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DUAL DETECTION SYSTEM FOR AIMP PFM DATA PROCESSING

by Thomas J. Karras

Goddard Space Flight Center
Greenbelt, Md.

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ABSTRACT

A dual detection system, used at present to process PFM telemetry data for satellites AIMP D and E at GSFC, has proved superior to a single threshold detection system. The dual system consists of: (1) threshold detection of 128 individual filters during buildup, when the filters are excited with a PFM burst, and (2) "auction detection," i.e., one filter (out of 128) which contains the largest amplitude near the end of the filter buildup. The threshold method is used only for system synchronization; the auction method is used only for data recovery. Auction and threshold detection use the same bank of filters. The theoretical gain offered by the auction method is 2 db. The actual gain measured in the laboratory was 1 to 2 db for low to high signal-to-noise ratios, respectively. The practical gain on real data tapes is greater than 2 db because of the 26-db dynamic range of the auction method in handling the burst-to-burst amplitude fluctuations and the nonstationary time-variant real-signal case. The auction method can tolerate 7.6 db more burst-to-burst amplitude modulation than can the old threshold method when used for data recovery. Also, the content of the data at times aggravates the threshold detection process within the comb filter, resulting in missing data; this aggravation (caused by inter-burst distortion) is not as severe for the auction technique. Up to 10 percent more data recovery on actual AIMP satellite tapes is being achieved; diminution up to one half in rms error in the experimenters analog data is expected. Test results on reprocessed telemetry data have shown a definite improvement in data recovery and resolution.

The incoming signal-to-noise threshold of the system has not been lowered, because line synchronization has remained unchanged.

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INTRODUCTION

A modification has recently been incorporated in the universal F-8 PFM* telemetry data-processing line (located in the Information Processing Division) and has been implemented for the 5- to 15-kc PFM data band, which is primarily used for satellites AIMP† D and E. This new method provides a dual detection system, with one system used for synchronization and one for data recovery; thus improving data-processing at small cost and, with slight line modification. The old technique is threshold detecting the 128 individual filter outputs. This method uses a fixed-threshold technique: the first filter whose output amplitude exceeds this threshold is generally used for data recovery and system synchronization. The modification is to add to the existing equipment an "auction detection" system, for data recovery only, while maintaining the old threshold detection system to obtain line synchronization. In auction detection, the amplitude of all the 128 filters is sampled at a prescribed instant for each incoming data burst; the filter that then contains the greatest energy is selected and presented to the output.

The auction circuit eliminates missing data points under severe amplitude modulation and, at the same time, improves the resolution of data, particularly by improving the crossover detection region from one card to the next. The dynamic range (including an input "soft" limiter) of the threshold detection system for burst-to-burst amplitude modulation is 18.4 db; that of the auction system is set at present, after thorough testing, at 26 db (although 36 db are available). A 7.6-db extension in the dynamic range has been provided, to tolerate more burst-to-burst amplitude modulation. Also, the crossover region for the threshold detection system is approximately ±10 cps, while that of the auction circuit is ±1 cps; this improves the resolution of acquired data. Also, the content in satellite data sometimes aggravates threshold detection within the "comb filter" (see below), especially in analog channels. The auction technique is not aggravated as much unless signal conditions are very poor.

*Pulse Frequency Modulation.

†Anchored Interplanetary Monitoring Platform.

THRESHOLD DETECTION SYSTEM

PFM data processing for low-resolution data is performed at GSFC with a bank of 128 contiguous filter elements called a "comb filter." Each filter element is a single-pole bandpass crystal filter with a 3-db bandwidth of 50* cps. Each filter is separated in center frequency by 100 cps. The nominal input frequency for analog data can be from 5 to 15 kc. The incoming 10-kc data band is resolved to only 1 of 100 possibilities, or provides 1-percent resolution. The total information band covered by the 128 filters is 3.6 to 16.3 kc or 12.7 kc. The incoming frequency is converted to 253.6—266.3 kc by a 250-kc local oscillator (Figure 1).

