          [25, 68, 55,
                                                       Points
                                                                         [15, 0]
82]
                                                       DstBlock
                                                                          "Switch"
         BackgroundColor
                              "cyan"
                                                       DstPort
         PortWidth
                                                      Line (
                           *-1*
         SampleTime
                                                                         "Inl"
                                                       SrcBlock
         DataType
                           "auto"
                                                        SrcPort
                           "auto"
         SignalType
                                                        Points
                                                                         [10, 0]
         Interpolate
                                                       Branch {
                                                      Points
                                                                    [0, -45; 195, 0]
       Block {
                                                      DstBlock
                                                                    "Switch"
         BlockType
                             Constant
                                                      DstPort
                                                                    1
         Name
                        "Constant1"
                                                      }
         Position
                          [100, 80,
                                                        Branch {
120, 100]
                                                      DstBlock
         BackgroundColor
                                                  "Relational\nOperator"
"darkGreen"
                                                      DstPort
         Value
                                                       }
                                                       Branch {
       Block {
                                                      Points
                                                                    [0, 110]
                        Fcn
"Fcn"
         BlockType
                                                      DstBlock
                                                                    "Sum"
         Name
                                                      DstPort
                                                                    2
         Position
                         [185, 165,
                                                       }
245, 1951
         BackgroundColor "yellow"
                                                      Line (
         Expr
                                                        SrcBlock
                                                                          "Constant1"
"20*log10(u/(3.1623*power(10,-6)))"
                                                        SrcPort
                                                                          1
                                                       DstBlock
       Block {
                                               "Relational\nOperator"
         BlockType
                                                      DstPort
RelationalOperator
         Name
                                                      Line {
"Relational\nOperator"
                                                        SrcBlock
        Position
                           [145, 67,
                                               "Relational\nOperator"
175, 981
                                                       SrcPort
         BackgroundColor
                               "yellow"
                                                        Points
                                                                          [30, 0]
         Operator
                                                       Branch {
                                                      DstBlock
                                                                    "Switch"
       Block {
                                                      DstPort
                                                                    2
         BlockType
                               Sum
                                                        }
```

```
Branch {
                                                    Line {
       Points
                      [0, 50; -105, 0]
                                                      SrcBlock
                                                                     "Sum"
       DstBlock
                                                      SrcPort
                      "Sum"
                                                                     1
       DstPort
                                                      DstBlock
                                                                     "Product1"
        }
                                                      DstPort
                                                                     2
       Line {
                                                    Line {
                            "Sum"
         SrcBlock
                                                      SrcBlock
                                                                     "In3"
         SrcPort
                                                      SrcPort
                                                                     1
         DstBlock
                            "Fcn"
                                                                      [15, 0; 0, -65; 205.
                                                      Points
         DstPort
                            1
                                                 0; 0, 201
                                                      DstBlock
                                                                      "Product1"
       Line {
                                                      DstPort
         SrcBlock
                            "Switch"
         SrcPort
                            1
                                                    Line {
         DstBlock
                            "Outl"
                                                       SrcBlock
                                                                      "Suml"
         DstPort
                                                       SrcPort
                                                                      7
       }
                                                       DstBlock
                                                                      "Sum2"
     }
                                                      DstPort
                                                                      1
   Block (
                                                     Line {
     BlockType
                    Constant
                                                       SrcBlock
                                                                      "Constant"
                     "effect"
     Name
                                                       SrcPort
     Position
                    [370, 210, 390, 230]
                                                       Points
                                                                      [105, 0]
     BackgroundColor "red"
Value "6"
                                                       Branch (
     Value
                                                        DstBlock
                                                                            "Suml"
                                                        DstPort
                                                                       1
   Block {
     BlockType
                    Outport
                                                       Branch {
     Name
                     "Outl"
                                                        Points
                                                                        [0, -20; 130, 0]
                    [1415, 88, 1445,
     Position
                                                         Branch {
1021
                                                          Points
                                                                             [120, 0; 0,
     BackgroundColor "cyan"
                                                 45]
                                                          DstBlock
                                                                              "Sum2"
     OutputWhenDisabled
                            "held"
                                                          DstPort
     InitialOutput
                            *0*
                                                         Branch {
   Line {
                                                          Points
                                                                              [0, -90]
                    "Inl"
     SrcBlock
                                                          DstBlock
                                                                              "Switch"
     SrcPort
                                                          DstPort
     Points
                     [5, 0]
     Branch {
                                                       }
       DstBlock
                           "Abs"
                                                     }
       DstPort
                      1
                                                     Line {
                                                       SrcBlock
                                                                      *Sum2 *
     Branch {
                                                       SrcPort
                                                                      1
       Points
                       [0, -80; 1145, 0]
                                                       Points
                                                                      [5, 0]
        DstBlock
                           *Product3*
                                                       DstBlock
                                                                      *Product2*
       DstPort
                                                       DstPort
                                                     Line {
   Line {
                                                       SrcBlock
                                                                      "Math\nFunction"
     SrcBlock
                     "Abs"
                                                       SrcPort
     SrcPort
                     1
                                                       DstBlock
                                                                      "Product2"
     Points
                     [5, 0]
                                                       DstPort
     Branch {
       DstBlock
                           "FastMoving"
                                                     Line {
       DstPort
                      1
                                                       SrcBlock
                                                                      *Product2*
                                                       SrcPort
     Branch {
                                                       DstBlock
                                                                      "Math\nFunction1"
       DstBlock
                           "SlowMoving"
                                                       DstPort
                                                                      1
       DstPort
                       1
     }
                                                     Line {
                                                       SrcBlock
                                                                      "Math\nFunction1"
   Line {
                                                       SrcPort
                                                                      1
     SrcBlock
                     "In5"
                                                       DstBlock
                                                                      "Product3"
     SrcPort
                     1
                                                       DstPort
     Points
                     [20, 0]
     DstBlock
                     "Sum"
                                                     Line [
     DstPort
                                                       SrcBlock
                                                                      *Product3*
                                                       SrcPort
```

```
DstBlock
                 "Outl"
                                                 Line {
  DstPort
                                                   SrcBlock
                                                                   *Logical\nOperator2*
                                                    SrcPort
                                                                   1
Line {
                                                   DstBlock
                                                                   *Product14*
  SrcBlock
                 *Product*
                                                   DstPort
                                                                   1
  SrcPort
  Points
                 [25, 0]
                                                  Line {
  Branch {
                                                   SrcBlock
    DstBlock
                       "Switch"
                                              "Relational\nOperator3"
   DstPort
                                                   SrcPort
                                                               1
                                                    Points
                                                                   [5, 0]
  Branch {
                                                    Branch {
    Points
                    [0, -10]
                                                     Points
                                                                     [0, -70]
    DstBlock
                       "Switch"
                                                      DstBlock
                                                                        "Product10"
    DstPort
                                                     DstPort
  }
}
                                                    Branch {
Line {
                                                     DstBlock
  SrcBlock
                  "Switch"
                                              "Logical\nOperator2"
  SrcPort
                                                     DstPort
                                                                     1
  DstBlock
                  "Math\nFunction"
  DstPort
                                                  Line {
Line {
                                                    SrcBlock
                                                                   *Product11*
  SrcBlock
                 "In4"
                                                    SrcPort
  SrcPort
                 1
                                                    DstBlock
                                                                   "Sum13"
  Points
                  [0, -40]
                                                    DstPort
                                                                   2
  Branch {
    DstBlock
                        "Sum"
                                                  Line {
    DstPort
                    1
                                                    SrcBlock
                                                                    *Product12*
                                                    SrcPort
                                                                   1
  Branch {
                                                    DstBlock
                                                                   "Sum13"
    Points
                    [-20, 0]
                                                    DstPort
                                                                   1
    DstBlock
                        "Fcn"
    DstPort
                                                  Line (
                                                    SrcBlock
                                                                    "Sum13"
                                                    SrcPort
                                                                   1
Line (
                                                    DstBlock
                                                                    "Product13"
  SrcBlock
                  "Fcn"
                                                    DstPort
  SrcPort
                  1
  DstBlock
                  "Product"
                                                  Line {
  DstPort
                                                    SrcBlock
                                                                    *Product10*
                                                    SrcPort
                                                                    1
Line {
                                                    Points
                                                                    [10, 0]
                  *Product4*
  SrcBlock
                                                    DstBlock
                                                                    " Sum8 "
  SrcPort
                                                    DstPort
                                                                    1
  Points
                  [5, 0]
  DstBlock
                  "Sum3"
                                                  Line {
  DstPort
                                                    SrcBlock
                                                                    *Product14*
                                                    SrcPort
                                                                    1
Line {
                                                    Points
                                                                    [10, 0]
  SrcBlock
                  "Constant1"
                                                    DstBlock
                                                                    *Sum8 *
  SrcPort
                  1
                                                    DstPort
                                                                    2
  Points
                  [60. 0]
  DstBlock
                  "Product4"
                                                  Line {
  DstPort
                                                    SrcBlock
                                                                    *Sum12*
                                                    SrcPort
                                                                   1
Line {
                                                    Points
                                                                    [0, 0]
  SrcBlock
                  *Product1*
                                                    Branch {
  SrcPort
                  1
                                                      Points
                                                                     [0, 0]
  Points
                  [20, 0; 0, 30]
                                                      DstBlock
                                                                          "Product11"
  DstBlock
                  "Sum3"
                                                     DstPort
  DstPort
                                                    Branch {
Line {
                                                      Points
                                                                      [0, 45]
  SrcBlock
                  "Sum3 "
                                                      DstBlock
                                                                          "Sum14"
  SrcPort
                                                      DstPort
                                                                     1
  Points
                  [0, -65; -60, 0]
  DstBlock
                  "Suml"
  DstPort
                                                  Line {
}
                                                    SrcBlock
                                                                    "effect"
```

```
SrcPort
                                                            Points
                                                                               [-85, 0; 0,
     Points
                     [0, 0]
                                                  551
     Branch {
                                                            DstBlock
                                                                                "Sum12"
       DstBlock
                           *Product12*
                                                            DstPort
       DstPort
                                                          Branch {
     Branch {
                                                            DstBlock
                                                                                "Product11"
       Points
                       [0, 120]
                                                            DstPort
        DstBlock
                           "Sum14"
       DstPort
                                                        }
     }
                                                      Line {
   Line {
                                                        SrcBlock
                                                                        "FastMoving"
     SrcBlock
                     "Sum14"
                                                        SrcPort
                                                                        1
      SrcPort
                                                                        [5, 0]
                                                        Points
      DstBlock
                     *Product13*
                                                        DstBlock
                                                                        "dB Conv"
     DstPort
                     2
                                                        DstPort
   Line {
                                                      Line {
      SrcBlock
                      "Product13"
                                                        SrcBlock
                                                                        "SlowMoving"
      SrcPort
                      1
                                                        SrcPort
      Points
                      [0, -65; -40, 0]
                                                        Points
                                                                        [5, 0]
      DstBlock
                      "Product14"
                                                        DstBlock
                                                                        "dB Conv.-LF"
      DstPort
                                                        DstPort
   Line {
                                                      Line {
                     "dB Conv"
      SrcBlock
                                                        SrcBlock
                                                                        "Fcnl"
      SrcPort
                                                        SrcPort
      Points
                      [45, 0; 0, 20; 40,
                                                        Points
                                                                        [25, 0; 0, -45]
01
                                                        DstBlock
                                                                        "Product"
      Branch (
                                                        DstPort
        Points
                        [0, -25]
        DstBlock
                            "Product10"
                                                      Line {
        DstPort
                                                        SrcBlock
                                                                        " Sum8 "
                                                         SrcPort
      Branch {
                                                         Points
                                                                        [10, 0]
        Points
                        [5, 0]
                                                         Branch {
        Branch {
                                                           DstBlock
                                                                              "Fcn1"
         Points
                            [-10, 0; 0,
                                                           DstPort
                                                                          1
1351
         Branch (
                                                         Branch {
        DstBlock
                        "Sum12"
                                                           Points
                                                                          [0, 35; -40, 0; 0,
        DstPort
                                                   1701
          }
                                                           DstBlock
                                                                              *Product4*
          Branch {
                                                           DstPort
                                                                          1
        DstBlock
                        "Product12"
        DstPort
                                                      }
          }
                                                         }
        Branch {
                                                       Block {
         Points
                              [50, 0]
                                                         BlockType
                                                                                SubSystem
          DstBlock
                                                         Name
"Relational\nOperator3"
                                                   "homomorphic\nmultiplicative AGC6"
         DstPort
                                                         Ports [4, 1, 0, 0, 0]
Position [440, 499, 470,
                              1
        }
      }
                                                   556]
                                                         BackgroundColor
                                                                                "orange"
    Line {
                                                         DropShadow
                                                                            on
      SrcBlock
                      "dB Conv.-LF"
                                                         ShowPortLabels
                                                                                off
      SrcPort
                                                         System {
      Points
                      [0, 5; 35, 0; 0, -
                                                      Name
15; 100, 0]
                                                       "homomorphic\rmultiplicative AGC6"
      Branch [
                                                       Location [105, 80, 881, 457]
        Points
                        [0, 0]
                                                       Open
                                                                      off
        DstBlock
                                                       ModelBrowserVisibility off
"Relational\nOperator3"
                                                       ModelBrowserWidth 200
       DstPort
                                                       ScreenColor
                                                                     "lightBlue"
                                                      PaperOrientation "landscape"
PaperPositionMode "auto"
      Branch {
        Points
                        [0. 65]
                                                       PaperType
                                                                      "usletter"
        Branch {
                                                       PaperUnits
                                                                      "inches"
```

```
ZcomFactor *100*
                                                  BlockType
                                                                SubSystem
                                                  Name
AutoZoom on
                                                                 "FastMoving"
                                                             [1, 1, 0, 0, 0]
[270, 57, 300, 113]
Block {
                                                  Ports
 BlockType
                Inport
                                                  Position
                "In1"
[150, 78, 180, 92]
                                                  BackgroundColor "orange"
 Name
 Position
                , /8,
r "cyan"
"1"
                                                  DropShadow
                                                                   on
  BackgroundColor
                                                  ShowPortLabels
                                                                   off
  Port
                                                  System {
  PortWidth
                                                    Name
                 "-I"
                                                                   "FastMoving"
                    --1-
  SampleTime
                                                    Location
                                                                      [75, 131, 863,
  DataType
                 "auto"
                                            4721
  SignalType
                 "auto"
                                                    Open
                                                                   off
                                                    ModelBrowserVisibility off
  Interpolate
                    on
                                                    ModelBrowserWidth 200
Block {
                                                    ScreenColor
  BlockType
                Inport
                                            "lightBlue"
  Name
                 "In3"
                                                    PaperOrientation
  Position
                 [710, 298, 740, 312]
                                            "landscape"
                , 258,
"Cyan"
"2"
  BackgroundColor
                                                    PaperPositionMode
                                                                          "auto"
                                                                      "usletter"
  Port
                                                    PaperType
                 --1-
                                                                      "inches"
  PortWidth
                                                    PaperUnits
  SampleTime
                  --1-
                                                                      -100-
                                                    ZoomFactor
                 "auto"
  DataType
                                                    AutoZoom
                                                                      on
                 "auto"
  SignalType
                                                    Block {
  Interpolate
                                                      BlockType
                    on
                                                                     "Inl"
                                                      Name
Block {
                                                      Position
                                                                      [75, 93,
  BlockType
                Inport
                                            105, 107]
  Name
                 "In4"
                                                      BackgroundColor
                                                                            "cyan"
                 [805, 298, 835, 312]
  Position
                                                                     -1-
                                                      Port
  BackgroundColor "cyan"
Port "3"
                                                      PortWidth
                                                                        -1-
                                                      SampleTime
  PortWidth
                 --1-
                                                      DataType
                                                                         "auto"
                   --1-
  SampleTime
                                                      SignalType
                                                                         "auto"
  DataType
                 "auto"
                                                      Interpolate
                                                                        on
  SignalType
                  "auto"
  Interpolate
                                                    Block {
                                                      BlockType
                                                                          Constant
Block {
                                                      Name
                                                                     "Constant"
  BlockType
                 Inport
                                                      Position
                                                                      [80, 134,
                 "In5"
  Name
                                             110, 156]
                 [865, 298, 895, 312]
  Position
                                                      BackgroundColor
                                                                            "red"
  BackgroundColor "cyan"
Port "4"
                                                      Value
                                                                     *160*
  PortWidth
                 --1-
                                                    Block {
                   --1-
  SampleTime
                                                      BlockType
  DataType
                 "auto"
                                             DataStoreMemory
  SignalType
                 "auto"
                                                      Name
                                                                     "Data
  Interpolate
                    on
                                             Store\nMemory*
                                                      Position
                                                                         [430, 35,
Block {
                                             462, 65]
  BlockType
                 Abs
                                                      BackgroundColor
                                                                             "orange"
                                                      DataStoreName
  Name
                 "Abs"
                                                                             *AGC6*
                [215, 70, 245, 100]
  Position
                                                      InitialValue
  BackgroundColor "red"
                                                    Block {
Block {
                                                      BlockType
  BlockType
                 Constant
                                             DataStoreRead
                 "Constant"
  Name
            "Constant
[710, 195, 740, 225]
                                                      Name
                                                                     "Data
  Position
                                             Store\nRead*
  BackgroundColor "green"
Value "1"
                                                      Position
                                                                         [210, 155,
  Value
                                             240, 185]
                                                      BackgroundColor
                                                                             "orange"
Block {
                                                      DataStoreName
                                                                           "AGC6"
  BlockType
                                                                      "1/Fs"
                 Constant
                                                      SampleTime
                 "Constant1"
  Name
                [910, 350, 940, 380]
                                                    Block {
  BackgroundColor "green"
Value "330"
                                                      BlockType
                                             DataStoreWrite
                                                      Name
                                                                     *Data
Block {
                                             Store\nWrite*
```

