CONSTRUCTION OF AN AUTOMATIC DATA COLLECTING SYSTEM

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1. Introduction

In order to carry out the investigation described in the previous paper "Some Remarks on Acoustic Parameter in Speech Disorders" it is necessary to collect a great amount of data. Since the measurements evidently cannot be carried out manually with sufficient speed, the need for some automatic data collecting equipment arose.

As the development went on, it became clear that the system had to be generally applicable in order to comply with a wish for a "general-purpose" automatic data collecting system.

The system now consists of a basic general-purpose unit, to which are added module units designed for the above-mentioned investigation. Furthermore, there is a possibility of adding units for special investigations.

The system at its present stage is shown in the block-diagram (Fig. 1). The general-purpose system consists of the blocks fully drawn. The blocks drawn with dotted lines show the special units developed for the acoustic analyses of speech disorders.

2. The general-purpose system

2.1. Multiplexer, A/D-converter and tape-puncher

The general-purpose system is constructed around a multiplexer, an analog/digital converter and a tape puncher.

The multiplexer is manufactured by Analogic (type MUXPAC MP 4108) with 8 single or 4 differential inputs and a settling time of max. 5 µsec.

BLOCK-DIAGRAM.

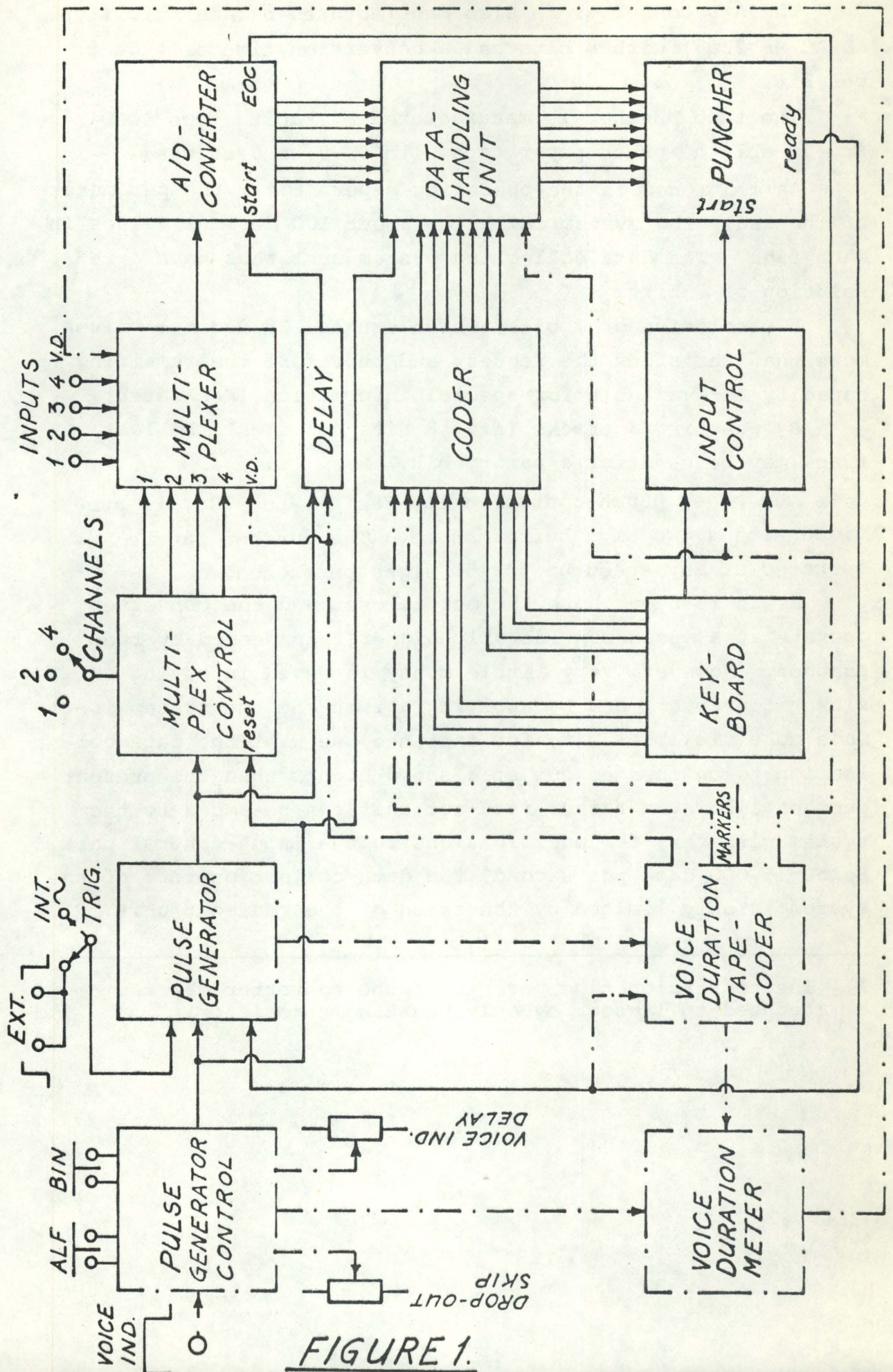

FIGURE 1.

The A/D-converter is also manufactured by Analogic (type ADPAC MP 2208) with 8 bits and a conversion time of 4 μsec. per bit.

The tape puncher is manufactured by Facit (type 4060) and is able to punch paper tape with 6, 7 or 8 tracks.

As mentioned in the preceding paper (6.4.) the parameters of the analyzing system calls for about 100 decimal values in each sign. The data collecting system must thus have a resolution of 7 bits.

A resolution of 7 bits, which equals 128 decimal values, more than satisfies the request and therefore the remaining capacity is available for special information (see later).

By punching 8 tracks (i.e. 8 bits per sign) the last track may be used for a parity bit.

The paper punch control unit, Facit type 5106, is provided with a two-sign buffer store. The puncher can be operated at any speed up to 150 signs per second.