The incoming data burst (10 milliseconds for AIMP D and E processed at a 16-times speedup rate) causes the appropriate filter to respond. Each filter is followed by a Schmitt Trigger set at 60 percent of the maximum value of the filter-detected envelope. When one Schmitt Trigger has been turned on, the thresholds of 127 others are raised. When the original envelope that turned on the first Schmitt Trigger drops to 40 percent of its maximum value, all thresholds will again be at their 60 percent value. Hence, a 1- to 0.6-volt change or 4.4-db burst-to-burst amplitude variation out of the filter element would cause a missing data point at the output. A slow-acting AGC (1 frame or 32 data burst time constant) in the comb filter takes care of long-term amplitude variations. A

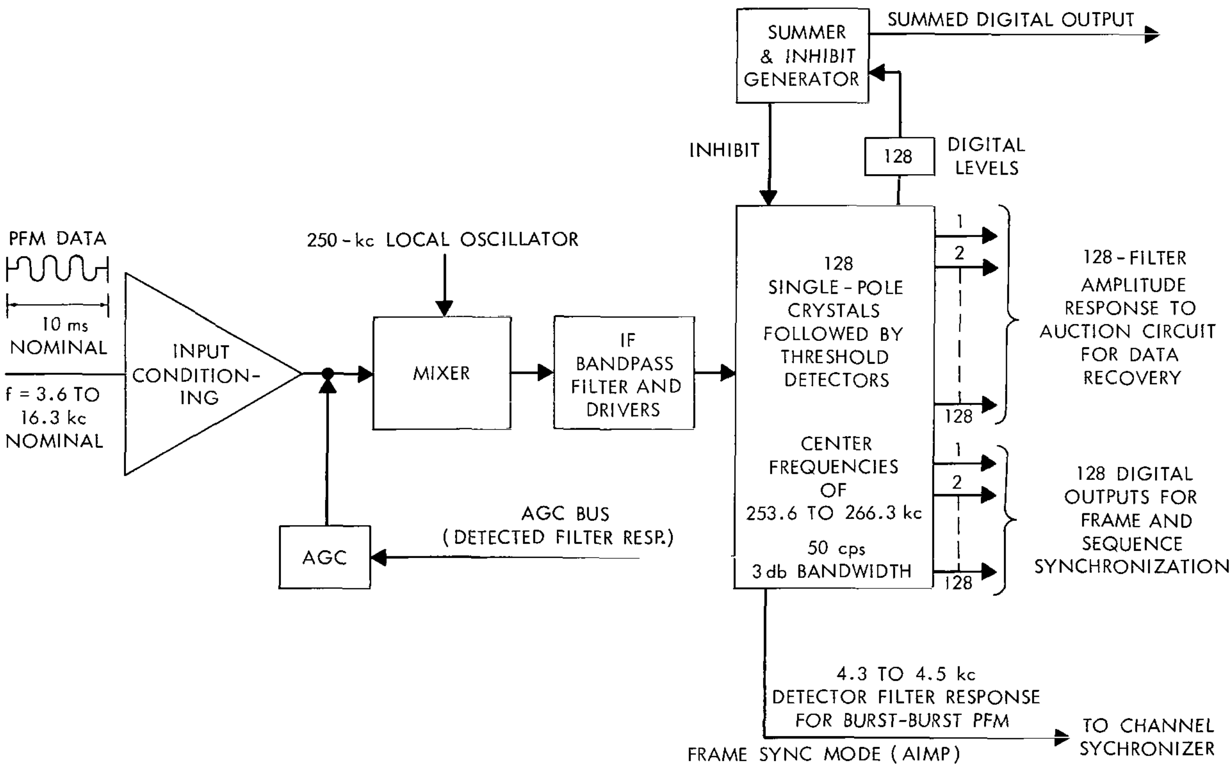

Figure 1—Comb-filter threshold detection system, block diagram.

*Only for the AIMP D and E F-8 PFM Data Processing Line.