```
Position
                          [435, 175,
                                                         SrcBlock
                                                                           "Constant"
                                                         SrcPort
465, 2051
                                                                           1
         BackgroundColor
                               "orange"
                                                         Points
                                                                            [15, 0]
                               "AGC6"
         DataStoreName
                                                         DstBlock
                                                                            "Product"
         SampleTime
                            "1/Fs"
                                                         DstPort
                                                                            2
       Block {
                                                       Line {
         BlockType
                                                         SrcBlock
                                                                            "In1"
Reference
                                                         SrcPort
                        "Integer Delay"
         Name
                                                         DstBlock
                                                                            "Product"
         Ports
                       [1, 1, 0, 0, 0]
                                                         DstPort
                           [200, 67,
         Position
245, 1031
                                                       Line {
         BackgroundColor
                              "red"
                                                                            "Data
                                                         SrcBlock
         SourceBlock
                                                Store\nRead*
"dspbdsp2/Integer Delay"
                                                         SrcPort
         SourceType
                            *Integer
                                                         Points
                                                                            [20, 0]
Delay*
                                                         DstBlock
                                                                            "Suml"
         delay
                        "160"
                                                         DstPort
                                                                            2
                        *0*
         ic
                        off
          frame
                                                       Line (
          df
                        on
                                                         SrcBlock
                                                                            "Integer
                            -1-
         numChans
                                                Delay*
                                                         SrcPort
       Block {
                                                         DstBlock
                                                                            "Sum1"
         BlockType
                              Product
                                                         DstPort
                        "Product"
[2, 1, 0, 0, 0]
         Name
          Ports
                                                       Line (
          Position
                            [145, 92,
                                                         SrcBlock
                                                                            "Suml"
175, 123]
                                                         SrcPort
                                                                            1
         Points
                                                                            [45, 0]
          Inputs
                                                         DstBlock
                                                                            "Sum"
          SaturateOnIntegerOverflow on
                                                         DstPort
                                                                            1
        Block (
                                                       Line {
          BlockType
                               Sum
                                                         SrcBlock
                                                                            "Product"
                       "Sum"
[2, 1, 0, 0, 0]
[375, 121,
          Name
                                                         SrcPort
                                                                            7
          Ports
                                                        Points
                                                                            [5, 0]
          Position
                                                         Branch {
405, 154]
                                                       Points
                                                                      [0, 0]
          BackgroundColor
                                "green"
                                                       DstBlock
                                                                      "Integer Delay"
          DropShadow
                            on
                                                       DstPort
          IconShape
                                                         }
"rectangular"
                                                         Branch (
         Inputs
                                                       Points
                                                                      [0, 35]
          SaturateOnIntegerOverflow on
                                                       DstBlock
                                                                      "Sum"
                                                       DstPort
        Block {
                                                         }
          BlockType
                                Sum
                        "Sum1"
[2, 1, 0, 0, 0]
[280, 77,
          Name
                                                       Line {
          Ports
                                                         SrcBlock
                                                                            "Sum"
          Position
                                                         SrcPort
                                                                            1
310, 108]
                                                         Points
                                                                            [10, 0]
          BackgroundColor
                              "green"
                                                        Branch (
          DropShadow
                            on
                                                       DstBlock
                                                                      "Data
          IconShape
                                                Store\nWrite*
"rectangular"
                                                       DstPort
                                                                      1
          Inputs
                                                         }
          SaturateOnIntegerOverflow on
                                                         Branch {
                                                       DstBlock
                                                                      "Outl"
        Block {
                                                       DstPort
                        Outport *Out1*
          BlockType
                                                         1
          Name
                                                       }
          Position
                           [490, 133,
                                                     ŀ
520, 147]
                                                    3
         BackgroundColor
                                "cyan"
                                                    Block {
                                                     BlockType
                                                                    Fcn
          OutputWhenDisabled
                                 "held"
                                                      Name
                                                                    "Fcn"
          InitialOutput
                                -0-
                                                     Position
                                                                   [835, 130, 895, 160]
                                                     BackgroundColor "yellow"
        Line {
```

```
Expr
                     "power(10,((u/20)-
                                                        BlockType
                                                                       Product
5.5))*
                                                        Name
Ports
                                                                       *Product11*
                                                                      [2, 1, 0, 0, 0]
   3
                                                                      [505, 257, 535, 288]
   Block {
                                                        Position
     BlockType
                                                        BackgroundColor *green*
Inputs *2*
                     Fcn
                     "Fcnl"
     Name
                                                        Inputs
                     [740, 110, 800, 140]
      Position
                                                        SaturateOnIntegerOverflow on
     BackgroundColor "yellow"
     Expr
                     *power(10,((u/20)-
                                                      Block {
                                                        BlockType
5.5))*
                                                                      Product
                                                        Name
                                                                        "Product12"
                                                                       [2, 1, 0, 0, 0]
[505, 212, 535, 243]
   Block (
                                                        Ports
     BlockType
                     Logic
                                                        Position
      Name
                     *Logical\nOperator2*
                                                        BackgroundColor "green"
Inputs "2"
                    [1, 1, 0, 0, 0]
[565, 144, 595, 176]
      Ports
                                                        Inputs
      Position
                                                        SaturateOnIntegerOverflow on
      BackgroundColor "yellow"
                     "NOT"
      Operator
                                                      Block {
                     -1-
      Inputs
                                                        BlockType
                                                                       Product
                                                                        "Product13"
                                                        Name
    Block {
                                                                        [2, 1, 0, 0, 0]
                                                        Ports
      BlockType
                     Math
                                                        Position
                                                                       [605, 311, 635, 344]
                                                        "Math\nFunction"
      Ports
                     {1, 1, 0, 0, 0}
[1075, 75, 1105,
      Position
                                                        SaturateOnIntegerOverflow on
1051
      BackgroundColor
                        "red"
                                                      Block (
      ShowName off
Operator "log"
                                                        BlockType
                                                                      Product
                                                        Ports
                                                        Name
                                                                        *Product14*
      OutputSignalType "auto"
                                                                        [2, 1, 0, 0, 0]
                                                        Position
                                                                       [615, 217, 645, 248]
                                                        BackgroundColor *green*
Inputs *2*
    Block {
      BlockType
                    Math
      Name
                     "Math\nFunction1"
                                                        SaturateOnIntegerOverflow on
                   [1, 1, 0, 0, 0]
[1260, 85, 1290,
      Ports
      Position
                                                      Block {
1151
                                                        BlockType
                                                                      Product
      BackgroundColor
                         "red"
                                                        Name
                                                                       "Product2"
      ShowName off
Operator "exp"
                                                        Ports
                                                                        [2, 1, 0, 0, 0]
[1175, 82, 1205,
                                                        Position
      OutputSignalType "auto"
                                                   113]
                                                         BackgroundColor "yellow"
                                                        Inputs
      BlockType Product
                                                        SaturateOnIntegerOverflow on
      Name
                     "Product"
      Ports [2, 1, 0, 0, 0]
Position [915, 72, 945, 103]
                                                      Block {
                                                        BlockType
                                                                       Product
      BackgroundColor "yellow"
Inputs "*/"
                                                        Name
                                                                        "Product3"
                                                        Ports
                                                                      [2, 1, 0, 0, 0]
[1350, 77, 1380,
      SaturateOnIntegerOverflow on
                                                         Position
                                                   1081
    Block (
                                                        BackgroundColor "yellow"
      BlockType
                    Product
                                                        Inputs
      Name
                     *Product1*
                                                        SaturateOnIntegerOverflow on
      Ports [2, 1, 0, 0, 0]
Position [995, 252, 1025,
                                                      Block {
2831
                                                        BlockType
                                                                       Product
      BackgroundColor
                                                        Name
                         "yellow"
                                                                       "Product4"
      Inputs
                                                                        [2, 1, 0, 0, 0]
[1020, 322, 1050,
                                                        Ports
      SaturateOnIntegerOverflow on
                                                        Position
                                                   3531
    Block {
                                                         BackgroundColor
      BlockType
                   Product
      Name
                     *Product10*
                                                        SaturateOnIntegerOverflow on
                    [2, 1, 0, 0, 0]
[615, 67, 645, 98]
      Position
                                                      Block {
      BackgroundColor
                        "green"
                                                        BlockType
                                                                      RelationalOperator
      Inputs
                                                        Name
      SaturateOnIntegerOverflow on
                                                   "Relational\nOperator3"
                                                        Position [510, 142, 540, 173]
    Block {
                                                        BackgroundColor "yellow"
```

```
Operator
                    *>=*
                                                          BlockType
                                                DataStoreWrite
   Block {
                                                          Name
                                                                         "Data
     BlockType
                    SubSystem
                                                Store\nWrite"
     Name
                     "SlowMoving"
                                                          Position
                                                                             [435, 175,
     Ports
                     [1, 1, 0, 0, 0]
                                                 465, 205]
     Position
                    [270, 137, 300, 193]
                                                          BackgroundColor
                                                                                 "orange"
     BackgroundColor
                        "orange"
                                                          DataStoreName
                                                                                 "AGCS6"
     DropShadow
                        on
                                                          SampleTime
                                                                             "1/Fs"
     ShowPortLabels
                       off
     System {
                                                        Block {
       Name
                      "SlowMoving"
                                                          BlockType
                         [77, 129, 865,
       Location
                                                 Reference
4701
                                                          Name
                                                                         "Integer Delay"
       Open
                      off
                                                          Ports
                                                                         [1, 1, 0, 0, 0]
       ModelBrowserVisibility off
                                                          Position
                                                                             [200, 67,
       ModelBrowserWidth 200
                                                 245, 103]
       ScreenColor
                                                          BackgroundColor
                                                                                 "red"
"lightBlue"
                                                          SourceBlock
       PaperOrientation
                                                 "dspbdsp2/Integer Delay"
"landscape"
                                                          SourceType
                                                                             *Integer
       PaperPositionMode
                             "auto"
                                                 Delay*
                          "usletter"
       PaperType
                                                          delay
                                                                         *3520*
                          "inches"
        PaperUnits
                                                                          .0.
                                                          ic
        ZoomFactor
                          *100*
                                                          frame
                                                                         off
        AutoZoom
                          OT
                                                          đf
                                                                         on
        Block {
                                                          numChans
         BlockType
                        "Inl"
                                Inport
         Name
                                                        Block {
                           [75, 93,
         Position
                                                          BlockType
                                                                                Product
105, 1071
                                                                          *Product*
                                                          Name
         BackgroundColor
                                "cyan"
                                                          Ports
                                                                          [2, 1, 0, 0, 0]
         Port
                                                          Position
                                                                             [145. 92.
         PortWidth
                                                 175, 1231
         SampleTime
                            -1-
                                                          BackgroundColor
                                                                                "green"
         DataType
                            "auto"
                                                          Inputs
                            "auto"
         SignalType
                                                          SaturateOnIntegerOverflow on
         Interpolate
                            on
                                                        Block {
        Block {
                                                          BlockType
         BlockType
                                Constant
                                                                          "Sum"
                                                          Name
         Name
                         "Constant"
                                                          Ports
                                                                          [2, 1, 0, 0, 0]
         Position
                           [80, 134,
                                                          Position
                                                                             [375, 121.
110, 156]
                                                 405, 154]
         BackgroundColor
                                "red"
                                                          BackgroundColor
                                                                                 "green"
                         *3520*
         Value
                                                          DropShadow
                                                                             on
                                                          IconShape
        Block {
                                                 "rectangular"
         BlockType
                                                          Imputs
                                                                              "++"
DataStoreMemory
                                                          SaturateOnIntegerOverflow on
         Name
                         "Data
Store\nMemory*
                                                        Block {
         Position
                             [430, 35,
                                                          BlockType
                                                                                Sum
462, 65]
                                                                          "Suml"
                                                          Name
         BackgroundColor
                                 "orange"
                                                                          [2, 1, 0, 0, 0]
                            "AGCS6"
                                                          Ports
         DataStoreName
                                                          Position
                                                                              [280, 77,
         InitialValue
                                                 310, 108]
                                                          BackgroundColor
                                                                                 "green"
        Block {
                                                          DropShadow
                                                                             on
         BlockType
                                                          IconShape
DataStoreRead
                                                 "rectangular"
         Name
                         *Data
                                                          Inputs
Store\nRead*
                                                          SaturateOnIntegerOverflow on
         Position
                             [210, 155,
240, 185]
                                                        Block {
         BackgroundColor
                                "orange"
                                                          BlockType
                                                                                 Outport
                                "AGCS6"
         DataStoreName
                                                                          "Outl"
                                                          Name
         SampleTime
                             "1/Fs"
                                                          Position
                                                                             [490, 133,
                                                 520, 147]
        Block {
                                                          BackgroundColor
                                                                                 "cyan"
                                                          Port
```

```
OutputWhenDisabled
                                   "held"
                                                                         "Sum"
                                                         Name
                                                                         [2, 1, 0, 0, 0]
          InitialOutput
                                  -0-
                                                         Ports
                                                                         [935, 258, 955, 287]
                                                         Position
        }
       Line {
                                                         BackgroundColor
                                                                            "orange"
          SrcBlock
                              "Constant"
                                                                         off
                                                         ShowName
                                                         IconShape
          SrcPort
                              1
                                                                         "rectangular"
          Points
                              [15, 0]
                                                         Inputs
          DstBlock
                              "Product"
                                                         SaturateOnIntegerOverflow on
          DstPort
                                                       Block {
        Line {
                                                         BlockType
                                                                         Sum
          SrcBlock
                              "Inl"
                                                         Name
                                                                          "Suml"
                                                                         [2, 1, 0, 0, 0]
[1055, 203, 1075,
          SrcPort
                                                         Ports
          DstBlock
                              "Product"
                                                         Position
          DstPort
                                                   2321
                                                                            "orange"
                                                         BackgroundColor
        Line {
                                                         ShowName
                                                                        off
          SrcBlock
                              "Data
                                                         IconShape
                                                                          "rectangular"
Store\nRead*
                                                         Inputs
                                                                         * -- *
          SrcPort
                                                         SaturateOnIntegerOverflow on
                              [20, 0]
          Points
          DstBlock
                              "Suml"
                                                       Block {
                                                         BlockType
          DstPort
                                                                          Sum
                                                         Name
                                                                          "Sum12"
        Line (
                                                                          [2, 1, 0, 0, 0]
[450, 262, 480, 293]
                                                         Ports
          SrcBlock
                              "Integer
                                                         Position
Delay"
                                                         BackgroundColor "green"
          SrcPort
                                                         IconShape
                                                                          "rectangular"
          DstBlock
                              "Suml"
                                                          Inputs
          DstPort
                              1
                                                         SaturateOnIntegerOverflow on
        Line (
                                                       Block {
          SrcBlock
                              "Sum1"
                                                         BlockType
                                                                          Sum
          SrcPort
                              1
                                                         Name
                                                                          "Sum13"
          Points
                              [45, 0]
                                                          Ports
                                                                          [2, 1, 0, 0, 0]
          DstBlock
                               "Sum"
                                                          Position
                                                                          [555, 252, 585, 283]
          DstPort
                                                          BackgroundColor "green"
                                                          IconShape
                                                                          "rectangular"
        Line {
                                                          Inputs
                              "Product"
          SrcBlock
                                                          SaturateOnIntegerOverflow on
          SrcPort
          Points
                              [5, 0]
                                                        Block {
          Branch (
                                                          BlockType
                                                                          Sum
        Points
                        [0, 0]
                                                                          "Sum14"
                                                          Name
        DstBlock
                        "Integer Delay"
                                                                          [2, 1, 0, 0, 0]
        DstPort
                                                          Position
                                                                          [510, 317, 540, 348]
          }
                                                          BackgroundColor "green"
          Branch (
                                                          IconShape
                                                                          "rectangular"
                        [0, 35]
        Points
                                                                          *++*
                                                          Inputs
        DstBlock
                        "Sum"
                                                          SaturateOnIntegerOverflow on
        DstPort
                        2
         }
                                                        Block (
                                                          BlockType
                                                                          Sum
        Line {
                                                          Name
                                                                          *Sum2 *
          SrcBlock
                               "Sum"
                                                          Ports
                                                                          [2, 1, 0, 0, 0]
          SrcPort
                              1
                                                          Position
                                                                          [1130, 213, 1150,
          Points
                               [10, 0]
                                                    2421
          Branch {
                                                          BackgroundColor
                                                                             "orange"
        DstBlock
                        *Data
                                                                        off
                                                          ShowName
Store\nWrite*
                                                          IconShape
                                                                          "rectangular"
       DstPort
                                                          Inputs
                                                          SaturateOnIntegerOverflow on
          Branch {
        DstBlock
                        "Out1"
                                                        Block {
        DstPort
                                                          BlockType
                                                                          Sum
          }
                                                          Name
                                                                          *Sum3 *
        }
                                                          Ports
                                                                          [2, 1, 0, 0, 0]
[1075, 293, 1095,
      }
                                                          Position
                                                    3221
    Block {
                                                          BackgroundColor
                                                                            "orange"
      BlockType
                      Sum
                                                                          off
                                                          ShowName
```

```
IconShape "rec
                                                         BlockType
                                                                             Fcn
                    "rectangular"
                                                                       "Fcn"
                                                        Name
     SaturateOnIntegerOverflow on
                                                         Position
                                                                       [185, 165,
                                               245, 195]
   Block {
                                                         BackgroundColor
                                                                               "yellow"
     BlockType
                                                         Expr
                    Sum
     Name
                    "Sum8"
                                               *20*log10(u/(3.1623*power(10,-6)))*
     Ports [2, 1, 0, 0, 0]
Position [675, 107, 705, 138]
BackgroundColor "green"
                                                       Block {
                                                         BlockType
     IconShape "rectangular"
                                               RelationalOperator
                   *++
     Inputs
                                                        Name
     SaturateOnIntegerOverflow on
                                               *Relational\nOperator*
                                                         Position
                                                                           [145, 67,
   Block {
                                               175, 98]
                                                                           "yellow"
                  Switch
     BlockType
                                                         BackgroundColor
                   "Switch"
     Name
                                                         Operator
                  [1000, 75, 1030,
     Position
1051
                                                       Block (
     BackgroundColor "yellow"
NamePlacement "alre
                                                         BlockType
                 "alternate"
                                                                               Sum
     NamePlacement
                                                                       "Sum"
                                                         Name
     ShowName
                                                         Ports
                                                                       [2, 1, 0, 0, 0]
     Threshold
                   "10.^-8"
                                                         Position
                                                                          [120, 162,
                                               150, 193]
   Block {
                                                         BackgroundColor
                                                                              "green"
                    SubSystem
                                                         IconShape
     BlockType
                    "dB Conv"
     Name
                                                "rectangular"
                    [1, 1, 0, 0, 0]
     Ports
                                                        Inputs
                 [1, 1, 0, 0, 5, 5]
     Position
                                                         SaturateOnIntegerOverflow on
     BackgroundColor "darkGreen"
     DropShadow
                       on
                                                       Block {
     ShowPortLabels
                     off
                                                         BlockType
                                                                              Switch
     System (
                                                                        "Switch"
                                                         Name
       Name
                      "dB Conv"
                                                                          [280, 70,
                                                         Position
                        [8, 74, 474,
       Location
                                               310, 100]
399]
                                                         BackgroundColor
                                                                               "orange"
                     off
                                                         Threshold
                                                                               -1-
       ModelBrowserVisibility off
ModelBrowserWidth 200
       ModelBrowserWidth
                                                       Block {
                                                                        Outport
       ScreenColor
                                                         BlockType
"lightBlue"
                                                         Name
       PaperOrientation
                                                         Position
                                                                          [360, 78,
"landscape"
                                               390, 92]
                                                         BackgroundColor *1*
       PaperPositionMode
                            "auto"
                                                                              "cyan"
       PaperType "usletter"
        PaperUnits
                         "inches"
                                                         OutputWhenDisabled
                                                                               "held"
                         "100"
       ZoomFactor
                                                         InitialOutput
       AutoZoom
                         on
        Block {
                                                       Line {
                        Inport
         BlockType
                                                         SrcBlock
                                                                            "Fcn"
         Name
                                                         SrcPort
                                                                            1
                         [25, 68, 55,
         Position
                                                         Points
                                                                            [15, 0]
821
                                                         DstBlock
                                                                            "Switch"
         BackgroundColor
                              "cyan"
                                                        DstPort
         Port
         PortWidth
                                                       Line {
                            -1-
         SampleTime
                                                                           "Inl"
                                                         SrcBlock
         DataType
                            "auto"
                                                         SrcPort
                                                                            1
         SignalType
                            "auto"
                                                         Points
                                                                            [10, 0]
         Interpolate
                            OIL
                                                         Branch {
                                                                      [0, -45; 195, 0]
                                                       Points
       Block {
                                                       DstBlock
                                                                     "Switch"
         BlockType
                               Constant
                                                       DstPort
                        "Constant1"
         Name
                                                         ł
         Position
                           [100, 80,
                                                        Branch {
120. 100]
                                                       DstBlock
         BackgroundColor
                                                   "Relational\nOperator"
"darkGreen"
                                                       DstPort
        Value
                                                        ŀ
                                                         Branch {
       Block {
                                                       Points
                                                                      [0, 110]
```