As it is seen, both the multiplexer and the converter operate at a speed considerably higher than needed by the puncher. However, very little money is saved in buying a slower converter, and by applying a fast one the system is made more flexible. If, for instance, we want the data collection to be carried out at a speed higher than the present puncher allows, a faster read-out unit can be added to the system with very few modifications to the input-control unit. Below 75,000 data per second[1] the data collection rate of the system is only limited by the speed of the read-out unit.

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1) The conversion time per bit of the converter may be reduced to 1 μsec. by only shunting a resistor.

2.2. Keyboard and coder

When dealing with different kinds of data, it is useful to be able to put comments to the different data sets. To this end the system has been provided with a keyboard. From here it is possible to put the normally used alphanumerical signs on the tape.

The keyboard is combined with a coder which transforms the signs into a seven-bit code. With reference to the computer[2] which is to be used for the data processing an ASCII code has been chosen.

Furthermore the keyboard acts as a control panel. By means of the keys "ALF" and "BIN" it is decided whether the data-handling unit shall allow the alphanumerical data from the keyboard or the binary data from the A/D-converter to be fed to the puncher.

2.3. Data-handling unit

Besides transferring the signals from keyboard and converter to the puncher, the data-handling unit acts as a generator of special signs and parity bits.

Only data having values between 1 and 119 are passed directly from the A/D-converter. If the value is 0 or negative the data-handling unit will generate a sign of "underflow". Similarly, if the value is greater than 119 a sign of "overflow" will be generated.

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2) A Digital Equipment computer type PDP8/e with an 8 K central processing unit will be installed at the laboratory during the autumn 1972.

In order to facilitate the software work, the area between 120 and 127 is reserved for special signs. In addition to "underflow" and "overflow", the signs "ALF" and "BIN" and the later explained "voice duration boundary markers" are placed here.