"soft" limiter prior to preceding the comb filter was needed to cope with short-term amplitude modulation variations as found in the AIMP D. The optimum limiting ratio found from laboratory testing was 5/1, meaning that a 5-volt input signal results in a 1-volt output, a 3-volt input results in a 1-volt output, etc., and signals under 1 volt are passed through unchanged. Test results with the limiter indicate only 1/2-db degradation near the system threshold, with a slight improvement in detection probability at signal-to-noise ratios near the knee of the data-recovery curve and no degradation at high signal-to-noise ratios. This "soft" limiter improved the short-term amplitude variations from burst-to-burst by 14 db for the threshold detection system, allowing a total of 18.4 db burst-to-burst amplitude modulation at high signal-to-noise ratios before missing a data point.

Because of severe amplitude modulation, other undesirable events occur in the threshold detection system besides missing data. The Schmitt Trigger hysteresis required for proper threshold detection operation generates a region of ±10 cps around the 3-db crossover points, whereby either filter detector can respond and the output data point be in error by 1 percent. Also, interburst distortion exists for analog data near the beginning and end of each data burst, when the burst-to-burst frequencies are nearly the same; the filter transient response is cancelled or reinforced depending on the phase-relationship of each data burst (a characteristic of noncoherent PFM). Interburst distortion aggravates both the AGC and threshold detection systems.

The threshold detection system lends itself to processing and synchronizing on digital frequencies for obtaining frame and sequence information. The 16 digital frequencies are spaced four filter elements apart so that groups of three threshold outputs can be selected for reliable system synchronization. This portion of the threshold detection system was retained in the dual threshold detection system for synchronization. The auction detection system described in the next section is used for data recovery.

AUCTION DETECTION SYSTEM

The auction detection system uses greatest-of-detection circuitry for data recovery. The inputs to the system are the 128 individual filter transient responses from the threshold detection comb filter. Figure 2 is a schematic of an individual auction detection unit consisting of an input buffer, amplifier, buffered envelope detector, auction transistor, and level matcher. There are five such circuits per card. The system was designed to be installed in Computer Control Company S-Pac drawers.

The nominal input from the comb filter is a 4-volt peak-to-peak signal. An amplifier adjustment on each circuit gives a plus-5-volt envelope-detected response at TP1 on each card for alignment purposes. When the system is ready for auctioning, an auction strobe is supplied to all 128 auction transistors Q5 (2N708). The largest signal appearing at the emitter of Q5 will back-bias all other transistors Q5; this transistor will turn on; its output pulse is used later for data recovery.

Figure 3 is a schematic of the auction sample-and-threshold circuit, consisting of a delayed multivibrator, a threshold adjustment, and a constant-current generator that supplies current to all 128 transistors. A satisfactory threshold adjustment is for a 4-to-1 change in the individual