```
"-1"
                      "Sum"
                                                         PortWidth
       DstBlock
       DstPort
                      2
                                                         SampleTime
                                                         DataType
                                                                            "auto"
        }
                                                         SignalType
                                                                            "auto"
       Line {
                                                         Interpolate
                                                                            on
         SrcBlock
                            "Constant1"
         SrcPort
                                                       Block {
         DstBlock
                                                         BlockType
                                                                               Constant
"Relational\nOperator"
                                                          Name
                                                                        "Constantl"
        DstPort
                                                          Position
                                                                           [100, 80,
                                                120, 100]
       Line {
                                                          BackgroundColor
        SrcBlock
                                                "darkGreen"
"Relational\nOperator"
                                                         Value
                                                                        -0-
        SrcPort
                            [30, 0]
         Points
                                                       Block {
                                                                        Fcn
"Fcn"
         Branch {
                                                          BlockType
       DstBlock
                      "Switch"
                                                          Name
       DstPort
                      2
                                                          Position
                                                                           [185, 165,
                                                245, 195]
         Branch {
                                                          BackgroundColor
                                                                                "yellow"
       Points
                      [0, 50; -105, 0]
                                                          Expr
       DstBlock
                      "Sum"
                                                *20*log10(u/(3.1623*power(10,-6)))*
       DstPort
         }
                                                        Block {
       }
                                                          BlockType
       Line {
                                                RelationalOperator
         SrcBlock
                            "Sum"
                                                         Name
         SrcPort
                            7
                                                "Relational\nOperator"
         DstBlock
                            "Fcn"
                                                          Position
                                                                             [145, 67.
         DstPort
                            1
                                                175, 98]
                                                          BackgroundColor
                                                                                "yellow"
       Line {
                                                          Operator
         SrcBlock
                            "Switch"
         SrcPort
                            1
                                                        Block (
         DstBlock
                            "Outl"
                                                          BlockType
                                                                                Sum
         DstPort
                            1
                                                          Name
                                                                         "Sum"
       }
                                                                        [2, 1, 0, 0, 0]
                                                          Ports
     }
                                                          Position
                                                                             [120, 162,
                                                150, 193]
    Block {
                                                          BackgroundColor
                                                                                "green"
     BlockType
                    SubSystem
                                                          IconShape
     Name
                    "dB Conv.-LF"
                                                "rectangular"
                    [1, 1, 0, 0, 0]
                                                          Inputs
     Position
                    [325, 158, 350, 192]
                                                          SaturateOnIntegerOverflow on
     BackgroundColor "darkGreen"
     DropShadow
                        on
                                                        Block {
     ShowPortLabels
                                                          BlockType
                      off
                                                                               Switch
     System {
                                                                         "Switch"
                                                          Name
                       "dB Conv.-LF"
       Name
                                                          Position
                                                                           [280, 70,
       Location
                        [152, 320,
                                                310, 100]
618, 6451
                                                          BackgroundColor
                                                                                "orange"
       0pen
                      off
                                                          Threshold
                                                                                -1-
       ModelBrowserVisibility off
ModelBrowserWidth 200
       ModelBrowserWidth
                                                        Block {
                                                                         Outport
       ScreenColor
                                                          BlockType
"lightBlue"
                                                          Name
       PaperOrientation
                                                          Position
                                                                           [360, 78,
"landscape"
                                                390, 921
       PaperPositionMode
                             "auto"
                                                          BackgroundColor
                                                                                "cyan"
        PaperType *usletter*
                                                          Port
        PaperUnits
                          "inches"
                                                          OutputWhenDisabled
                                                                                 "held"
        ZoomFactor
                          *100*
                                                          InitialOutput
                                                                                "[]"
        AutoZoom
                          on
        Block (
                                                        Line {
                        Inport
         BlockType
                                                          SrcBlock
                                                                             "Fcn"
          Name
                                                          SrcPort
                                                                             1
          Position
                          [25, 68, 55,
                                                          Points
                                                                             [15, 0]
821
                                                         DstBlock
                                                                             "Switch"
          BackgroundColor
                                "cyan"
                                                         DstPort
          Port
                                                        ł
```

```
Line {
                                                    InitialOutput
                                                                        -0-
         SrcBlock
                          "Inl"
         SrcPort
                                                  Line {
                           [10, 0]
                                                                   "Inl"
        Points
                                                    SrcBlock
        Branch {
                                                    SrcPort
                                                                   1
                     [0, -45; 195, 0]
       Points
                                                    Points
                                                                   [5, 0]
      DstBlock
                     "Switch"
                                                    Branch {
       DstPort
                                                     DstBlock
                                                                         "Abs"
        }
                                                      DstPort
                                                                    1
         Branch {
       DstBlock
                                                    Branch (
   "Relational\nOperator"
                                                      Points
                                                                    [0, -80; 1145, 0]
      DstPort
                                                      DstBlock
                                                                         "Product3"
        }
                                                      DstPort
        Branch {
       Points
                     [0, 110]
       DstBlock
                     "Sum"
                                                   Line {
       DstPort
                     2
                                                     SrcBlock
                                                                   "Abs"
       }
                                                     SrcPort
                                                                   1
                                                     Points
                                                                   [5, 0]
       Line {
                                                    Branch {
         SrcBlock
                           "Constant1"
                                                      DstBlock
                                                                         "FastMoving"
         SrcPort
                           1
                                                      DstPort
                                                                     1
        DstBlock
"Relational\nOperator"
                                                     Branch {
        DstPort
                           2
                                                      DstBlock
                                                                         "SlowMoving"
                                                      DstPort
                                                                     1
       Line {
        SrcBlock
"Relational\nOperator"
                                                   Line {
        SrcPort
                                                     SrcBlock
                                                                    "In5"
         Points
                           [30, 0]
                                                     SrcPort
                                                                    1
        Branch (
                                                     Points
                                                                    [20, 0]
       DstBlock
                     "Switch"
                                                     DstBlock
                                                                    "Sum"
       DstPort
                     2
                                                     DstPort
         }
         Branch (
                                                   Line {
                     [0, 50; -105, 0]
       Points
                                                     SrcBlock
                                                                    "Sum"
       DstBlock
                      "Sum"
                                                     SrcPort
       DstPort
                                                     DstBlock
                                                                    "Product1"
         }
                                                     DstPort
       Line {
                                                   Line {
         SrcBlock
                            "Sum"
                                                     SrcBlock
                                                                    *In3*
         SrcPort
                            1
                                                     SrcPort
         DstBlock
                            "Fcn"
                                                     Points
                                                                    [15, 0; 0, -65; 205.
        DstPort
                                               0; 0, 20]
       }
                                                     DstBlock
                                                                    *Product1*
       Line {
                                                     DstPort
                                                                    1
         SrcBlock
                           "Switch"
         SrcPort
                           1
                                                   Line {
         DstBlock
                            "Outl"
                                                     SrcBlock
                                                                    "Sum1"
         DstPort
                                                     SrcPort
       }
                                                                    *Sum2 *
                                                     DstBlock
     }
                                                     DstPort
   }
   Block {
                                                   Line (
     BlockType
                   Constant
                                                     SrcBlock
                                                                    "Constant"
     Name
                    "effect"
                                                     SrcPort
                                                                    1
                   [370, 210, 390, 230]
     Position
                                                     Points
                                                                    [105, 0]
     BackgroundColor "red"
Value "6"
                                                     Branch {
     Value
                                                       DstBlock
                                                                         "Sum1"
                                                       DstPort
                                                                     1
   Block {
     BlockType
                    Outport
                                                     Branch {
     Name
                    "Out1"
                                                       Points
                                                                      [0, -20; 130, 0]
                    [1415, 88, 1445,
     Position
                                                       Branch {
102]
                                                        Points
                                                                           [120, 0; 0,
     BackgroundColor
                      "cyan"
                                               45]
     Port
                                                         DstBlock
                                                                            "Sum2"
     OutputWhenDisabled "held"
                                                         DstPort
                                                                           2
```

```
}
   Branch (
     Points
                         [0, -90]
                                                 Line {
     DstBlock
                                                                   "Fcn"
                         "Switch"
                                                   SrcBlock
     DstPort
                         3
                                                   SrcPort
   ł
                                                   DstBlock
                                                                   "Product"
 }
                                                   DstPort
                                                                   2
Line (
                                                 Line {
  SrcBlock
                 "Sum2"
                                                   SrcBlock
                                                                   "Product4"
  SrcPort
                                                   SrcPort
                                                                   1
                 [5, 0]
  Points
                                                   Points
                                                                   [5, 0]
  DstBlock
                 "Product2"
                                                   DstBlock
                                                                   "Sum3"
 DstPort
                                                   DstPort
Line (
                                                 Line {
                 "Math\nFunction"
  SrcBlock
                                                   SrcBlock
                                                                   "Constant1"
  SrcPort
                                                    SrcPort
  DstBlock
                 "Product2"
                                                   Points
                                                                   [60, 0]
  DstPort
                                                   DstBlock
                                                                   "Product4"
                                                   DstPort
Line {
  SrcBlock
                 "Product2"
                                                  Line {
  SrcPort
                                                    SrcBlock
                                                                   "Product1"
  DstBlock
                 "Math\nFunction1"
                                                    SrcPort
  DstPort
                                                    Points
                                                                   [20, 0; 0, 30]
                                                   DstBlock
                                                                   *Sum3 *
Line {
                                                    DstPort
  SrcBlock
                 "Math\nFunction1"
  SrcPort
                                                  Line {
  DstBlock
                 "Product3"
                                                    SrcBlock
                                                                   "Sum3"
  DstPort
                                                    SrcPort
                                                    Points
                                                                   [0, -65; -60, 0]
Line {
                                                    DstBlock
                                                                   "Suml"
  SrcBlock
                 "Product3"
                                                    DstPort
  SrcPort
  DstBlock
                  "Out1"
                                                  Line (
  DstPort
                 1
                                                                   *Logical\nOperator2*
                                                    SrcBlock
                                                    SrcPort
Line (
                                                    DstBlock
                                                                   *Product14*
  SrcBlock
                 "Product"
                                                    DstPort
  SrcPort
                 1
  Points
                  [25, 0]
                                                  Line {
  Branch {
                                                    SrcBlock
    DstBlock
                       "Switch"
                                              "Relational\nOperator3"
    DstPort
                   2
                                                    SrcPort
                                                    Points
                                                                   [5, 0]
  Branch {
                                                    Branch (
    Points
                    [0, -10]
                                                     Points
                                                                     [0, -70]
    DstBlock
                        "Switch"
                                                      DstBlock
                                                                         "Product10"
    DstPort
                                                     DstPort
  }
                                                    Branch (
Line {
                                                     DstBlock
  SrcBlock
                  "Switch"
                                              "Logical\nOperator2"
  SrcPort
                                                     DstPort
                                                                     1
  DstBlock
                  "Math\nFunction"
                                                    }
  DstPort
                  1
                                                  Line {
Line {
                                                    SrcBlock
                                                                   "Product11"
  SrcBlock
                  "In4"
                                                    SrcPort
  SrcPort
                 1
                                                    DstBlock
                                                                   "Sum13"
  Points
                  [0, -40]
                                                    DstPort
                                                                   2
  Branch {
    DstBlock
                       "Sum"
                                                  Line {
    DstPort
                                                    SrcBlock
                                                                   *Product12*
                                                    SrcPort
                                                                   1
  Branch {
                                                    DstBlock
                                                                   "Sum13"
    Points
                    [-20, 0]
                                                    DstPort
    DstBlock
                       "Fcn"
    DstPort
                                                  Line {
```

```
SrcBlock
                    "Sum13"
                                                      Branch (
     SrcPort
                                                                      [5, 0]
                                                        Points
     DstBlock
                    *Product13*
                                                        Branch {
     DstPort
                    1
                                                          Points
                                                                           [-10, 0; 0,
                                                1351
   Line {
                                                         Branch (
     SrcBlock
                    *Product10*
                                                        DstBlock
                                                                       "Sum12"
     SrcPort
                    1
                                                        DstPort
                                                                       1
     Points
                    [10, 0]
                                                          }
     DstBlock
                    "Sum8"
                                                          Branch {
     DstPort
                                                        DstBlock
                                                                       "Product12"
                                                        DstPort
                                                                       2
   Line (
                                                         }
     SrcBlock
                    "Product14"
     SrcPort
                                                        Branch {
                    [10, 0]
     Points
                                                          Points
                                                                            [50, 0]
     DstBlock
                     "Sum8"
                                                          DstBlock
     DstPort
                    2
                                                "Relational\nOperator3"
                                                         DstPort
                                                                             1
   Line {
                                                        }
     SrcBlock
                    "Sum12"
                                                      }
     SrcPort
     Points
                    [0, 0]
                                                    Line {
     Branch (
                                                      SrcBlock
                                                                     "dB Conv.-LF"
      Points
                     [0.0]
                                                      SrcPort
                                                                     1
       DstBlock
                        "Product11"
                                                      Points
                                                                     [0, 5; 35, 0; 0, -
       DstPort
                                                15; 100, 0]
                                                      Branch (
     Branch (
                                                        Points
                                                                      [0, 0]
       Points
                      [0, 45]
                                                        DstBlock
       DstBlock
                          "Sum14"
                                                 "Relational\nOperator3"
       DstPort
                                                       DstPort
                                                      Branch {
   Line {
                                                        Points
                                                                       [0, 65]
     SrcBlock
                     "effect"
                                                        Branch {
     SrcPort
                     1
                                                         Points
                                                                             [-85, 0; 0,
     Points
                     [0, 0]
                                                55]
     Branch {
                                                          DstBlock
                                                                             "Sum12"
      DstBlock
                          "Product12"
                                                          DstPort
       DstPort
                                                        Branch {
     Branch (
                                                          DstBlock
                                                                             "Product11"
      Points
                       [0, 120]
                                                          DstPort
        DstBlock
                          "Sum14"
        DstPort
                                                      }
     }
                                                    Line {
   Line {
                                                      SrcBlock
                                                                     "FastMoving"
                     "Suml4"
     SrcBlock
                                                      SrcPort
                                                                     1
     SrcPort
                                                      Points
                                                                     [5, 0]
     DstBlock
                     "Product13"
                                                      DstBlock
                                                                      "dB Conv"
     DstPort
                                                      DstPort
                                                                     1
   Line {
                                                    Line {
     SrcBlock
                     *Product13*
                                                      SrcBlock
                                                                     "SlowMoving"
     SrcPort
                     1
                                                      SrcPort
                                                                     1
     Points
                     [0, -65; -40, 0]
                                                                     [5, 0]
                                                      Points
     DstBlock
                     "Product14"
                                                      DstBlock
                                                                      "dB Conv.-LF"
     DstPort
                                                      DstPort
                                                                     1
   Line {
                                                    Line {
     SrcBlock
                     "dB Conv"
                                                      SrcBlock
                                                                     "Fcnl"
     SrcPort
                                                      SrcPort
     Points
                     [45, 0; 0, 20; 40,
                                                                     [25, 0; 0, -45]
                                                      Points
01
                                                      DstBlock
                                                                      "Product"
     Branch {
                                                      DstPort
      Points
                       [0, -25]
        DstBlock
                          *Product10*
                                                    Line (
       DstPort
                                                      SrcBlock
                                                                     "Sum8"
                                                      SrcPort
                                                                     1
```