As mentioned above a parity generator adds an eighth bit to the data before it is transferred to the puncher. Odd or even parity can be chosen at discretion.

2.4. Additional units

The general-purpose function of the remaining units is quite trivial.

When the pulse generator control is set to binary-mode (automatic data collection), the pulse generator generates a pulse for every positive or negative triggering edge applied to the "EXT. TRIG." input. This pulse is generated on condition that a "ready"-signal has been received from the puncher. This happens when the average frequency of every 3 triggerings does not exceed 150 per second.

The output from the pulse generator is fed to the multiplex control, which chooses among the multiplexer inputs which one should be fed through. The possibilities are: input 1 alone, input 1 and 2 alternately, and input 1, 2, 3 and 4 successively. The "RESET" input of the multiplex control ensures that input 1 is always the first one to be activated when the measuring-mode has been started.

The output of the pulse generator also starts the A/D-converter. This is done via a delay corresponding to the settling time of the multiplexer. When the conversion has been performed an EOC (end of conversion) signal is sent to the input control, which starts the puncher.

3. The special-purpose system

3.1. Pulse generator control

In the special-purpose mode the pulse generator control is managed by a "voice-indicator", in fact a voltage which is a logical "1" for voiced segments and a "0" for voiceless segments. This management means that the pulse generator is running only when the voice indicator is a logical "1".

In order to avoid that short drop-outs in the voice indicator may interrupt the pulse generator, the pulse generator control is provided with a "drop-out skip" facility. Such drop-outs in the voicing may be caused by articulatory reasons as for instance a rolled "r" or a flapped "d". The maximum duration of the drop-outs to be skipped is adjustable in the range 5-50 msec.

As it is of no interest to make measurements in the beginning of a voiced segment, e.g. during a voiced stop consonant, the onset of the pulse generator is delayed. The delay is adjustable.

3.2. Pulse generator

The internal triggering of the pulse generator is operated from the mains supply (50 Hz). In order to make nearly synchronous measurements of fundamental frequency (channel 1) and intensity (channel 2), two pulses for the multiplex control are generated for every triggering. The duration of every pulse is 300 µsec. and the interval between them 150 µsec. It is impossible to make more than two nearly synchronous measurements at a time, as the average frequency of every three triggerings of the puncher must not exceed 150 per second.

Figure 2 shows how the sampling of the inputs is organized in the mode of 1, 2 or 4 sampled channels.

SAMPLING OF INPUTS.