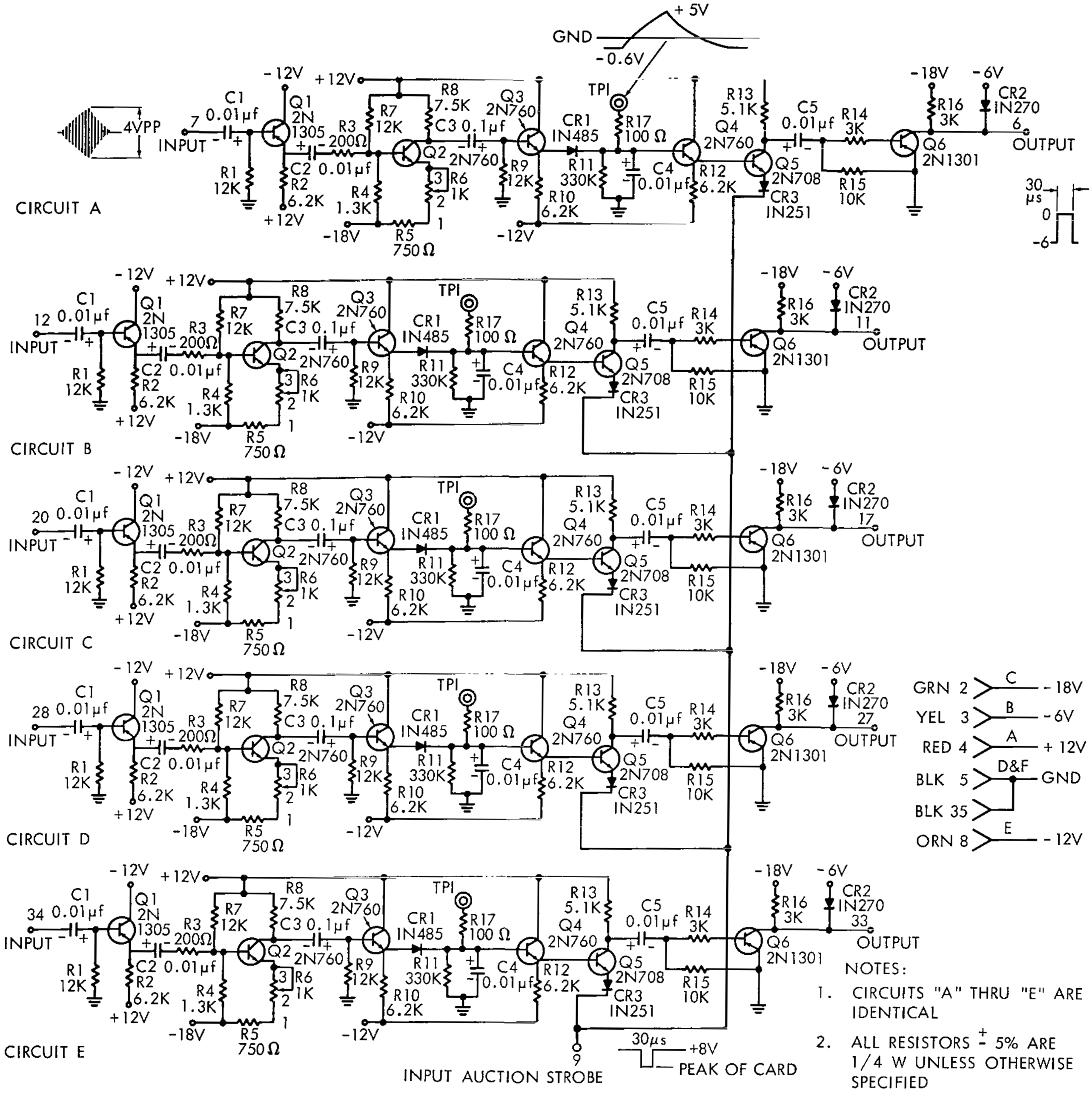

Figure 2—Auction circuit F-8, line schematic.

input filter signals to cause a missing data point. (Raising the threshold causes too many missing data points; lowering it causes errors in the data when the amplitude modulation is severe.)

Figure 4 is a block diagram of the individual auction detection system with all analog card positions and pin assignments.