```
Points
                   [10, 0]
                                                       SignalType
                                                                           "auto"
     Branch {
                                                       Interpolate
                                                                           on
       DstBlock
                           "Fcnl"
       DstPort
                       1
                                                     Block {
                                                       BlockType
                                                                       Inport
     Branch (
                                                       Name
                                                                       "In5"
       Points
                       [0, 35; -40, 0; 0,
                                                       Position
                                                                       [865, 298, 895, 312]
                                                                       , 238,
"cyan"
"44"
1701
                                                       BackgroundColor
       DstBlock
                           "Product4"
                                                       Port
                                                                       -1-
       DstPort
                                                       PortWidth
                                                                          .
-1-
     }
                                                        SampleTime
   }
                                                       DataType
                                                                       "auto"
      }
                                                        SignalType
                                                                           "auto"
                                                       Interpolate
                                                                           on
    Block {
      BlockType
                             SubSystem
                                                     Block {
                                                       BlockType
      Name
                                                                      Abs
"homomorphic\nmultiplicative AGC7"
                                                        Name
                                                                       "Abs"
             [4, 1, 0, 0, 0]
      Ports
                                                                       [215, 70, 245, 100]
                                                        Position
                         [440, 589, 470,
      Position
                                                       BackgroundColor "red"
646]
      BackgroundColor
                             "orange"
                                                      Block {
      DropShadow
                         on
                                                        BlockType
                                                                      Constant
      ShowPortLabels
                             off
                                                        Name
                                                                       "Constant"
      System (
                                                        Position
                                                                      [710, 195, 740, 225]
    Name
                                                        BackgroundColor "green"
Value "1"
    "homomorphic\nmultiplicative AGC7"
    Location [107, 78, 883, 455]
    Open
                  off
                                                      Block {
    ModelBrowserVisibility off
                                                        BlockType
                                                                      Constant
    ModelBrowserWidth 200
                                                        Name
                                                                       "Constant1"
    ScreenColor "lightBlue"
                                                        Position
                                                                      [910, 350, 940, 380]
    PaperOrientation "landscape"
PaperPositionMode "auto"
                                                        BackgroundColor "green"
Value "330"
                                                        Value
    PaperType
                  "usletter"
                  "inches"
    PaperUnits
                                                      Block {
                   *100*
    ZoomFactor
                                                        BlockType
                                                                       SubSystem
    AutoZoom
                   on
                                                        Name
                                                                       "FastMoving"
    Block {
                                                        Ports
                                                                       [1, 1, 0, 0, 0]
[270, 57, 300, 113]
      BlockType
                    Inport
                                                        Position
      Name
                     "Inl"
                                                        BackgroundColor "orange"
                     [150, 78, 180, 92]
      Position
                                                        DropShadow
                                                                           on
      BackgroundColor "cyan"
                                                        ShowPortLabels
                                                                          off
      Port
                     -1-
                                                        System (
      PortWidth
                      -1-
                                                          Name
                                                                         "FastMoving"
      SampleTime
                                                          Location
                                                                            [77, 129, 865,
      DataType
                      "auto"
                                                  470 I
      SignalType
                         "auto"
                                                          Open
                                                                         off
      Interpolate
                         on
                                                          ModelBrowserVisibility off
                                                          ModelBrowserWidth
    Block (
                                                          ScreenColor
      BlockType
                     Inport
                                                  "lightBlue"
      Name
                     "In3"
                                                          PaperOrientation
                     [710, 298, 740, 312]
      Position
                                                  "landscape"
      BackgroundColor "cyan"
Port "2"
                                                          PaperPositionMode
                                                                                "auto"
                                                          PaperType
                                                                             "usletter"
                     --1-
      PortWidth
                                                          PaperUnits
                                                                             "inches"
      SampleTime
                        "-1"
                                                          ZoomFactor
                                                                             *100*
      DataType
                      "auto"
                                                          AutoZoom
                                                                             on
      SignalType
                        "auto"
                                                          Block {
      Interpolate
                         on
                                                            BlockType
                                                                                   Inport
                                                                           "Inl"
                                                            Name
    Block {
                                                            Position
                                                                             [75, 93,
      BlockType
                     Inport
                                                  105, 107]
      Name
                      "In4"
                                                            BackgroundColor
                                                                                   "cyan"
                      [805, 298, 835, 312]
      Position
                                                            Port
                                                                           *1*
      BackgroundColor
                        "cyan"
                                                            PortWidth
                     -3-
      Port
                                                            SampleTime
                                                                               -1-
                     -1-
-1-
      PortWidth
                                                            DataType
                                                                               "auto"
      SampleTime
                                                            SignalType
                                                                               "auto"
      DataType
                     "auto"
                                                            Interpolate
                                                                               OΠ
```

```
BlockType
                                                                                  Sum
                                                                          "Sum"
        Block {
                                                           Name
                                                                          [2, 1, 0, 0, 0]
          BlockType
                           Constant
                                                           Ports
                         "Constant"
                                                                              [375, 121,
          Name
                                                           Position
          Position
                                                 405, 154]
                           [80, 134,
110. 156]
                                                           BackgroundColor
                                                                                  "green"
         BackgroundColor
                                 "red"
                                                           DropShadow
                                                                              On
                         *160*
         Value
                                                           IconShape
                                                 "rectangular"
        Block {
                                                                              -++
                                                           Inputs
         BlockType
                                                           SaturateOnIntegerOverflow on
DataStoreMemory
                         "Data
         Name
                                                         Block {
                                                           BlockType
Store\nMemory*
                                                                                  Sum
          Position
                             [430, 35,
                                                           Name
                                                                           *Suml *
                                                                          [2, 1, 0, 0, 0]
462, 651
                                                           Ports
          BackgroundColor
                                 "orange"
                                                           Position
          DataStoreName
                                 *AGC7*
                                                 310, 108]
                             -0-
          InitialValue
                                                           BackgroundColor
                                                                                  "green"
                                                           DropShadow
                                                                              on
        Block {
                                                           IconShape
          BlockType
                                                  "rectangular"
DataStoreRead
                                                           Inputs
                                                           SaturateOnIntegerOverflow on
         Name
                         *Data
Store\nRead*
         Position
                             [210, 155,
                                                         Block {
240, 185]
                                                           BlockType
                                                                                 Outport
          BackgroundColor
                                                                           "Outl"
                                 "orange"
                                                           Name
          DataStoreName
                                 *AGC7*
                                                           Position
                                                                             [490, 133,
          SampleTime
                             "1/Fs"
                                                 520, 1471
                                                           BackgroundColor
                                                                                  "cyan"
        Block (
                                                                          -1-
                                                           Port
          BlockType
                                                           OutputWhenDisabled
                                                                                   "held"
DataStoreWrite
                                                           InitialOutput
          Name
                         *Data
Store\nWrite*
                                                         Line {
          Position
                             [435, 175,
                                                                               "Constant"
                                                           SrcBlock
465, 205]
                                                           SrcPort
                                                                              1
          BackgroundColor
                                 "orange"
                                                           Points
                                                                              [15. 0]
          DataStoreName
                                 *AGC7*
                                                           DstBlock
                                                                               "Product"
          SampleTime
                             "1/Fs"
                                                           DstPort
                                                         3
        Block {
                                                         Line {
          BlockType
                                                           SrcBlock
                                                                               "Inl"
Reference
                                                           SrcPort
          Name
                         "Integer Delay"
                                                           DstBlock
                                                                               *Product*
                         [1, 1, 0, 0, 0]
[200, 67,
          Ports
                                                           DstPort
          Position
245, 103]
                                                         Line {
                                 "red"
          BackgroundColor
                                                           SrcBlock
                                                                               *Data
          SourceBlock
                                                  Store\nRead*
"dspbdsp2/Integer Delay"
                                                           SrcPort
                                                                               1
                             "Integer
          SourceType
                                                                               [20, 0]
                                                           Points
Delay*
                                                                               "Suml"
                                                           DstBlock
          delay
                         *160*
                                                           DstPort
                                                                               2
                          -0-
          ic
          frame
                         off
                                                         Line {
          đf
                         on
                                                           SrcBlock
                                                                               *Integer
          numChans
                             -1-
                                                  Delay"
                                                           SrcPort
        Block {
                                                           DstBlock
                                                                               "Suml"
          BlockType
                                Product
                                                           DstPort
                                                                               1
                         "Product"
          Name
          Ports
                          [2, 1, 0, 0, 0]
                                                         Line {
          Position
                             [145, 92,
                                                           SrcBlock
                                                                               "Sum1"
175, 1231
                                                           SrcPort
                                                                               1
          BackgroundColor
                                 "green"
                                                           Points
                                                                               [45, 0]
          Inputs
                                                           DstBlock
                                                                               "Sum"
          SaturateOnIntegerOverflow on
                                                           DstPort
                                                                               1
        Block {
                                                         Line {
```

```
SrcBlock
                             "Product"
                                                        Position
                                                                      [1260, 85, 1290,
                                                  1151
         SrcPort
                             [5, 0]
                                                        BackgroundColor "red"
         Points
                                                        ShowName off
         Branch {
       Points
                      [0.0]
                                                                       exp"
                                                        Operator
       DstBlock
                      "Integer Delay"
                                                        OutputSignalType "auto"
       DstPort
                                                      Block {
         1
         Branch (
                                                        BlockType
                                                                       Product
                       [0, 35]
       Points
                                                        Name
                                                                        "Product"
                                                                       [2, 1, 0, 0, 0]
[915, 72, 945, 103]
                       "Sum"
       DstBlock
                                                        Ports
       DstPort
                       2
                                                        Position
                                                        BackgroundColor "yellow"
Inputs ""/"
        }
       Line {
                                                        SaturateOnIntegerOverflow on
         SrcBlock
                             "Sum"
         SrcPort
                             1
                                                      Block {
         Points
                             [10, 0]
                                                        BlockType
                                                                      Product
         Branch (
                                                                       "Product1"
       DstBlock
                       "Data
                                                                       [2, 1, 0, 0, 0]
[995, 252, 1025,
                                                        Ports
Store\nWrite"
                                                        Position
       DstPort
                                                  2831
                                                        }
         Branch {
       DstBlock
                       "Outl"
                                                        SaturateOnIntegerOverflow on
       DstPort
                       1
         }
                                                      Block {
        }
                                                        BlockType
                                                                        Product
     }
                                                        Name
                                                                        *Product10*
                                                                       [2, 1, 0, 0, 0]
[615, 67, 645, 98]
                                                        Ports
    Block {
                                                        Position
                                                        BackgroundColor "green"
Inouts "2"
      BlockType
                     Fcn
                     "Fcn" [835, 130, 895, 160]
      Name
      Position
                                                        SaturateOnIntegerOverflow on
      BackgroundColor "yellow"
     Expr
                     "power(10,((u/20)-
                                                      Block {
5.5))*
                                                        BlockType
                                                                        Product
                                                                        "Product11"
                                                        Name
    Block {
                                                                        [2, 1, 0, C, 0]
[505, 257, 535, 288]
                                                        Ports
      BlockType
                     Fcn
                                                        Position
                                                                        , 23/,
"green"
"2"
      Name
                     "Fcn1"
                                                        BackgroundColor
      Position
                     [740, 110, 800, 140]
                                                        Inputs
      BackgroundColor "yellow"
                                                        SaturateOnIntegerOverflow on
                     "power(10,((u/20)-
      Expr
5.5))*
                                                      Block {
                                                        BlockType
                                                                        Product
    Block (
                                                        Name
                                                                        "Product12"
      BlockType
                     Logic
                                                        Ports
                                                                        [2, 1, 0, 0, 0]
      Name
                      "Logical\nOperator2"
                                                                       [505, 212, 535, 243]
                                                        Position
                                                                        "2"
"green"
                     [1, 1, 0, 0, 0]
[565, 144, 595, 176]
                                                        BackgroundColor
      Ports
                                                        Inputs
      BackgroundColor "yellow"
                                                        SaturateOnIntegerOverflow on
                     "NOT"
      Operator
      Inputs
                      -1-
                                                      Block {
                                                        BlockType
                                                                        Product
    Block {
                                                        Name
                                                                        *Product13*
      BlockType
                     Math
                                                        Ports
                                                                        [2, 1, 0, 0, 0]
                      "Math\nFunction"
                                                        Position
                                                                        [605, 311, 635, 344]
      Ports
                     [1, 1, 0, 0, 0]
[1075, 75, 1105,
                                                        BackgroundColor *green*
Inputs **/*
      Position
                                                        Inputs
105]
                                                        SaturateOnIntegerOverflow on
      BackgroundColor
      ShowName
                off
                                                      Block {
      Operator
                     "log"
                                                        BlockType
                                                                        Product
      OutputSignalType "auto"
                                                        Name
                                                                        "Product14"
                                                                        [2, 1, 0, 0, 0]
    Block {
                                                        Position
                                                                       [615, 217, 645, 248]
      BlockType
                                                        BackgroundColor "green"
Inputs "2"
                     Math
      Name
                     "Math\nFunction1"
                                                        Inputs
      Ports
                      [1, 1, 0, 0, 0]
                                                        SaturateOnIntegerOverflow on
```

Block (	DataType "auto"
BlockType Product	SignalType "auto"
Name "Product2"	Interpolate on
Ports [2, 1, 0, 0, 0]	}
Position [1175, 82, 1205,	Block {
1131	BlockType Constant
BackgroundColor "yellow"	Name "Constant"
Inputs "**"	Position [80, 134,
SaturateOnIntegerOverflow on	110, 156]
} Block {	BackgroundColor "red"
·	Value "3520"
BlockType Product Name "Product3"	} Plack (
Ports [2, 1, 0, 0, 0]	Block (
Position [1350, 77, 1380,	BlockType
108]	DataStoreMemory Name "Data
BackgroundColor "yellow"	Name "Data Store\nMemory"
Inputs "**"	_ <del>7</del>
SaturateOnIntegerOverflow on	Position [430, 35, 462, 65]
}	BackgroundColor "orange"
Block {	DataStoreName "AGCS7"
BlockType Product	InitialValue "0"
Name "Product4"	}
Ports [2, 1, 0, 0, 0]	Block {
Position [1020, 322, 1050,	BlockType
353]	DataStoreRead
BackgroundColor "yellow"	Name "Data
Inputs "*/"	Store\nRead*
SaturateOnIntegerOverflow on	Position [210, 155,
}	240, 185]
Block (	BackgroundColor "orange"
BlockType RelationalOperator	DataStoreName "AGCS7"
Name	SampleTime "1/Fs"
"Relational\nOperator3"	}
Position [510, 142, 540, 173]	Block {
BackgroundColor "yellow"	BlockType
BackgroundColor "yellow" Operator ">="	BlockType DataStoreWrite
Operator ">="	
Operator ">=" } Block {	DataStoreWrite
Operator ">=" } Block { BlockType SubSystem	DataStoreWrite Name "Data Store\nWrite" Position [435, 175,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving"	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205]
Operator ">=" } Block {    BlockType SubSystem    Name "SlowMoving"    Ports [1, 1, 0, 0, 0]	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange"
Operator ">=" } Block {     BlockType	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7"
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange"	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs"
Operator ">=" } Block {     BlockType	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" }
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" Block {
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System {	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving"	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867,	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block ( BlockType Reference Name "Integer Delay"
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867,	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0]
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block ( BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0] Position [200, 67,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0] Position [200, 67,
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200	DataStoreWrite
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0] Position [200, 67, 245, 103] BackgroundColor "red" SourceBlock
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1,1,0,0,0] Position [270,137,300,193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79,127,867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue"	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0] Position [200, 67, 245, 103] BackgroundColor "red" SourceBlock "dspbdsp2/Integer Delay"
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0] Position [200, 67, 245, 103] BackgroundColor "red" SourceBlock "dspbdsp2/Integer Delay" SourceType "Integer
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape"	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0] Position [200, 67, 245, 103] BackgroundColor "red" SourceBlock "dspbdsp2/Integer Delay" SourceType "Integer Delay"
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto"	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0] Position [200, 67, 245, 103] BackgroundColor "red" SourceBlock "dspbdsp2/Integer Delay" SourceType "Integer Delay" delay "3520"
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape"	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0] Position [200, 67, 245, 103] BackgroundColor "red" SourceBlock "dspbdsp2/Integer Delay" SourceType "Integer Delay" delay "3520" ic "0"
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter"	DataStoreWrite
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches"	DataStoreWrite
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100"	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0] Position [200, 67, 245, 103] BackgroundColor "red" SourceBlock "dspbdsp2/Integer Delay" SourceType "Integer Delay" delay "3520" ic "0" frame off df on
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0] Position [200, 67, 245, 103] BackgroundColor "red" SourceBlock "dspbdsp2/Integer Delay" SourceType "Integer Delay" delay "3520" ic "0" frame off df on numChans "1"
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on Block { BlockType Inport Name "In1"	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0] Position [200, 67, 245, 103] BackgroundColor "red" SourceBlock "dspbdsp2/Integer Delay" SourceType "Integer Delay"  delay "3520" ic "0" frame off df on numChans "1" } Block {
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on Block { BlockType Inport	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205] BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0] Position [200, 67, 245, 103] BackgroundColor "red" SourceBlock "dspbdsp2/Integer Delay" SourceType "Integer Delay" delay "3520" ic "0" frame off df on numChans "1" } Block { BlockType Product
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on Block { BlockType Inport Name "In1"	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205]  BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0] Position [200, 67, 245, 103] BackgroundColor "red" SourceBlock "dspbdsp2/Integer Delay" SourceType "Integer Delay"  delay "3520" ic "0" frame off df on numChans "1" } Block { BlockType Product Name "Product"
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on Block { BlockType Inport Name "In1" Position [75, 93,	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205]  BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0] Position [200, 67, 245, 103] BackgroundColor "red" SourceBlock "dspbdsp2/Integer Delay" SourceType "Integer Delay"  delay "3520" ic "0" frame off df on numChans "1" } Block { BlockType Product Name "Product" Ports [2, 1, 0, 0, 0]
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on Block { BlockType Inport Name "In1" Position [75, 93, 105, 107]	DataStoreWrite Name "Data Store\nWrite" Position [435, 175, 465, 205]  BackgroundColor "orange" DataStoreName "AGCS7" SampleTime "1/Fs" } Block { BlockType Reference Name "Integer Delay" Ports [1, 1, 0, 0, 0] Position [200, 67, 245, 103] BackgroundColor "red" SourceBlock "dspbdsp2/Integer Delay" SourceType "Integer Delay"  delay "3520" ic "0" frame off df on numChans "1" } Block { BlockType Product Name "Product" Ports [2, 1, 0, 0, 0]
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on Block { BlockType Import Name "In1" Position [75, 93, 105, 107] BackgroundColor "cyan"	DataStoreWrite
Operator ">=" } Block { BlockType SubSystem Name "SlowMoving" Ports [1, 1, 0, 0, 0] Position [270, 137, 300, 193] BackgroundColor "orange" DropShadow on ShowPortLabels off System { Name "SlowMoving" Location [79, 127, 867, 468] Open off ModelBrowserVisibility off ModelBrowserWidth 200 ScreenColor "lightBlue" PaperOrientation "landscape" PaperPositionMode "auto" PaperType "usletter" PaperUnits "inches" ZoomFactor "100" AutoZoom on Block { BlockType Inport Name "In1" Position [75, 93, 105, 107] BackgroundColor "cyan" Port "1"	DataStoreWrite