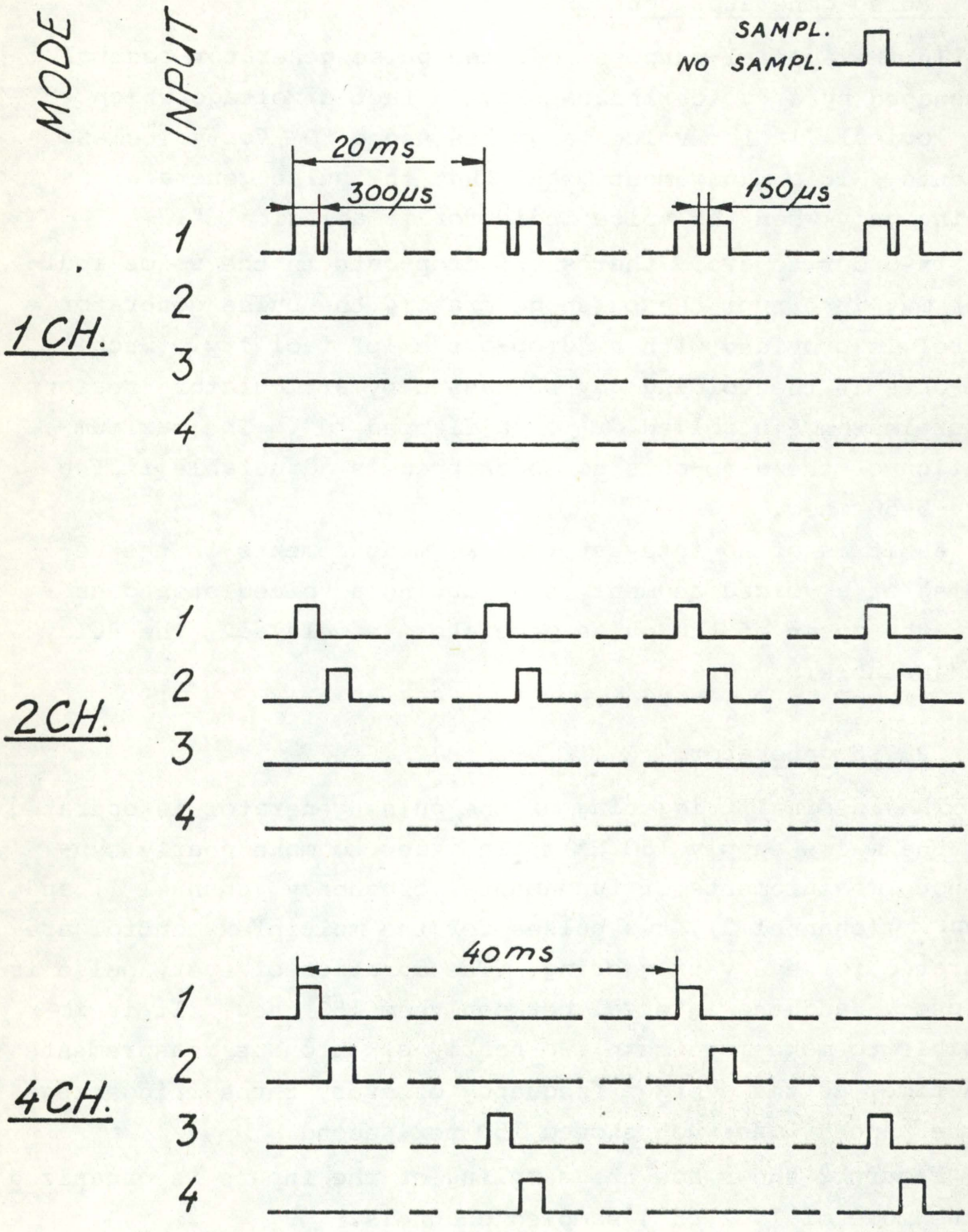

FIGURE 2.

3.3. Voice duration meter

As length of phonation is a significant parameter of the present investigation, special circuitry has been constructed to measure and read out this quantity.

The voice duration meter contains a controlled integrator charged by a step voltage synchronized with the voice indicator. So the output is a voltage proportional to the length of phonation. The integrator is started when phonation starts and is reset when a signal from the voice duration tape-coder indicates that the output has been read out. The signal is fed through a fifth channel of the multiplexer controlled by the voice duration tape-coder.

3.4. Voice duration tape-coder

Since voice duration data by itself in no way differ from other data on the tape, it is necessary to mark them in some way. This is done by the voice duration tape-coder, which puts a "boundary marker" in front of and behind the measurement. The boundary markers are special, easily recognizable signs placed in the area between 120 and 127 as previously mentioned.

The voice duration tape-coder is controlled by an "end of voicing"-detector. When the pulse generator has been idle for a period slightly longer than 20 msec. the detector causes the first boundary marker to be generated. The boundary marker is followed by a signal permitting the output of the voice duration meter to pass the fifth channel of the multiplexer (V.D. in the block-diagram), and then the generator of the second boundary marker is triggered by the next ready-signal from the puncher.

As a part of the procedure the data-handling unit and the input control are of course manipulated to select the proper inputs.

This pretty troublesome procedure is necessitated by the wish for a fast read-out routine in conjunction with the demand of ensuring that both data and markers are accepted by the puncher.

Acknowledgement

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