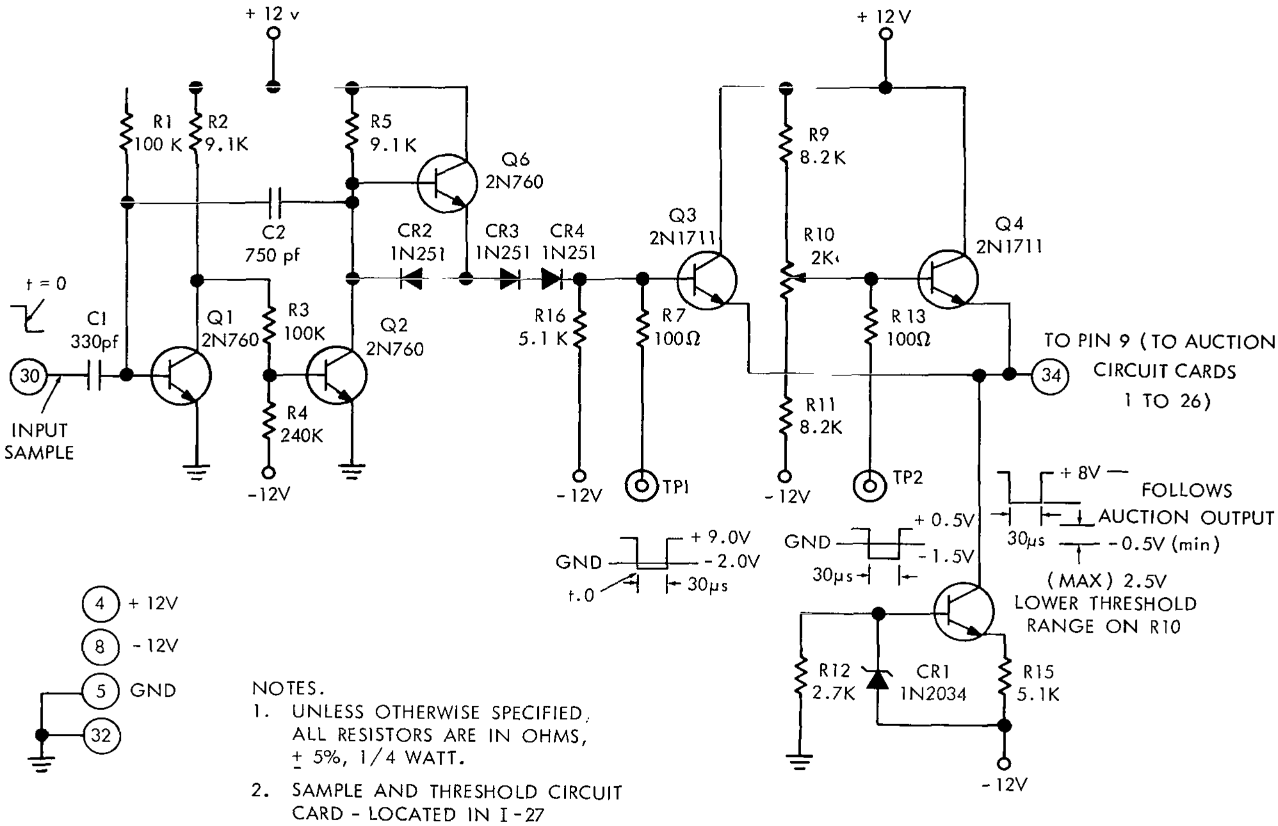

Figure 3—F-8 auction sample-and-threshold circuit, schematic.

DUAL DETECTION SYSTEM

Figure 5 is a block diagram of the auction detection system interfaced with the Interstate Comb Filter (Threshold Detection System) used in the F-8 PFM data-processing line for AIMP D and E. The 128 outputs of the auction unit are used for data recovery, while the 128 outputs of the comb filter are for system synchronization. Input-signal conditioning consists of eliminating 60 cps with a high-pass filter and restoring about ground the PFM data that precede the "soft" limiter.

The comb filter used for AIMP D and E data-processing in the F-8 line has a 50 cps 3-db bandwidth; this bandwidth is optimum for burst-burst data with auction detection for data recovery.* Figure 6 represents a typical filter-envelope transient response when excited with a 10-ms data burst. Both the threshold detection and auction detection outputs are shown with respect to their system strobes. The optimum system-synchronization strobing found by testing occurs 0.7 ms after the end of the input-data burst. The optimum data recovery strobe for the auction detection system found by testing occurs 2.0 ms before the end of the input data burst for a wide range of

*New York University Technical Memorandum No. 29, March 10, 1963, and No. 32, June 1, 1963 under Contract NAS5-3106.