```
SaturateOnIntegerOverflow on
                                                             DstPort
                                                                                 1
       Block {
                                                           Line {
         BlockType
                                                             SrcBlock
                                                                                 "Product"
                                 Sum
         Name
                          "Sum"
                                                             SrcPort
                          [2, 1, 0, 0, 0]
[375, 121,
          Ports
                                                             Points
                                                                                 [5, 0]
          Position
                                                             Branch {
405, 1541
                                                           Points
                                                                           [0. 0]
          BackgroundColor
                                                           DstBlock
                                  "green"
                                                                           "Integer Delay"
          DropShadow
                             on
                                                           DstPort
          IconShape
                                                             }
"rectangular"
                                                             Branch {
          Inputs
                                                           Points
                                                                           [0, 35]
          SaturateOnIntegerOverflow on
                                                           DstBlock
                                                                           "Sum"
                                                           DstPort
        Block {
                                                             1
          BlockType
                                 Sum
                         "Sum1"
[2, 1, 0, 0, 0]
[280, 77,
          Name
                                                           Line {
          Ports
                                                             SrcBlock
                                                                                 "Sum"
          Position
                                                             SrcPort
310, 108]
                                                             Points
                                                                                  [10, 0]
          BackgroundColor
                                  "green"
                                                             Branch {
          DropShadow
                              on
                                                           DstBlock
                                                                           "Data
          IconShape
                                                   Store\nWrite"
"rectangular"
                                                           DstPort
         Inputs
                                                             }
          SaturateOnIntegerOverflow on
                                                             Branch (
                                                           DstBlock
                                                                           "Outl"
        Block (
                                                           DstPort
                                                                           1
          BlockType
                                 Outport
                                                             }
                          "Outl"
          Name
                                                           ŀ
                             [490, 133,
          Position
                                                         }
520, 147]
          BackgroundColor
                                  "cyan"
                                                       Block {
          Port
                                                          BlockType
                                                                         Sum
          OutputWhenDisabled
                                  "held"
                                                                          "Sum"
                                                         Name
                                                                         [2, 1, 0, 0, 0]
[935, 258, 955, 287]
          InitialOutput
                                  -0-
                                                         Ports
                                                          Position
        Line (
                                                          BackgroundColor
                                                                            "orange"
          SrcBlock
                              "Constant"
                                                                         off
                                                          ShowName
          SicPort
                              1
                                                         IconShape
                                                                         "rectangular"
          Points
                              [15, 0]
                                                          Inputs
                                                                         * +- *
          DstBlock
                              "Product"
                                                          SaturateOnIntegerOverflow on
          DstPort
                              2
                                                       Block {
        Line {
                                                         BlockType
                                                                         Sum
          SrcBlock
                              "Inl"
                                                          Name
                                                                          "Sum1"
          SrcPort
                                                          Ports
                                                                          [2, 1, 0, 0, 0]
          DstBlock
                              "Product"
                                                          Position
                                                                          [1055, 203, 1075,
          DstPort
                              1
                                                    2321
                                                          BackgroundColor
                                                                             "orange"
        Line {
                                                                        off
                                                          ShowName
         SrcBlock
                              "Data
                                                          IconShape
                                                                          "rectangular"
Store\nRead*
                                                                          *+-
                                                          Inputs
          SrcPort
                                                          SaturateOnIntegerOverflow on
          Points
                              [20, 0]
          DstBlock
                              "Sum1"
                                                       Block {
          DstPort
                              2
                                                          BlockType
                                                                         Sum
                                                          Name
                                                                          "Sum12"
        Line {
                                                                         [2, 1, 0, 0, 0]
[450, 262, 480, 293]
                                                          Ports
          SrcBlock
                              *Integer
                                                          Position
Delay*
                                                          BackgroundColor *green*
          SrcPort
                                                          IconShape
                                                                         "rectangular"
          DstBlock
                              "Sum1"
                                                          Inputs
          DstPort
                              1
                                                          SaturateOnIntegerOverflow on
        Line {
                                                       Block {
          SrcBlock
                              "Sum1"
                                                          BlockType
                                                                         Sum
          SicPort
                              1
                                                          Name
                                                                          "Sum13"
                                                                         [2, 1, 0, 0, 0]
[555, 252, 585, 283]
          Points
                              [45, 0]
                                                         Ports
          DstBlock
                              "Sum"
                                                         Position
```

```
BackgroundColor *green*
                                                                        off
                "rectangular"
                                                         ModelBrowserVisibility off
     IconShape
                    *++*
                                                                               200
     Inputs
                                                         ModelBrowserWidth
     SaturateOnIntegerOverflow on
                                                         ScreenColor
                                                 "lightBlue"
   Block {
                                                         PaperOrientation
     BlockType
                                                  "landscape"
                     Sum
     Name
                     "Sum14"
                                                         PaperPositionMode
                                                                               "auto"
                     [2, 1, 0, 0, 0]
[510, 317, 540, 348]
                                                         PaperType
     Ports
                                                                            "usletter"
     Position
                                                         PaperUnits
                                                                            "inches"
     BackgroundColor *green*
                                                                            *100*
                                                         ZoomFactor
     IconShape "rectangular"
                                                         AutoZoom
                                                                            on
     Inputs
                                                         Block (
                                                                          Inport
     SaturateOnIntegerOverflow on
                                                           BlockType
                                                           Name
   Block {
                                                                             [25, 68, 55,
                                                           Position
     BlockType
                                                 821
                     Sum
     Name
                     *Sum2 *
                                                           BackgroundColor
                                                                                  "cyan"
                     [2, 1, 0, 0, 0]
     Ports
                                                           Port
                     [1130, 213, 1150,
     Position
                                                           PortWidth
2421
                                                                              --1-
                                                           SampleTime
      BackgroundColor
                         "orange"
                                                           DataType
                                                                               "auto"
                   off
     ShowName
                                                           SignalType
                                                                               "auto"
      IconShape
                     "rectangular"
                                                           Interpolate
                                                                               OB
                     *+-*
      Inputs
     SaturateOnIntegerOverflow on
                                                         Block {
                                                           BlockType
                                                                                  Constant
   Block {
                                                           Name
                                                                           "Constantl"
      BlockType
                                                           Position
                                                                               [100, 80,
     Name
                     *Sum3 *
                                                  120, 1001
                     [2, 1, 0, 0, 0]
[1075, 293, 1095,
      Ports
                                                           BackgroundColor
      Position
                                                  "darkGreen"
3221
                                                           Value
                                                                           *0*
      BackgroundColor
                        "orange"
                 off
      ShowName
                                                         Block {
      IconShape
                     "rectangular"
                                                            BlockType
                                                                                  Fcn
                                                                           "Fcn"
                                                           Name
     SaturateOnIntegerOverflow on
                                                            Position
                                                                             [185, 165,
                                                  245, 195]
   Block {
                                                           BackgroundColor
                                                                                   "yellow"
      BlockType
                     Sum
                                                            Expr
                     *Sum8 *
      Name
                                                  "20*log10(u/(3.1623*power(10,-6)))"
                     [2, 1, 0, 0, 0]
[675, 107, 705, 138]
      Ports
      Position
                                                         Block {
      BackgroundColor *green*
                                                           BlockType
      IconShape
                     "rectangular"
                                                  RelationalOperator
                     *++*
      Inputs
                                                           Name
      SaturateOnIntegerOverflow on
                                                  "Relational\nOperator"
                                                            Position
                                                                               [145, 67,
    Block {
                                                  175, 981
     BlockType
                     Switch
                                                            BackgroundColor
                                                                                   "yellow"
      Name
                     "Switch"
                                                           Operator
                     [1000, 75, 1030,
      Position
1051
                                                         Block {
      BackgroundColor
                         "yellow"
                                                            BlockType
                                                                                  Sum
      NamePlacement
                             "alternate"
                                                            Name
                                                                           "Sum"
                     off
      ShowName
                                                                           [2, 1, 0, 0, 0]
                                                            Ports
      Threshold
                     "10.^-8"
                                                            Position
                                                                               [120, 162,
                                                  150, 193]
    Block {
                                                           BackgroundColor
                                                                                   "green"
      BlockType
                     SubSystem
                                                            IconShape
                     "dB Conv"
      Name
                                                  "rectangular"
                     [1, 1, 0, 0, 0]
      Ports
                                                            Inputs
      Position
                     [325, 63, 350, 97]
                                                            SaturateOnIntegerOverflow on
      BackgroundColor
                         "darkGreen"
      DropShadow
                         OR
                                                         Block {
      ShowPortLabels
                         off
                                                            BlockType
                                                                                  Switch
      System {
                                                                           "Switch"
                                                           Name
       Name
                       "dB Conv"
                                                            Position
                                                                             [280, 70,
                           [8, 74, 474,
        Location
                                                  310, 100]
399]
                                                            BackgroundColor
```

```
Threshold
                               *1*
                                                        DstPort
                                                                     1
                                                      }
                                                    }
       Block {
         BlockType
                               Outport
                        "Outl"
         Name
                                                   Block {
                         [360, 78,
         Position
                                                     BlockType
                                                                   SubSystem
                                                     Name
390, 92]
                                                                   "dB Conv.-LF"
                                                               [1, 1, 0, 0, 0]
[325, 158, 350, 192]
         BackgroundColor
                               "cyan"
                                                     Ports
         Port
                                                     Position
                              "held"
                                                     BackgroundColor *darkGreen*
         OutputWhenDisabled
                              -[]-
         InitialOutput
                                                     DropShadow
                                                                       on
                                                     ShowPortLabels
                                                                      off
       Line {
                                                     System {
         SrcBlock
                           "Fcn"
                                                      Name
                                                                     *dB Conv.-LF*
         SrcPort
                                                       Location
                                                                        [152, 320,
         Points
                           [15, 0]
                                               618, 645]
         DstBlock
                           "Switch"
                                                       Open
                                                                     off
                                                       ModelBrowserVisibility off
ModelBrowserWidth 200
         DstPort
                           3
       Line {
                                                       ScreenColor
         SrcBlock
                           "Inl"
                                               "lightBlue"
         SrcPort
                                                       PaperOrientation
                                               "landscape"
        Points
                           [10, 0]
         Branch {
                                                       PaperPositionMode
                                                                            "auto"
                     [0, -45; 195, 0]
       Points
                                                       PaperType
                                                                        "usletter"
       DstBlock
                      "Switch"
                                                                        "inches"
                                                       PaperUnits
       DstPort
                                                       ZoomFactor
                                                                        *100*
         }
                                                       AutoZoom
                                                                         on
         Branch {
                                                       Block (
                                                                       Inport
                                                         BlockType
       DstBlock
    "Relational\nOperator"
                                                         Name
       DstPort
                                                         Position
                                                                          [25, 68, 55,
        }
                                               821
         Branch {
                                                         BackgroundColor
                                                                              "cyan"
                     [0, 110]
       Points
                                                         Port
       DstBlock
                     "Sum"
                                                         PortWidth
       DstPort
                      2
                                                         SampleTime
        }
                                                                           "auto"
                                                         DataType
                                                         SignalType
                                                                           "auto"
       Line {
                                                         Interpolate
                                                                           on
         SrcBlock
                            "Constantl"
         SrcPort
                            1
                                                       Block {
         DstBlock
                                                         BlockType
                                                                              Constant
"Relational\nOperator"
                                                         Name
                                                                        "Constantl"
        DstPort
                                                         Position
                                                                          [100, 80,
                                                120, 100]
       Line {
                                                         BackgroundColor
         SrcBlock
                                                "darkGreen"
"Relational\nOperator"
                                                         Value
                                                                       -0-
         SrcPort
         Points
                            [30, 0]
                                                       Block {
         Branch {
                                                         BlockType
                                                                              Fcn
       DstBlock
                                                                        *Fcn*
                      "Switch"
                                                         Name
       DstPort
                                                         Position
                                                                         [185, 165,
                                                245, 195]
         Branch {
                                                         BackgroundColor "yellow"
       Points
                      [0, 50; -105, 0]
                                                         Expr
       DstBlock
                      "Sum"
                                                *20*log10(u/(3.1623*power(10,-6)))*
       DstPort
         }
                                                       Block {
                                                         BlockType
        Line {
                                                RelationalOperator
         SrcBlock
                            "Sum"
                                                         Name
         SrcPort
                            1
                                                "Relational\nOperator"
         DstBlock
                            "Fcn"
                                                        Position
                                                                           [145, 67,
         DstPort
                            1
                                                175, 98]
                                                         BackgroundColor
                                                                               "yellow"
        Line {
                                                        Operator
         SrcBlock
                            "Switch"
         SrcPort
                                                       Block {
         DstBlock
                            "Out1"
                                                         BlockType
                                                                               Sum
```

```
Branch {
                                                   Points [0, 50; -105, 0]
                                                   DstBlock
                                                                 "Sum"
150, 1931
                                                   DstPort
        BackgroundColor
                             "green"
                                                    }
        IconShape
"rectangular"
                                                   Line {
                                                    SrcBlock
        Inputs
                                                                       "Sum"
                                                                     1
        SaturateOnIntegerOverflow on
                                                     SrcPort
                                                     DstBlock
                                                                       "Fcn"
       Block {
                                                    DstPort
                                                                      1
        BlockType
                             Switch
                      "Switch"
        Name
                                                   Line {
        Position
                       [280, 70,
                                                                      "Switch"
                                                    SrcBlock
310, 100]
                                                     SrcPort
                                                                      1
        BackgroundColor
                             "orange"
                                                     DstBlock
                                                                       "Outl"
                             -1-
        Threshold
                                                     DstPort
                                                   }
       Block {
                      Outport
                                                  }
        BlockType
         Name
                                                Block {
        Position
                      [360, 78,
                                                              Constant
                                                  BlockType
                                                  Name "effect"
Position [370, 210, 390, 230]
390, 921
        BackgroundColor
                             "cyan"
                                                  BackgroundColor "red"
Value "6"
        Port
OutputWhenDisabled *he *[]*
                            "held"
                                                  Value
                                                Block {
       Line {
                                                              Outport
                                                  BlockType
                         "Fcn"
                                                  Name "Out1"
Position [1415, 88, 1445,
         SrcBlock
         SrcPort
                         [15, 0]
"Switch"
         Points
                                             102]
                                                  BackgroundColor "cyan"
Port "1"
         DstBlock
        DstPort
                                                  OutputWhenDisabled
                                                                       "held"
       Line {
                                                  InitialOutput
                                                                     -0-
                        "Inl"
         SrcBlock
         SrcPort
                        1
                                                Line {
                                                  SrcBlock 'Inl'
SrcPort 1
Points [5, 0]
         Points
                          [10, 0]
        Branch {
       Points [0, -45; 195, 0]
DstBlock "Switch"
DstPort 1
                                                  Branch (
       DstPort
                                                   DstBlock
                                                                      "Abs"
        }
                                                                1
                                                   DstPort
        Branch {
       DstBlock
                                                  Branch {
   "Relational\nOperator"
                                                   Points
                                                                 [0, -80; 1145, 0]
       DstPort
                   1
                                                   DstBlock
                                                                      *Product3*
        }
                                                   DstPort
        Branch {
                 [0, 110]
"Sum"
2
       Points
       DstBlock
                                                Line {
       DstPort
                                                  SrcBlock
                                                                "Abs"
        }
                                                  SrcPort
                                                                1
                                                  Points
                                                                [5. 0]
       Line {
                                                  Branch (
        SrcBlock
                          "Constant1"
                                                    DstBlock
                                                                      "FastMoving"
         SrcPort
                                                                 1
                                                   DstPort
        DstBlock
"Relational\nOperator"
                                                  Branch {
       DstPort
                                                   DstBlock
                                                                     "SlowMoving"
                                                    DstPort
                                                                 1
       Line {
                                                  }
        SrcBlock
"Relational\nOperator"
                                                Line {
        SrcPort
                                                  SrcBlock
                                                                "In5"
         Points
                          [30, 0]
                                                  SrcPort
                                                                1
        Branch {
                                                  Points
                                                                [20, 0]
       DstBlock
                     "Switch"
                                                  DstBlock
                                                                "Sum"
       DstPort
                    2
                                                                2
                                                  DstPort
        }
```

```
Line {
                                                      DstBlock
                                                                      "Outl"
     SrcBlock
                    "Sum"
                                                      DstPort
     SrcPort
                    1
     DstBlock
                     "Product1"
                                                    Line {
                                                                      "Product"
     DstPort
                     2
                                                       SrcBlock
                                                       SrcPort
                                                                      1
   Line (
                                                                      [25, 0]
                                                       Points
     SrcBlock
                     "In3"
                                                       Branch {
     SrcPort
                    1
                                                       DstBlock
                                                                           "Switch"
                    [15, 0; 0, -65; 205,
     Points
                                                        DstPort
                                                                        2
0; 0, 20]
     DstBlock
                     *Product1*
                                                       Branch (
     DstPort
                                                        Points
                                                                        [0, -10]
                                                         DstBlock
                                                                          "Switch"
   Line {
                                                         DstPort
     SrcBlock
                     "Suml"
                                                       }
     SrcPort
                     1
     DstBlock
                     " Sum2 "
                                                     Line {
     DstPort
                     1
                                                       SrcBlock
                                                                      "Switch"
                                                       SrcPort
   Line {
                                                       DstBlock
                                                                       "Math\nFunction"
      SrcBlock
                     "Constant"
                                                       DstPort
      SrcPort
      Points
                     [105, 0]
                                                     Line {
      Branch (
                                                                      "In4"
                                                       SrcBlock
       DstBlock
                           "Sumi"
                                                       SrcPort
       DstPort
                                                       Points
                                                                      [0, -40]
                                                       Branch {
      Branch {
                                                        DstBlock
                                                                            "Sum"
        Points
                       [0, -20; 130, 0]
                                                        DstPort
                                                                        1
        Branch {
         Points
                             [120, 0: 0,
                                                       Branch (
451
                                                         Points
                                                                        [-20, 0]
         DstBlock
                             *Sum2*
                                                         DstBlock
                                                                           "Fcn"
        DstPort
                                                         DstPort
                                                       }
        Branch {
          Points
                             [0, -90]
                                                     Line {
          DstBlock
                             "Switch"
                                                       SrcBlock
                                                                       "Fcn"
          DstPort
                                                       SrcPort
                                                                       "Product"
                                                       DstBlock
     ŀ
                                                       DstPort
    Line {
                                                     Line {
      SrcBlock
                     "Sum2"
                                                       SrcBlock
                                                                       "Product4"
      SrcPort
                     1
                                                       SrcPort
                                                                       1
                     [5, 0]
      Points
                                                       Points
                                                                       [5. 0]
      DstBlock
                     "Product2"
                                                       DstBlock
                                                                       "Sum3"
      DstPort
                                                       DstPort
    Line {
                                                     Line {
      SrcBlock
                     "Math\nFunction"
                                                       SrcBlock
                                                                       "Constant1"
      SrcPort
                                                       SrcPort
                                                                       1
      DstBlock
                     "Product2"
                                                       Points
                                                                       [60, 0]
      DstPort
                                                       DstBlock
                                                                       "Product4"
                                                       DstPort
    Line {
      SrcBlock
                     "Product2"
                                                     Line {
      SrcPort
                     7
                                                       SrcBlock
                                                                       *Product1*
      DstBlock
                     "Math\nFunction1"
                                                       SrcPort
      DstPort
                                                       Points
                                                                       [20, 0; 0, 30]
                                                       DstBlock
                                                                       "Sum3"
    Line {
                                                       DstPort
      SrcBlock
                     "Math\nFunction1"
      SrcPort
                                                     Line (
      DstBlock
                     "Product3"
                                                       SrcBlock
                                                                       *Sum3 *
      DstPort
                                                       SrcPort
                                                       Points
                                                                       [0, -65; -60, 0]
    Line (
                                                       DstBlock
                                                                       "Sum1"
      SrcBlock
                     *Product3*
                                                       DstPort
      SrcPort
                     1
```