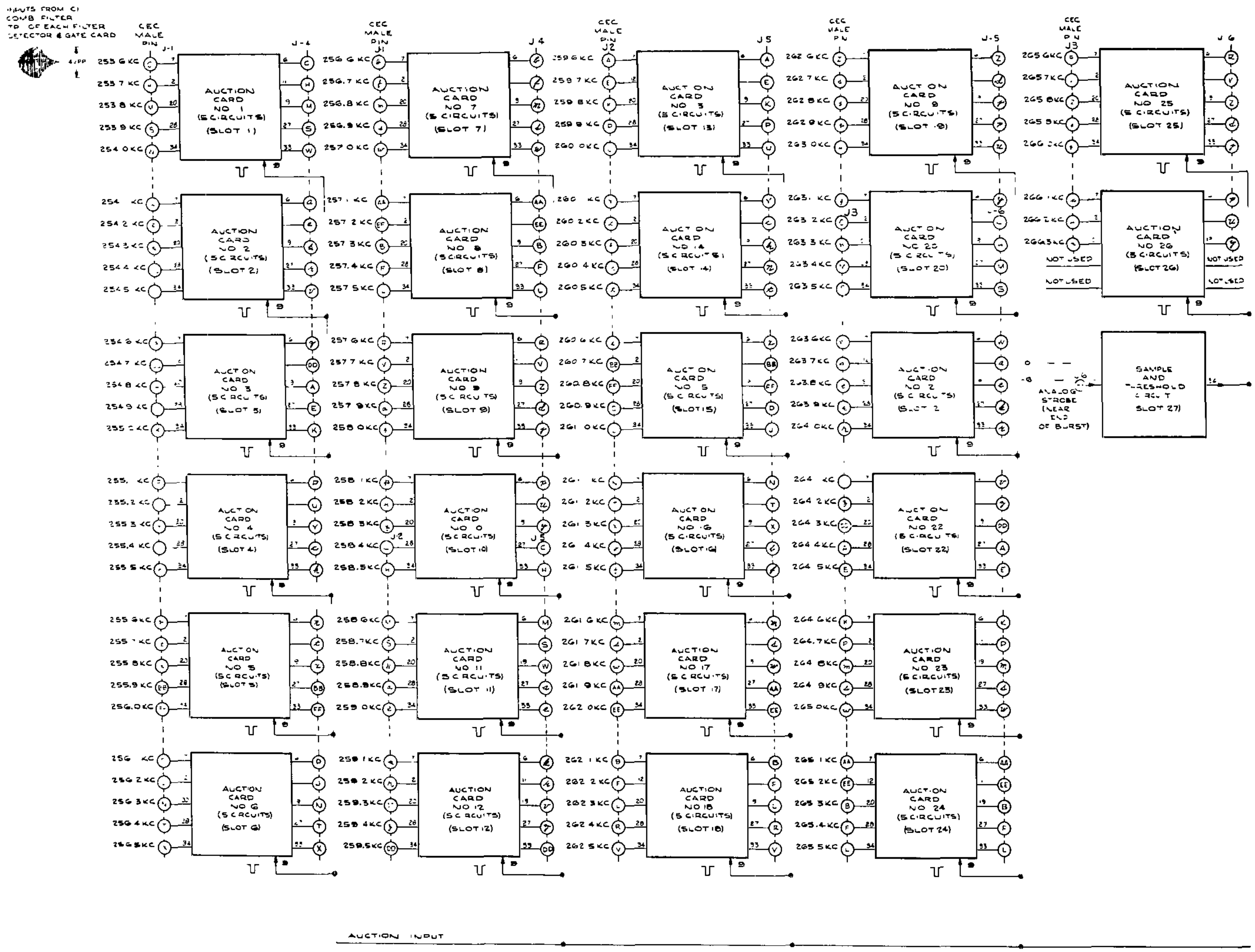

Figure 4—F-8 auction circuit, block diagram.

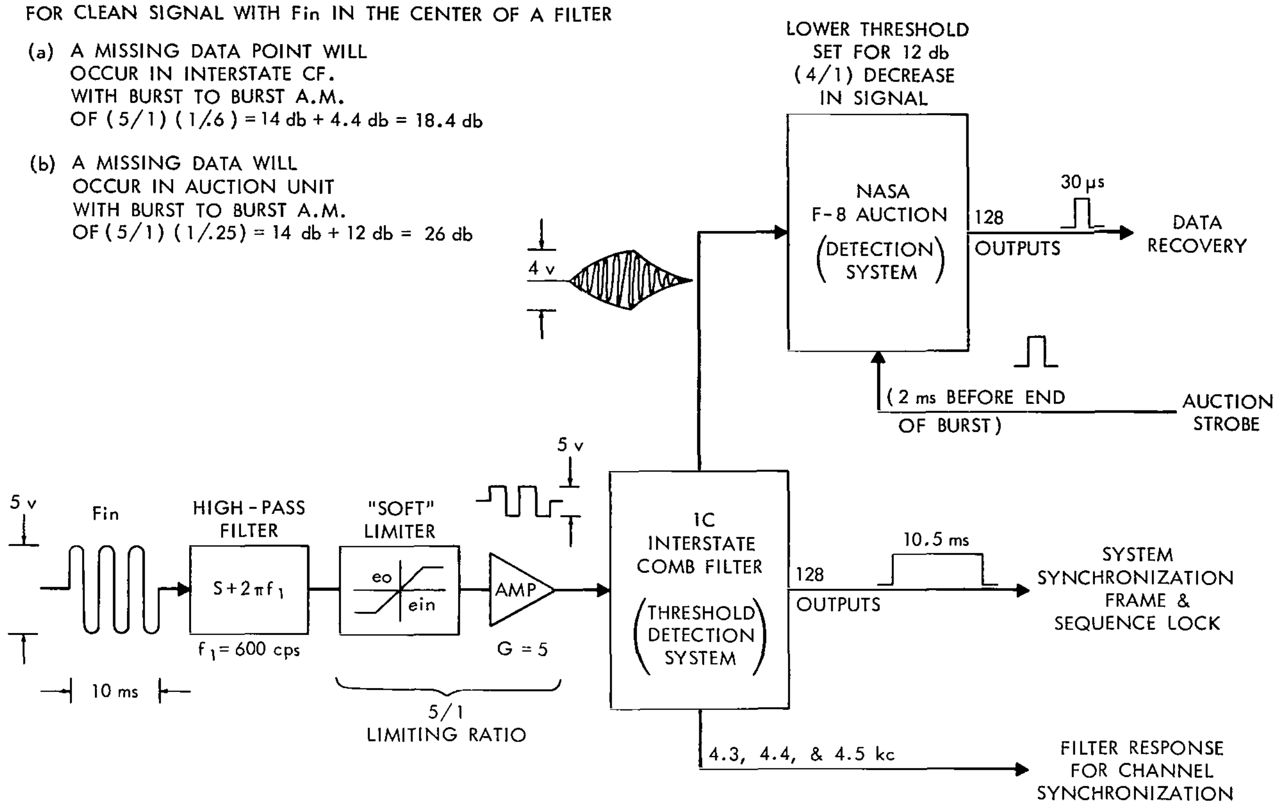

Figure 5—F-8 line dual detection system for AIMP D and E, block diagram.

input signal-to-noise ratios. Figure 7 indicates the differences in dynamic range between the threshold and auction detection systems for data recovery.

PFM PERFORMANCE WITH THE DUAL DETECTION SYSTEM

Evaluation Using Simulated Data

The results of the dual detection system were optimized and verified by extensive procedures. Figures 8 and 9 are the test results, for both detection systems, obtained from simulated burst-burst PFM random data added to White-Gaussian noise bandlimited with a 20-kc equivalent noise bandwidth filter for various signal-to-noise ratios. The auction detection system was from 1 to 2 db better than the threshold detection system. A similar improvement was obtained from another test tape used for daily line testing in the data-processing facilities (Figure 10). In both simulated analog tapes (in which every data point is know), tests show that the increased recovery is not achieved at the cost of more erroneous detections. (Note: The signal-to-noise ratios in Figure 10 should not be compared with those in Figure 9. In the former, a quantization of 14 errors and missing data points is used and the Equivalent Noise Bandwidth (ENBW) used for line test is not exactly known.)