```
SrcPort
                                                               1
   Line {
                 "Logical\nOperator2"
                                                                [0, 0]
    SrcBlock
                                                   Points
                 I
     SrcPort
                                                   Branch {
     DstBlock
                  "Product14"
                                                    DstBlock
                                                                      *Product12*
    DstPort
                                                    DstPort
                                                                  1
   Line {
                                                  Branch {
     SrcBlock
                                                   Points
                                                                  [0, 120]
"Relational\nOperator3"
                                                    DstBlock
                                                                       "Suml4"
    SrcPort 1
                                                   DstPort
     Points
                  [5, 0]
     Branch {
      Points
                   [0, -70]
                                                 Line {
       DstBlock
                         "Product10"
                                                   SrcBlock
                                                                 "Suml4"
      DstPort
                                                   SrcPort
                                                   DstBlock
                                                                 *Product13*
     Branch (
                                                  DstPort
      DstBlock
"Logical\nOperator2"
                                                 Line {
     DstPort
                   1
                                                   SrcBlock
                                                                 "Product13"
     }
                                                   SrcPort
                                                                 1
                                                   Points
                                                                 [0, -65; -40, 0]
   Line {
                                                   DstBlock
                                                                 "Product14"
     SrcBlock
                   "Product11"
                                                   DstPort
     SrcPort
     DstBlock
                   "Sum13"
                                                 Line (
     DstPort
                                                   SrcBlock
                                                                 "dB Conv"
                                                   SrcPort
   Line (
                                                   Points
                                                                 [45, 0; 0, 20; 40,
     SrcBlock
                   "Product12"
                                             10
     SrcPort
                                                   Branch {
     DstBlock
                   "Sum13"
                                                     Points
                                                                  [0, -25]
     DstPort
                   1
                                                     DstBlock
                                                                      "Product10"
                                                    DstPort
   Line {
     SrcBlock
                   "Sum13"
                                                   Branch (
     SrcPort
                                                     Points
                                                                  [5, 0]
     DstBlock
                   "Product13"
                                                     Branch {
     DstPort
                   1
                                                                   [-10, 0; 3,
                                                      Points
                                             1351
   Line (
                                                      Branch (
     SrcBlock
                   "Product10"
                                                     DstBlock
                                                                   "Sum12"
     SrcPort
                   1
                                                     DstPort
     Points
                   [10, 0]
                                                       }
     DstBlock
                   "Sum8"
                                                      Branch (
     DstPort
                   1
                                                     DstBlock
                                                                   *Product12*
                                                     DstPort
                                                                   2
   Line {
                                                      }
     SrcBlock
                   "Product14"
     SrcPort
                   1
                                                     Branch {
     Points
                   [10. 0]
                                                       Points
                                                                        [50, 0]
     DstBlock
                   * Sum8 *
                                                       DstBlock
     DstPort
                                              "Relational\nOperator3"
                                                      DstPort
   Line {
                                                     }
     SrcBlock
                   "Sum12"
                                                   ŀ
     SrcPort
                   1
     Points
                   [0, 0]
                                                 Line {
     Branch {
                                                   SrcBlock
                                                                 "dB Conv.-LF"
                    [0, 0]
      Points
                                                   SrcPort
       DstBlock
                         "Product11"
                                                   Points
                                                                 [0, 5; 35, 0; 0, -
      DstPort
                                              15; 100, 0]
                                                   Branch {
     Branch {
                                                     Points
                                                                  [0, 0]
      Points
                     [0, 45]
                                                     DstBlock
       DstBlock
                        "Suml4"
                                              "Relational\nOperator3"
       DstPort
                                                    DstPort
     ŀ
                                                   Branch {
   Line {
                                                    Points
                                                                  [0, 65]
     SrcBlock
                   "effect"
                                                     Branch (
```

```
Points
                             [-85, 0; 0,
                                                      ZoomFactor
                                                                     -100-
551
                                                      AutoZoom
                                                                     on
         DstBlock
                             "Sum12"
                                                      Block {
          DstPort
                                                        BlockType
                                                                       Inport
        }
                                                        Name
                                                                       "Inl"
                                                        Position
                                                                       [150, 78, 180, 92]
        Branch {
                                                        BackgroundColor *cyan*
          DstBlock
                             "Productll"
          DstPort
                                                        Port
        }
                                                        PortWidth
                                                                       -1-
     }
                                                        SampleTime
                                                                          -1-
                                                        DataType
                                                                       "auto"
    Line {
                                                        SignalType
                                                                           "auto"
     SrcBlock
                     "FastMoving"
                                                        Interpolate
                                                                           on
      SrcPort
                     1
                     [5, 0]
      Points
                                                      Block {
     DstBlock
                     "dB Conv"
                                                        BlockType
                                                                       Inport
      DstPort
                     1
                                                        Name
                                                                        "In3"
                                                        Position
                                                                       [710, 298, 740, 312]
    Line (
                                                                          "cyan"
                                                        BackgroundColor
      SrcBlock
                     "SlowMoving"
                                                        Port
      SrcPort
                     1
                                                        PortWidth
                                                                       -1-
                     [5, 0]
      Points
                                                                           --1-
                                                        SampleTime
      DstBlock
                     "dB Conv.-LF"
                                                        DataType
                                                                        "auto"
      DstPort
                     1
                                                        SignalType
                                                                         "auto"
                                                        Interpolate
    Line {
      SrcBlock
                     "Fcml"
                                                      Block {
      SrcPort
                     1
                                                        BlockType
                                                                       Inport
      Points
                     [25, 0; 0, -45]
                                                        Name
                                                                        "In4"
      DstBlock
                     "Product"
                                                                        [805, 298, 835, 312]
                                                        Position
      DstPort
                                                        BackgroundColor
                                                                          "cyan"
                                                                        *3*
                                                        Port
                                                                       "-1"
"-1"
    Line {
                                                        PortWidth
      SrcBlock
                     "Sum8"
                                                        SampleTime
      SrcPort
                                                        DataType
                                                                        "auto"
      Points
                     [10, 0]
                                                        SignalType
                                                                           "auto"
      Branch (
                                                        Interpolate
                                                                           on
       DstBlock
                           "Fcm1"
        DstPort
                       1
                                                      Block {
                                                        BlockType
                                                                        Inport
      Branch {
                                                        Name
                                                                        "In5"
        Points
                       [0, 35; -40, 0; 0,
                                                        Position
                                                                        [865, 298, 895, 312]
                                                                       , 498,
"Cyan"
"4"
170]
                                                        BackgroundColor
        DstBlock
                           "Product4"
        DstPort
                       1
                                                        PortWidth
                                                                        -1-
                                                                           *-1*
                                                        SampleTime
    }
                                                        DataType
                                                                        "auto"
      }
                                                        SignalType
                                                                           "auto"
                                                        Interpolate
                                                                           on
    Block {
      BlockType
                             SubSystem
                                                      Block {
      Name
                                                        BlockType
                                                                       Abs
"homomorphic\nmultiplicative AGC8"
                                                        Name
                                                                        "Abs"
      Ports [4, 1, 0, 0, 0]
                                                        Position
                                                                        [215, 70, 245, 100]
      Position
                          [440, 679, 470,
                                                        BackgroundColor
                                                                          "red"
736I
      BackgroundColor
                              "orange"
                                                      Block {
      DropShadow
                         on
                                                        BlockType
                                                                        Constant
      ShowPortLabels
                             off
                                                        Name
                                                                        "Constant"
      System {
                                                        Position
                                                                        [710, 195, 740, 225]
                                                        BackgroundColor "green"
Value "1"
    Name
    "homomorphic\nmultiplicative AGC8"
    Location [109, 76, 885, 453]
                  off
                                                      Block {
    ModelBrowserVisibility off
                                                        BlockType
                                                                       Constant
    ModelBrowserWidth 200
                                                        Name
                                                                        "Constant1"
    ScreenColor *lightBlue*
                                                        Position
                                                                        [910, 350, 940, 380]
    PaperOrientation "landscape"
PaperPositionMode "auto"
                                                        BackgroundColor "green"
Value "330"
                                                        Value
                "usletter"
    PaperType
                   "inches"
    PaperUnits
                                                      Block {
```

BlockType SubSystem	Position [435, 175,
Name "FastMoving"	Position [435, 175, 465, 205]
Ports [1, 1, 0, 0, 0]	BackgroundColor "orange"
Position [270, 57, 300, 113]	DataStoreName "AGC8"
BackgroundColor "orange"	SampleTime "1/Fs"
DropShadow on	) Plack f
ShowPortLabels off System {	Block ( BlockType
Name "FastMoving"	Reference
Location [79, 127, 867,	Name "Integer Delay"
468]	Ports [1, 1, 0, 0, 0]
Open off	Position [200, 67,
ModelBrowserVisibility off	245, 103]
ModelBrowserWidth 200 ScreenColor	BackgroundColor "red" SourceBlock
"lightBlue"	"dspbdsp2/Integer Delay"
PaperOrientation	SourceType "Integer
"landscape"	Delay*
PaperPositionMode "auto"	delay "160"
PaperType "usletter" PaperUnits "inches"	ic "0"
ZoomFactor "100"	frame off df on
AutoZoom on	numChans "1"
Block (	}
BlockType Inport	Block (
Name "Inl"	BlockType Product
Position [75, 93, 105, 107]	Name "Product"
BackgroundColor *cyan*	Ports [2, 1, 0, 0, 0] Position [145, 92,
Port "1"	175, 123]
PortWidth *-1*	BackgroundColor *green*
SampleTime "-1"	Inputs "*/"
DataType "auto" SignalType "auto"	SaturateOnIntegerOverflow on
Interpolate on	} Block {
}	BlockType Sum
Block {	Name "Sum"
BlockType Constant	Ports [2, 1, 0, 0, 0]
Name "Constant"	Position [375, 121,
Position [80, 134, 110, 156]	405, 154]
BackgroundColor "red"	BackgroundColor "green" DropShadow on
Value "160"	IconShape
}	"rectangular"
Block {	Inputs "++"
BlockType DataStoreMemorv	SaturateOnIntegerOverflow on
Name "Data	} Block {
Store\nMemory"	BlockType Sum
Position [430, 35,	Name "Suml"
462, 65]	Ports [2, 1, 0, 0, 0]
BackgroundColor "orange" DataStoreName "AGCS"	Position [280, 77,
DataStoreName "AGCS" InitialValue "O"	310, 108]
}	BackgroundColor "green" DropShadow on
Block {	IconShape
BlockType	"rectangular"
DataStoreRead Name "Data	Inputs "-+"
Name "Data Store\nRead"	SaturateOnIntegerOverflow on
Position [210, 155,	} Block {
240, 185]	BlockType Outport
BackgroundColor "orange"	Name "Outl"
DataStoreName "AGC8"	Position [490, 133,
SampleTime *1/Fs*	520, 147]
} Block {	BackgroundColor "cyan"
BlockType	Port "1"
DataStoreWrite	OutputWhenDisabled "held" InitialOutput "0"
Name "Data	}
Store\nWrite*	Line (

```
SrcBlock
                             "Constant"
                                                       Expr
                                                                      "power(10,((u/20)-
         SrcPort
                                                 5.5))*
                             1
                             [15, 0]
         Points
         DstBlock
                             "Product"
                                                     Block {
         DstPort
                             2
                                                       BlockType
                                                                      Fcn
                                                       Name
                                                                      "Fcnl"
       Line {
                                                                      [740, 110, 800, 140]
                                                       Position
         SrcBlock
                             "Inl"
                                                       BackgroundColor "yellow"
         SrcPort
                                                                      *power(10,((u/20)-
                                                       Expr
                             "Product"
         DstBlock
                                                 5.5))*
         DstPort
                                                     Block {
       Line {
                                                       BlockType
                                                                      Logic
         SrcBlock
                             "Data
                                                       Name
                                                                      "Logical\nOperator2"
                                                                     [1, 1, 0, 0, 0]
[565, 144, 595, 176]
Store\nRead*
                                                       Ports
         SrcPort
                                                       Position
                             [20, 0]
         Points
                                                       BackgroundColor "yellow"
Operator "NOT"
          DstBlock
                             "Suml"
                                                       Operator
          DstPort
                                                       Inputs
                                                                       -1-
       Line {
                                                     Block {
          SrcBlock
                             "Integer
                                                       BlockType
                                                                      Math
Delay"
                                                       Name
                                                                      "Math\nFunction"
          SrcPort
                                                                      [1, 1, 0, 0, 0]
                                                       Ports
          DstBlock
                             "Suml"
                                                       Position
                                                                      [1075, 75, 1105,
         DstPort
                             1
                                                 105]
                                                       BackgroundColor
                                                       ShowName off
        Line (
          SrcBlock
                             "Sum1"
                                                       Operator
                                                                      "log"
          SrcPort
                             1
                                                       OutputSignalType "auto"
          Points
                             [45, 0]
          DstBlock
                             "Sum"
                                                     Block {
         DstPort
                                                       BlockType
                                                                      Math
                                                       Name
                                                                      "Math\nFunction1"
        Line {
                                                                     [1, 1, 0, 0, 0]
[1260, 85, 1290,
                                                       Ports
                             *Product*
          SrcBlock
                                                       Position
          SrcPort
                                                  1151
          Points
                             [5, 0]
                                                       BackgroundColor
                                                                          "red"
         Branch {
                                                       ShowName off
        Points
                       [0. 0]
                                                       Operator
                                                                      exp.
       DstBlock
                       "Integer Delay"
                                                       OutputSignalType "auto"
       DstPort
                       1
         }
                                                     Block {
         Branch (
                                                       BlockType
                                                                     Product
        Points
                       [0, 35]
                                                       Name
                                                                      "Product"
        DstBlock
                       "Sum"
                                                                      [2, 1, 0, 0, 0]
[915, 72, 945, 103]
                                                       Ports
        DstPort
                                                       Position
                                                                      , ,2, 94
r "yellow"
"*/"
         }
                                                       BackgroundColor
                                                       Inputs
        Line {
                                                       SaturateOnIntegerOverflow on
          SrcBlock
                             "Sum"
          SrcPort
                                                     Block {
         Points
                             [10, 0]
                                                       BlockType
                                                                      Product
         Branch (
                                                       Name
                                                                      "Product1"
        DstBlock
                       "Data
                                                       Ports
                                                                      [2, 1, 0, 0, 0]
Store\nwrite"
                                                        Position
                                                                      [995, 252, 1025,
       DstPort
                                                  2831
                                                                      r "yellow"
         }
                                                       BackgroundColor
         Branch {
                                                        Inputs
        DstBlock
                       "Outl"
                                                       SaturateOnIntegerOverflow on
       DstPort
                       1
          }
                                                     Block {
        ł
                                                       BlockType
                                                                      Product
      }
                                                       Name
                                                                       "Product10"
    }
                                                                       [2, 1, 0, 0, 0]
    Block {
                                                       Position
                                                                       [615, 67, 645, 98]
      BlockType
                     Fcn
                                                       BackgroundColor
                                                                         "green"
      Name
                     "Fcn"
                                                       Inputs
      Position
                     [835, 130, 895, 160]
                                                        SaturateOnIntegerOverflow on
      BackgroundColor "yellow"
                                                     Block {
```

BlockType	Product	Operator ">="	
Name	"Product11"	}	
Ports Position	[2, 1, 0, 0, 0]	Block (	
	[505, 257, 535, 288] lor "green"		ystem wMoving"
Inputs	*2*		1, 0, 0, 0]
<u>-</u>	tegerOverflow on	Position [270	137. 300. 1931
}		BackgroundColor	
Block {			on
BlockType	Product	ShowPortLabels	off
Name	*Product12*	System (	
Ports	[2, 1, 0, 0, 0]		lowMoving*
	[505, 212, 535, 243]	Location	[81, 125, 869,
— ·	olor "green" "2"	466]	
Inputs SaturateOnIn	tegerOverflow on	Open of ModelBrowserVisib	
}	.cegeroverrrow on	ModelBrowserWidth	
Block {		ScreenColor	
BlockType	Product	"lightBlue"	
Name	"Product13"	PaperOrientation	
Ports	[2, 1, 0, 0, 0]	"landscape"	
Position	[605, 311, 635, 344]	PaperPositionMode	
	olor "green"	PaperType	"usletter"
	**/*	PaperUnits	"inches"
SaturateOnir }	tegerOverflow on	ZoomFactor	*100*
Block {		AutoZoom	on
BlockType	Product	Block ( BlockType	Tanava
Name	*Product14*	Name	Inport "Inl"
Ports	[2, 1, 0, 0, 0]	Position	[75, 93,
Position	[615, 217, 645, 248]	105, 107]	,
BackgroundCo	olor "green"	BackgroundColor	c "cyan"
Inputs		Port	-1-
	ntegerOverflow on	PortWidth	*-1*
} Block {		SampleTime	*-1*
BlockType	Product	DataType	"auto"
Name	*Product2*	SignalType Interpolate	"auto"
Ports	[2, 1, 0, 0, 0]	}	on
Position	[1175, 82, 1205,	Block {	
113]		BlockType	Constant
	olor "yellow"	Name	"Constant"
Inputs	***	Position	[80, 134,
}	ntegerOverflow on	110, 156]	
Block {		BackgroundColo: Value	r "red" "3520"
BlockType	Product	}	3320
Name	"Product3"	Block {	
Ports	[2, 1, 0, 0, 0]	BlockType	
Position	[1350, 77, 1380,	DataStoreMemory	
108]		Name	*Data
BackgroundCo	olor "yellow"	Store\nMemory"	
Inputs		Position	[430, 35,
}	ntegerOverflow on	462, 65]	
Block {		BackgroundColo	-
BlockType	Product	DataStoreName InitialValue	*AGCS8*
Name	"Product4"	}	-0-
Ports	[2, 1, 0, 0, 0]	Block {	
Position	[1020, 322, 1050,	BlockType	
353]	·	DataStoreRead	
BackgroundCo	• • • • • • • • • • • • • • • • • • •	Name	*Data
Inputs	**/*	Store\nRead*	
_	ntegerOverflow on	Position	[210, 155,
} Plack f		240, 185]	
Block { BlockType	Polations Manager	BackgroundColo	
Name	RelationalOperator	DataStoreName	"AGCS8"
"Relational\nOper	ator3"	SampleTime	"1/Fs"
Position	[510, 142, 540, 173]	} Block {	
	olor "vellow"	DAUGE (	

```
BlockType
                                                            OutputWhenDisabled
                                                                                    "held"
                                                                                   -0-
DataStoreWrite
                                                            InitialOutput
                        *Data
         Name
Store\nWrite"
                                                          Line {
          Position
                             [435, 175,
                                                            SrcBlock
                                                                               "Constant"
465, 2051
                                                            SrcPort
         BackgroundColor
                                 "orange"
                                                            Points
                                                                               [15, 0]
          DataStoreName
                                 "AGCS8"
                                                            DstBlock
                                                                               "Product"
          SampleTime
                             "1/Fs"
                                                            DstPort
        Block {
                                                          Line {
          BlockType
                                                                               "Inl"
                                                            SrcBlock
Reference
                                                            SrcPort
          Name
                         "Integer Delay"
                                                            DstBlock
                                                                               "Product"
          Ports
                         [1, 1, 0, 0, 0]
                                                            DstPort
          Position
                             [200, 67,
245, 1031
                                                          Line {
          BackgroundColor
                                 "red"
                                                            SrcBlock
                                                                               *Data
          SourceBlock
                                                  Store\nRead*
"dspbdsp2/Integer Delay"
                                                            SrcPort
          SourceType
                             "Integer
                                                            Points
                                                                               [20. 0]
Delay*
                                                            DstBlock
                                                                               "Suml"
                         *3520*
          delay
                                                            DstPort
          ic
                         -0-
                         off
          frame
                                                          Line {
          df
                                                            SrcBlock
                         on
                                                                               "Integer
          numChans
                                                  Delay"
                                                            SrcPort
        Block {
                                                            DstBlock
                                                                               "Suml"
          BlockType
                                Product
                                                            DstPort
                                                                               1
          Name
                         "Product"
          Ports
                         [2, 1, 0, 0, 0]
[145, 92,
                                                          Line (
          Position
                                                            SrcBlock
                                                                               "Sum1"
175. 1231
                                                            SrcPort
          BackgroundColor
                             "green"
                                                            Points
                                                                               [45, 0]
          Inputs
                                                            DstBlock
                                                                                "Sum"
          SaturateOnIntegerOverflow on
                                                           DstPort
        Block {
                                                          Line {
          BlockType
                                 Sum
                                                                               "Product"
                                                            SrcBlock
                          "Sum"
          Name
                                                            SrcPort
          Ports
                         [2, 1, 0, 0, 0]
[375, 121,
                                                            Points
                                                                               [5. 0]
          Position
                                                            Branch (
405, 154]
                                                          Points
                                                                         [0, 0]
          BackgroundColor
                                 "green"
                                                          DstBlock
                                                                         "Integer Delay"
          DropShadow
                             on
                                                          DstPort
          IconShape
                                                            }
"rectangular"
                                                            Branch {
          Inputs
                                                          Points
                                                                         [0, 35]
          SaturateOnIntegerOverflow on
                                                          DstBlock
                                                                         "Sum"
                                                          DstPort
                                                                         2
        Block {
                                                           }
          BlockType
                                 Sum
          Name
                          "Sum1"
                                                          Line {
                         [2, 1, 0, 0, 0]
[280, 77,
          Ports
                                                            SrcBlock
                                                                               "Sum"
          Position
                                                            SrcPort
                                                                               1
310, 108]
                                                            Points
                                                                               [10, 0]
          BackgroundColor
                                 "green"
                                                            Branch {
          DropShadow
                             on
                                                         DstBlock
                                                                         *Data
          IconShape
                                                  Store\nWrite*
"rectangular"
                                                        DstPort
                                                                         1
          Inputs
                                                           3
          SaturateOnIntegerOverflow on
                                                            Branch {
                                                          DstBlock
                                                                         "Out1"
        Block {
                                                          DstPort
                                                                         1
          BlockType
                                Outport
                                                           }
                          "Outl"
          Name
                                                          ŀ
          Position
                             [490, 133,
                                                        ŀ
520, 147]
          BackgroundColor
                                 "cyan"
                                                      Block (
          Port
                                                        BlockType
                                                                       Sum
```

```
"Sum"
     Name
                                                      IconShape
                                                                      "rectangular"
                    [2, 1, 0, 0, 0]
[935, 258, 955, 287]
                                                                     -++
     Ports
                                                      Inputs
     Position
                                                      SaturateOnIntegerOverflow on
     BackgroundColor
                        "orange"
                  off
     ShowName
                                                    Block {
                    "rectangular"
     IconShape
                                                      BlockType
                                                                     Sum
                                                                      *Sum8*
     Inputs
                                                      Name
     SaturateOnIntegerOverflow on
                                                      Ports
                                                                      [2, 1, 0, 0, 0]
                                                      Position
                                                                     [675, 107, 705, 138]
   Block (
                                                      BackgroundColor "green"
     BlockType
                    Sum
                                                      IconShape "rectangular"
     Name
                    "Sum1"
                                                                      *++*
                                                      Inputs
                    [2, 1, 0, 0, 0]
     Ports
                                                      SaturateOnIntegerOverflow on
                    [1055, 203, 1075,
     Position
2321
                                                    Block {
     BackgroundColor
                      "orange"
                                                      BlockType
                                                                      Switch
                 off
     ShowName
                                                      Name
                                                                      "Switch"
     IconShape
                    "rectangular"
                                                      Position
                                                                     [1000, 75, 1030,
                                                 1051
     Inputs
                    *+-*
                                                                       "yellow"
     SaturateOnIntegerOverflow on
                                                      BackgroundColor
                                                      NamePlacement
                                                                          "alternate"
                                                                     off
   Block {
                                                      ShowName
     BlockType
                    Sum
                                                      Threshold
                                                                      *10. ~-8*
     Name
                    "Sum12"
                    [2, 1, 0, 0, 0]
     Ports
                                                    Block {
     Position
                    [450, 262, 480, 293]
                                                      BlockType
                                                                      SubSystem
     BackgroundColor *green*
                                                      Name
                                                                      "dB Conv"
     IconShape
                    "rectangular"
                                                                      [1, 1, 0, 0, 0]
                                                       Ports
     Inputs
                                                       Position
                                                                      [325, 63, 350, 97]
     SaturateOnIntegerOverflow on
                                                       BackgroundColor
                                                                         "darkGreen"
                                                       DropShadow
                                                                         on
   Block {
                                                       ShowPortLabels
                                                                        off
     BlockType
                    Sum
                                                       System (
     Name
                     "Sum13"
                                                                        "dB Conv"
                                                        Name
                    [2, 1, 0, 0, 0]
[555, 252, 585, 283]
     Ports
                                                         Location
                                                                           [8, 74, 474,
     Position
                                                 3991
     BackgroundColor "green"
                                                         Open
                                                                        off
     IconShape "rectangular"
                                                         ModelBrowserVisibility off
                     *++*
     Inputs
                                                         ModelBrowserWidth
     SaturateOnIntegerOverflow on
                                                         ScreenColor
                                                 "lightBlue"
   Block {
                                                         PaperOrientation
     BlockType
                     Sum
                                                 "landscape"
     Name
                     "Sum14"
                                                         PaperPositionMode
                                                                               "auto"
                     [2, 1, 0, 0, 0]
[510, 317, 540, 348]
     Ports
                                                                           "usletter"
                                                         PaperType
     Position
                                                         PaperUnits
                                                                           "inches"
     BackgroundColor "green"
                                                         ZoomFactor
                                                                            -100-
      IconShape
                     "rectangular"
                                                         AutoZoom
                                                                            on
                     *++*
      Inputs
                                                         Block {
      SaturateOnIntegerOverflow on
                                                           BlockType
                                                                                 Inport
                                                           Name
                                                                          "Inl"
   Block {
                                                           Position
                                                                             [25, 68, 55,
     BlockType
                     Sum
                                                 821
     Name
                     "Sum2"
                                                           BackgroundColor
                                                                                 "cyan"
                    [2. 1, 0, 0, 0]
[1130, 213, 1150,
      Ports
                                                           Port
      Position
                                                           PortWidth
2421
                                                                              --1-
                                                           SampleTime
     BackgroundColor
                        "orange"
                                                           DataType
                                                                              "auto"
     ShowName
                  off
                                                           SignalType
                                                                              "auto"
      IconShape
                     "rectangular"
                                                           Interpolate
                                                                              on
                     "+-"
     Inputs
     SaturateOnIntegerOverflow on
                                                         Block {
                                                           BlockType
                                                                                 Constant
   Block (
                                                           Name
                                                                          "Constant1"
     BlockType
                     Sum
                                                           Position
                                                                             [100, 80,
     Name
                     "Sum3"
                                                 120, 1001
                     [2, 1, 0, 0, 0]
     Ports
                                                           BackgroundColor
     Position
                     [1075, 293, 1095,
                                                 "darkGreen"
322I
                                                           Value
                                                                          *0*
     BackgroundColor "orange"
                                                         ŀ
      ShowName
                    off
                                                         Block {
```

```
Fcn
        BlockType
                                                    DstBlock
                                                                  "Sum"
                       "Fcn"
        Name
                                                    DstPort
                 *Fcn [185, 165,
                                                                  2
        Position
245, 195]
        BackgroundColor
                            "yellow"
                                                    Line {
        Expr
                                                      SrcBlock
                                                                        "Constantl"
*20*log10(u/(3.1623*power(10,-6)))*
                                                      SrcPort
                                                      DstBlock
       Block {
                                             "Relational\nOperator"
        BlockType
                                                     DstPort
RelationalOperator
        Name
                                                    Line {
"Relational\nOperator"
                                                      SrcBlock
        Position
                          [145, 67,
                                             "Relational\nOperator"
175, 981
                                                     SrcPort
        BackgroundColor
                              "yellow"
                                                      Points
                                                                       [30. 0]
                                                     Branch {
        Operator
                                                    DstBlock
                                                                  "Switch"
       Block {
                                                    DstPort
        BlockType
                             Sum
                                                      }
                      "Sum"
        Name
Ports
                                                      Branch {
                      [2, 1, 0, 0, 0]
[120, 162,
                                                    Points
                                                                  [0, 50; -105, 0]
         Position
                                                    DstBlock
                                                                  "Sum"
150, 193]
                                                    DstPort
        BackgroundColor
                             "green"
                                                     }
        IconShape
"rectangular"
                                                    Line {
        Inputs
                                                     SrcBlock
                                                                        "Sum"
         SaturateOnIntegerOverflow on
                                                      SrcPort
                                                      DstBlock
                                                                        "Fcn"
       Block {
                                                      DstPort
                                                                        1
         BlockType
                             Switch
                       "Switch"
         Name
                                                    Line {
         Position
                        [280, 70,
                                                     SrcBlock
                                                                        "Switch"
310, 100]
                                                      SrcPort
         BackgroundColor
                              "orange"
                                                      DstBlock
                                                                        "Out1"
         Threshold
                                                      DstPort
                                                                        1
                                                    }
       Block {
                       Outport *Outl*
                                                  }
         BlockType
                                                 }
         Name
                                                 Block {
         Position
                       [360, 78,
                                                   BlockType
                                                               SubSystem
390, 92]
                                                   Name
                                                                *dB Conv.-LF*
                                                             [1, 1, 0, 0, 0]
[325, 158, 350, 192]
         BackgroundColor
                             "cyan"
                                                   Ports
         Port
                                                   Position
                              "held"
         OutputWhenDisabled
                                                   BackgroundColor "darkGreen"
         InitialOutput
                            •[]•
                                                   DropShadow
                                                                    on
                                                   ShowPortLabels off
       Line {
                                                   System {
         SrcBlock
                          "Fcn"
                                                                  *dB Conv.-LF*
                                                    Name
         SrcPort
                          1
                                                     Location
                                                                   [152, 320,
         Points
                           [15, 0]
                                             618, 645]
         DstBlock
                           "Switch"
                                                     Open
                                                                  off
        DstPort
                                                     ModelBrowserVisibility off
                                                     ModelBrowserWidth 200
       Line {
                                                     ScreenColor
         SrcBlock
                          "Inl"
                                              "lightBlue"
         SrcPort
                           1
                                                     PaperOrientation
         Points
                           [10, 0]
                                              "landscape"
                                                    ape"
PaperPositionMode "auto"
PaperType "usletter"
"inches"
        Branch {
       Points
                    [0, -45; 195, 0]
       DstBlock
                     "Switch"
       DstPort
                     1
                                                     ZoomFactor
                                                                      *100*
        }
                                                     AutoZoom
                                                                      on
        Branch {
                                                     Block {
                                                                     Inport
                                                      BlockType
       DstBlock
   "Relational\nOperator"
                                                      Name
       DstPort
                                                      Position
                                                                       [25, 68, 55,
                                             82]
        Branch {
                                                      BackgroundColor
                                                                          "cyan"
       Points
                   [0, 110]
                                                      Port
```

```
PortWidth
                                                     Line {
                         --1-
                                                                  "Inl"
1
[10, 0]
        SampleTime
                                                       SrcBlock
                                                       SrcPort
         DataType
                          "auto"
                          "auto"
        SignalType
                                                      Points
         Interpolate
                          on
                                                      Branch {
                                                                  [0, -45; 195, 0]
                                                    Points
DstBlock
       Block {
                                                                  "Switch"
                             Constant
        BlockType
                                                    DstPort
                       "Constant1"
         Name
                                                      }
        Position
                          [100, 80,
                                                       Branch {
120, 1001
                                                     DstBlock
        BackgroundColor
                                                 "Relational\nOperator"
"darkGreen"
                                                    DstPort
       Value
                                                      }
                                                       Branch {
                                                                  [0, 110]
       Block {
                                                     Points
         BlockType
                             Fcn
                                                     DstBlock
                                                                   "Sum"
         Name
                       "Fcn"
                                                     DstPort
         Position
                        [185, 165,
                                                      }
245, 195]
         BackgroundColor
                             "yellow"
                                                     Line {
         Expr
                                                      SrcBlock
                                                                         "Constantl"
"20"log10(u/(3.1623"power(10,-6)))"
                                                       SrcPort
                                                      DstBlock
       Block {
                                              "Relational\nOperator"
        BlockType
                                                      DstPort
                                                                         2
RelationalOperator
         Name
                                                     Line {
"Relational\nOperator"
                                                       SrcBlock
                           [145, 67,
         Position
                                              "Relational\nOperator"
175, 98]
                                                      SrcPort
         BackgroundColor
                              "yellow"
                                                       Points
                                                                        [30, 0]
         Operator
                                                      Branch {
                                                     DstBlock
DstPort
                                                                   "Switch"
       Block {
                      Sum
"Sum"
         BlockType
                                                      }
         Name
                                                      Branch (
                      [2, 1, 0, 0, 0]
         Ports
                                                     Points
                                                                   [0, 50; -105, 0]
                                                     DstBlock
         Position
                          [120, 162,
                                                                   "Sum"
150. 1931
                                                     DstPort
         BackgroundColor
                              "green"
                                                      }
         IconShape
"rectangular"
                                                     Line {
         Inputs
                                                      SrcBlock
                                                                         "Sum"
         SaturateOnIntegerOverflow on
                                                       SrcPort
                                                                         1
                                                       DstBlock
                                                                         "Fcn"
       Block {
                                                      DstPort
         BlockType
                             Switch
         Name
                       "Switch"
                                                     Line {
         Position
                        [280, 70,
                                                       SrcBlock
                                                                         "Switch"
310, 1001
                                                       SrcPort
                                                                         1
         BackgroundColor
                              "orange"
                                                       DstBlock
                                                                         "Outl"
                              •1•
         Threshold
                                                       DstPort
                                                   }
                                                                         1
       Block {
                       Outport
         BlockType
         Name
                                                 Block {
         Position
                          [360, 78,
                                                   BlockType
                                                                Constant 
"effect"
390, 921
                                                   Name
         BackgroundColor
                              "cyan"
                                                   Position
                                                                 [370, 210, 390, 230]
         Port
                                                   BackgroundColor "red"
Value "6"
         OutputWhenDisabled
                               "held"
                                                   Value
         InitialOutput
                              •[]•
                                                 Block {
       Line {
                                                   BlockType
                                                                 Outport
         SrcBlock
                           "Fcn"
                                                   Mame
                                                                  "Out1"
         SrcPort
                                                   Position
                                                                 [1415, 88, 1445,
         Points
                          [15, 0]
                                              1021
         DstBlock
                           "Switch"
                                                   BackgroundColor "cyan"
         DstPort
                           3
                                                   Port
       }
                                                   OutputWhenDisabled "held"
```

```
InitialOutput *0*
   }
                                                        Branch {
   Line (
                                                          Points
                                                                             [0, -90]
                   "Inl"
     SrcBlock
                                                          DstBlock
                                                                             "Switch"
                    1
     SrcPort
                                                          DstPort
     Points
                    [5, 0]
                                                        }
     Branch {
                                                      }
       DstBlock
                          "Abs"
      DstPort
                      1
                                                    Line {
                                                      SrcBlock
                                                                     "Sum2"
     Branch (
                                                      SrcPort
                      [0, -80; 1145, 0]
       Points
                                                      Points
                                                                     [5, 0]
                          "Product3"
       DstBlock
                                                      DstBlock
                                                                     *Product2*
       DstPort
                                                      DstPort
     }
                                                    Line (
   Line {
                                                      SrcBlock
                                                                     "Math\nFunction"
     SrcBlock
                    "Abs"
                                                      SrcPort
     SrcPort
                                                      DstBlock
                                                                      "Product2"
                    [5, 0]
     Points
                                                      DstPort
     Branch (
       DstBlock
                          "FastMoving"
                                                    Line {
       DstPort
                      1
                                                      SrcBlock
                                                                      "Product2"
                                                      SrcPort
                                                                     1
     Branch {
                                                      DstBlock
                                                                      "Math\nFunction1"
       DstBlock
                          "SlowMoving"
                                                      DstPort
       DstPort
     }
                                                    Line {
                                                      SrcBlock
                                                                      "Math\nFunction1"
   Line {
                                                      SrcPort
                    "In5"
     SrcBlock
                                                      DstBlock
                                                                      *Product3*
     SrcPort
                                                      DstPort
                                                                     2
                     [20, 0]
     Points
     DstBlock
                     "Sum"
                                                    Line {
     DstPort
                                                      SrcBlock
                                                                      "Product3"
                                                      SrcPort
   Line (
                                                      DstBlock
                                                                      "Out1"
     SrcBlock
                     "Sum"
                                                      DstPort
     SrcPort
                     1
     DstBlock
                     *Product1*
                                                    Line {
     DstPort
                                                      SrcBlock
                                                                      "Product"
                                                      SrcPort
                                                                      1
   Line {
                                                      Points
                                                                      [25, 0]
                    "In3"
     SrcBlock
                                                      Branch (
     SrcPort
                                                        DstBlock
                                                                           "Switch"
                     [15, 0; 0, -65; 205,
     Points
                                                        DstPort
0; 0, 20]
     DstBlock
                     *Product1*
                                                      Branch (
     DstPort
                     1
                                                        Points
                                                                        [0, -10]
                                                        DstBlock
                                                                            "Switch"
   Line (
                                                        DstPort
     SrcBlock
                     "Sum1"
                                                      1
     SrcPort
                     1
     DstBlock
                     "Sum2"
                                                     Line {
     DstPort
                                                      SrcBlock
                                                                      "Switch"
                                                       SrcPort
   Line {
                                                      DstBlock
                                                                      "Math\nFunction"
                     *Constant*
     SrcBlock
                                                      DstPort
     SrcPort
     Points
                     [105, 0]
                                                    Line {
     Branch {
                                                      SrcBlock
                                                                      "In4"
       DstBlock
                          "Sum1"
                                                       SrcPort
       DstPort
                      1
                                                       Points
                                                                      [0, -40]
                                                      Branch {
     Branch {
                                                        DstBlock
                                                                           "Sum"
       Points
                       [0, -20; 130, 0]
                                                        DstPort
                                                                       1
       Branch {
         Points
                            [120, 0; 0,
                                                      Branch (
45]
                                                        Points
                                                                        [-20, 0]
                            "Sum2"
         DstBlock
                                                        DstBlock
                                                                           "Fcn"
         DstPort
                            2
                                                        DstPort
                                                                        1
```

```
}
                                                                      "Sum13"
                                                      SrcBlock
                                                      SrcPort
   Line {
                                                      DstBlock
                                                                      *Product13*
                    "Fcn"
     SrcBlock
                                                      DstPort
     SrcPort
    DstBlock
                    "Product"
                                                    Line {
    DstPort
                                                      SrcBlock
                                                                      *Product10*
                                                      SrcPort
   Line {
                                                      Points
                                                                      [10, 0]
     SrcBlock
                    *Product4*
                                                      DstBlock
                                                                      "Sum8"
     SrcPort
                    1
                                                      DstPort
                                                                      1
     Points
                    [5, 0]
     DstBlock
                    "Sum3 "
                                                    Line {
    DstPort
                                                      SrcBlock
                                                                      *Product14*
                                                      SrcPort
   Line {
                                                      Points
                                                                      [10, 0]
                    "Constantl"
     SrcBlock
                                                      DstBlock
                                                                      "Sum8 "
     SrcPort
                                                      DstPort
                                                                      2
     Points
                    [60. 0]
     DstBlock
                    "Product4"
                                                    Line {
     DstPort
                                                      SrcBlock
                                                                      "Sum12"
                                                      SrcPort
   Line {
                                                      Points
                                                                      [0, 0]
     SrcBlock
                    *Product1*
                                                      Branch {
     SrcPort
                                                        Points
                                                                        [0. 0]
     Points
                    [20, 0; 0, 30]
                                                        DstBlock
                                                                           "Product11"
     DstBlock
                    *Sum3 *
                                                        DstPort
     DstPort
                                                      Branch (
   Line {
                                                        Points
                                                                        [0, 45]
     SrcBlock
                    "Sum3 "
                                                        DstBlock
                                                                            "Sum14"
     SrcPort
                    1
                                                        DstPort
     Points
                    [0, -65; -60, 0]
                                                      }
     DstBlock
                    "Sum1"
     DstPort
                                                     Line {
                                                       SrcBlock
                                                                      "effect"
   Line {
                                                       SrcPort
     SrcBlock
                    "Logical\nOperator2"
                                                       Points
                                                                      [0, 0]
     SrcPort
                    1
                                                      Branch (
                    "Product14"
     DstBlock
                                                        DstBlock
                                                                            "Product12"
     DstPort
                                                        DstPort
                                                                        1
   Line {
                                                       Branch {
     SrcBlock
                                                        Points
                                                                        [0, 120]
"Relational\nOperator3"
                                                        DstBlock
                                                                            "Sum14"
     SrcPort
                                                        DstPort
                                                                        2
                    [5, 0]
     Points
     Branch {
       Points
                      [0, -70]
                                                     Line {
       DstBlock
                           "Product10"
                                                       SrcBlock
                                                                      "Sum14"
       DstPort
                                                       SrcPort
                                                                      1
                                                       DstBlock
                                                                      "Product13"
     Branch {
                                                       DstPort
       DstBlock
"Logical\nOperator2"
                                                     Line (
       DstPort
                                                       SrcBlock
                                                                      *Product13*
                                                       SrcPort
                                                                      1
                                                                      [0, -65; -40, 0]
                                                       Points
   Line {
                                                       DstBlock
                                                                      "Product14"
     SrcBlock
                    *Product11*
                                                       DstPort
                                                                      2
     SrcPort
                    1
     DstBlock
                    "Sum13"
                                                     Line {
     DstPort
                                                       SrcBlock
                                                                      "dB Conv"
                                                       SrcPort
   Line {
                                                       Points
                                                                      [45, 0; 0, 20; 40,
     SrcBlock
                    *Product12*
                                                 01
     SrcPort
                    1
                                                       Branch {
     DstBlock
                    "Sum13"
                                                        Points
                                                                        [0, -25]
     DstPort
                                                        DstBlock
                                                                            "Product10"
                                                        DstPort
   Line {
```

```
Branch {
                                                   Points
                                                                [10, 0]
                 [5, 0]
       Points
                                                   Branch {
       Branch (
                                                    DstBlock
                                                                      "Fcnl"
       Points
                         [-10, 0; 0,
                                                    DstPort
135]
       Branch {
                                                   Branch (
                     "Sum12"
       DstBlock
                                                                   [0, 35; -40, 0; 0,
                                                    Points
       DstPort
                                              1701
        }
                                                     DstBlock
                                                                       "Product4"
        Branch {
                                                    DstPort
                                                                   1
       DstBlock
                                                   }
                     *Product12*
       DstPort
                                                 }
        }
       Branch {
                                                  Line {
        Points
                          [50, 0]
                                                   SrcBlock
                                                                     "Subsystem"
        DstBlock
                                                   SrcPort
"Relational\nOperator3"
                                                   DstBlock
        DstPort
                                              "homomorphic\nmultiplicative AGC1"
       }
                                                  DstPort
     }
                                                 Line (
   Line {
                                                   SrcBlock
                                                                     "NHT1"
     SrcBlock
                   "dB Conv.-LF"
                                                   SrcPort
     SrcPort
                                                   Points
                                                                     [50, 0]
                   [0, 5; 35, 0; 0, -
     Points
                                                   DstBlock
15; 100, 0]
                                              "homomorphic\nmultiplicative AGC1"
     Branch {
                                                   DstPort
       Points
                    [0, 0]
       DstBlock
                                                 Line {
"Relational\nOperator3"
                                                    SrcBlock
                                                                     "UCL1"
                                                    SrcPort
      DstPort
                                                   Points
                                                                     [0, -10]
     Branch {
                                                   DstBlock
       Points
                                              "homomorphic\nmultiplicative AGC1"
                     [0, 65]
       Branch {
                                                   DstPort
        Points
                          [-85, 0; 0,
55]
                                                  Line {
        DstBlock
                           "Sum12"
                                                   SrcBlock
                                                                     "HL1"
        DstPort
                                                    SrcPort
                                                   Points
                                                                     [10, 0: 0, -25]
       Branch {
                                                   DstBlock
         DstBlock
                           "Product11"
                                              "homomorphic\nmultiplicative AGC1"
         DstPort
                                                   DstPort
     }
                                                  Line (
                                                  SrcBlock
                                                                     "Subsystem"
    Line {
                                                    SrcPort
                    "FastMoving"
     SrcBlock
                                                   Points
                                                                     [0, -5]
     SrcPort
                                                   DstBlock
     Points
                    [5, 0]
                                               "homomorphic\nmultiplicative AGC2"
     DstBlock
                    *dB Conv*
                                                  DstPort
     DstPort
                                                 Line {
    Line {
                                                    SrcBlock
                                                                      "NHT2 "
     SrcBlock
                    "SlowMoving"
                                                    SrcPort
     SrcPort
                    1
                                                   DstBlock
     Points
                    [5, 0]
                                              "homomorphic\nmultiplicative AGC2"
     DstBlock
                    "dB Conv.-LF"
                                                  DstPort
     DstPort
                                                 Line {
    Line {
                                                    SrcBlock
                                                                     *HL2*
     SrcBlock
                    "Fcn1"
                                                    SrcPort
                                                                     1
     SrcPort
                                                   Points
                                                                      [10, 0; 0, -30]
     Points
                    [25, 0; 0, -45]
                                                   DstBlock
     DstBlock
                    "Product"
                                               "homomorphic\nmultiplicative AGC2"
     DstPort
                                                   DstPort
    Line {
                                                  Line {
     SrcBlock
                    "Sum8"
                                                    SrcBlock
                                                                      "UCL2"
     SrcPort
                                                    SrcPort
                                                                      1
```

```
Points
                       [0, -15]
                                                     DstBlock
     DstBlock
                                               "homomorphic\nmultiplicative AGC5"
"homomorphic\nmultiplicative AGC2"
                                                   DstPort
     DstPort
                                                   Line {
                                                    SrcBlock
                                                                       "HL5"
   Line {
     SrcBlock
                       "Subsystem"
                                                     SrcPort
     SrcPort
                                                     Points
                                                                       [0, -30]
     Points
                        [0, -5]
                                                    DstBlock
     DstBlock
                                               "homomorphic\nmultiplicative AGC5"
"homomorphic\nmultiplicative AGC3"
                                                    DstPort
     DstPort
                                                   Line {
   Line {
                                                     SrcBlock
                                                                       *NHT5 *
     SrcBlock
                       *HL3*
                                                     SrcPort
     SrcPort
                                                     DstBlock
                       [10, 0; 0, -30]
     Points
                                               "homomorphic\nmultiplicative AGC5"
     DstBlock
                                                    DstPort
"homomorphic\nmultiplicative AGC3"
     DstPort
                                                   Line {
                                                     SrcBlock
                                                                       *UCL5 *
    Line (
                                                     SrcPort
                       "UCL3"
      SrcBlock
                                                     Points
                                                                       [0, -15]
      SrcPort
                                                    DstBlock
      Points
                       [0, -15]
                                               "homomorphic\nmultiplicative AGC5"
     DstBlock
                                                    DstPort
"homomorphic\nmultiplicative AGC3"
     DstPort 3
                                                   Line (
                                                     SrcBlock
                                                                       "Subsystem"
    Line {
                                                     SrcPort
     SrcBlock
                        "NHT3 "
                                                     Points
                                                                       [0, -5]
      SrcPort
                                                     DstBlock
     DstBlock
                                               "homomorphic\nmultiplicative AGC6"
"homomorphic\nmultiplicative AGC3"
                                                     DstPort
      DstPort
                                                   Line (
    Line {
                                                                       "HL6"
                                                     SrcBlock
      SrcBlock
                       "Subsystem"
                                                     SrcPort
      SrcPort
                                                     Points
                                                                       [0, -30]
      Points
                       [0, -5]
                                                     DstBlock
     DstBlock
                                                "homomorphic\nmultiplicative AGC6"
"homomorphic\nmultiplicative AGC4"
                                                     DstPort
     DstPort
                                                   Line {
    Line (
                                                     SrcBlock
                                                                       "UCL6"
      SrcBlock
                       "HL4"
                                                     SrcPort
      SrcPort
                                                     Points
      Points
                        [10, 0; 0, -30]
                                                     DstBlock
      DstBlock
                                                "homomorphic\nmultiplicative AGC6"
"homomorphic\nmultiplicative AGC4"
                                                   DstPort
     DstPort
                                                   Line {
    Line (
                                                     SrcBlock
                                                                        "NHT6"
      SrcBlock
                        "UCL4"
                                                     SrcPort
      SrcPort
                                                     DstBlock
      Points
                        [0, -15]
                                                "homomorphic\nmultiplicative AGC6"
     DstBlock
                                                    DstPort
"homomorphic\nmultiplicative AGC4"
    DstPort
                                                   Line {
                                                     SrcBlock
                                                                        "Subsystem"
    Line [
                                                     SrcPort
      SrcBlock
                        "NHT4"
                                                     Points
                                                                       [0, -5]
      SrcPort
                                                     DstBlock
      DstBlock
                                                "homomorphic\nmultiplicative AGC7"
"homomorphic\nmultiplicative AGC4"
                                                     DstPort
     DstPort
                                                   Line {
    Line {
                                                     SrcBlock
                                                                       "HL7"
      SrcBlock
                        "Subsystem"
                                                     SrcPort
                                                                       Ī
      SrcPort
                                                     Points
                                                                       [0, -30]
      Points
                        [0, -5]
```

```
DstBlock
                                                      DstBlock
                                                                         "Sum"
"homomorphic\nmultiplicative AGC7"
                                                      DstPort
     DstPort
                                                    Line {
   Line {
                                                      SrcBlock
     SrcBlock
                        "NHT7"
                                                "homomorphic\nmultiplicative AGC4"
     SrcPort
                                                      SrcPort
                                                                        1
     DstBlock
                                                                        [125, 0; 0, 70]
                                                      Points
"homomorphic\nmultiplicative AGC7"
                                                      DstBlock
                                                                        "Sum"
     DstPort
                        4
                                                      DstPort
   Line {
                                                    Line {
                        "UCL7"
     SrcBlock
                                                      SrcBlock
     SrcPort
                                                "homomorphic\nmultiplicative AGC6"
     Points
                       [5, 0; 0, -15]
                                                      SrcPort
                                                                    1
     DstBlock
                                                                         [140, 0; 0, -70]
                                                      Points
"homomorphic\nmultiplicative AGC7"
                                                      DstBlock
                                                                         "Sum"
     DstPort
                                                      DstPort
   Line {
                                                    Line {
     SrcBlock
                        *Subsystem*
                                                      SrcBlock
     SrcPort
                                                "homomorphic\nmultiplicative AGC7"
     Points
                        [0, -5]
                                                      SrcPort 1
     DstBlock
                                                      Points
                                                                         [155, 0; 0, -
"homomorphic\nmultiplicative AGC8"
                                                140]
     DstPort
                                                      DstBlock
                                                                         "Sum"
                                                      DstPort
   Line {
     SrcBlock
                        "HL8"
                                                    Line {
     SrcPort
                                                      SrcBlock
     Points
                        [0, -30]
                                                "homomorphic\nmultiplicative AGC8"
     DstBlock
                                                      SrcPort
"homomorphic\nmultiplicative AGC8"
                                                      Points
                                                                         [180, 0]
     DstPort
                                                      DstBlock
                                                                         "Sum"
    }
                                                      DstPort
   Line {
     SrcBlock
                        "NHT8"
                                                    Line {
      SrcPort
                                                      SrcBlock
                                                                         "Sum"
     DstBlock
                                                      SrcPort
"homomorphic\nmultiplicative AGC8"
                                                      DstBlock
                                                                         "Output signal"
     DstPort
                        4
                                                      DstPort
   Line {
                                                    Line {
                        "UCL8"
      SrcBlock
                                                      SrcBlock
      SrcPort
                                                 "homomorphic\nmultiplicative AGC5"
      Points
                        [5, 0; 0, -15]
                                                      SrcPort
                                                                        1
     DstBlock
                                                      DstBlock
                                                                         "Sum"
"homomorphic\nmultiplicative AGC8"
                                                      DstPort
     DstPort
                                                    Line {
   Line {
                                                      SrcBlock
                                                                         "Sound
     SrcBlock
                                                Signal\nfrom\nWorkspace*
"homomorphic\nmultiplicative AGC1"
                                                      SrcPort
     SrcPort
                  1
                                                      DstBlock
                                                                         "Subsystem"
      Points
                        [160, 0; 0, 275]
                                                      DstPort
      DstBlock
                        "Sum"
     DstPort
                        1
                                                    Annotation {
                                                      Position
                                                                         [736, 56]
   Line {
                                                      ForegroundColor
                                                                             "white"
      SrcBlock
                                                      BackgroundColor
                                                                             "red"
"homomorphic\nmultiplicative AGC2"
                                                      Text
      SrcPort
                                                "HOMOMORPHIC\nMULTIPLICATIVE\nAGC\nHEARIN
                       1
      Points
                        [150, 0; 0, 210]
                                                G AID\n"
      DstBlock
                        "Sum"
                                                 "SIMULATOR"
     DstPort
                        2
                                                      FontSize
                                                                         14
                                                      FontWeight
                                                                         "bold"
   Line {
                                                      FontAngle
                                                                             "italic"
     SrcBlock
"homomorphic\nmultiplicative AGC3"
                                                  ł
     SrcPort
                                                }
      Points
                        [140, 0; 0, 140]
```

## **VITA AUCTORIS**

NAME: Erkan Onat

PLACE OF BIRTH Izmir, Turkey

YEAR OF BIRTH 1975

EDUCATION Istanbul Anadolu High School, Istanbul, Turkey

1986-1993

Istanbul Technical University, Istanbul, Turkey 1993-1995 Transfered to Bogazici University

Bogazici University, Istanbul, Turkey 1995-1998 B.Sc. in Electrical Engineering

University of Windsor, Windsor, Ontario 1998-2001 M.A.Sc. in Electrical Engineering