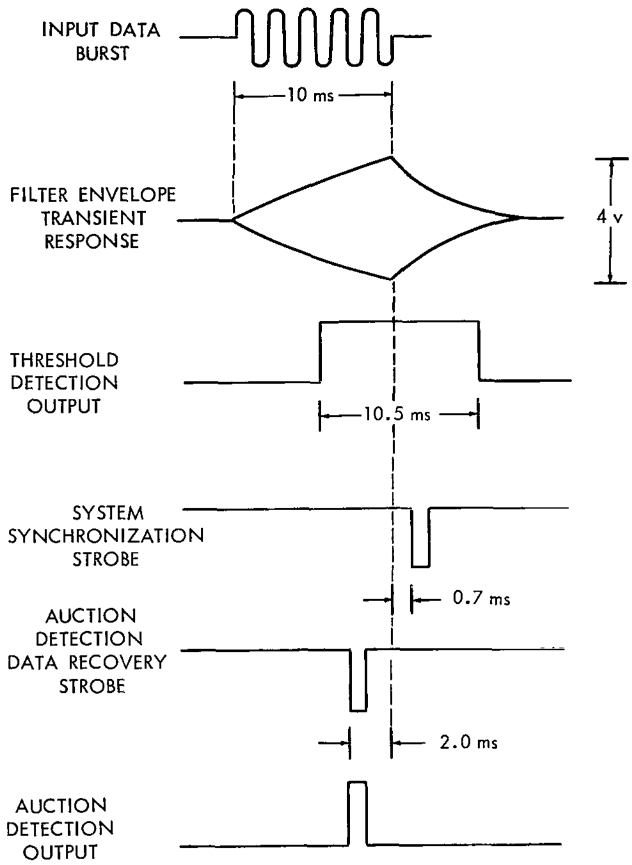

Figure 6—Dual comb-filter detection strobes, F-8 PFM data-processing line.

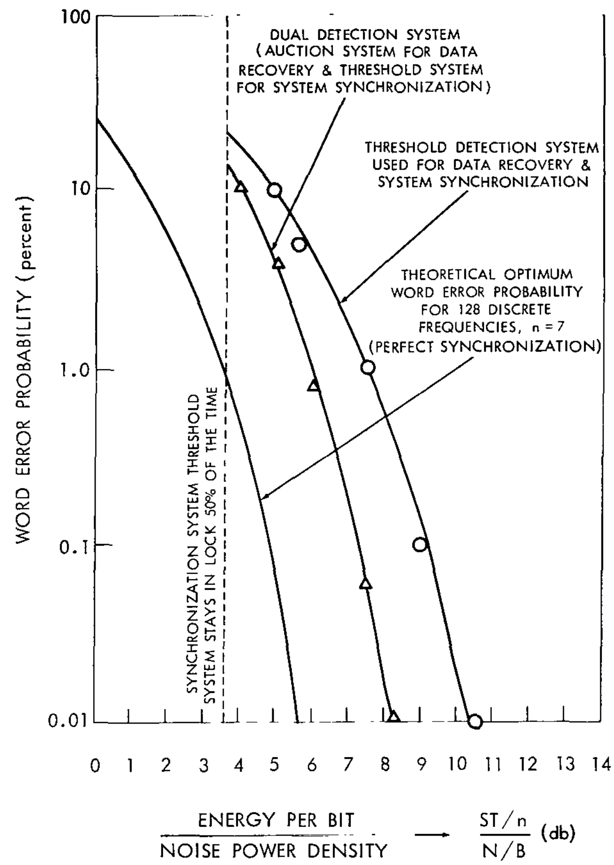

Figure 8—PFM word error probability for F-8 PFM data-processing line (AIMP D and E).

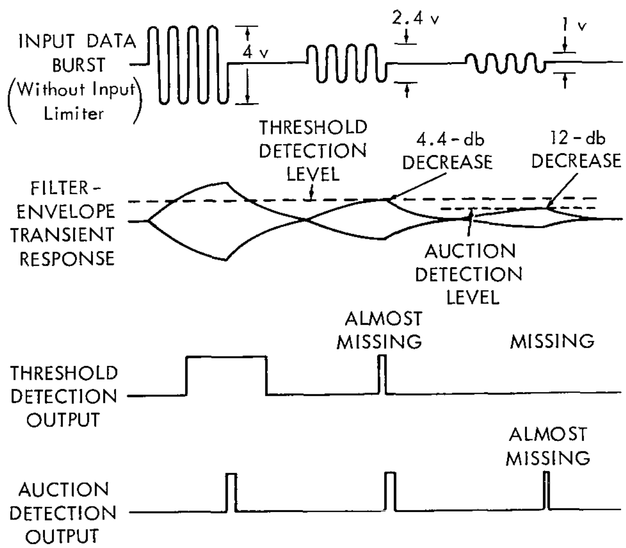

Figure 7—Comparison of dynamic ranges for the threshold and auction detection systems.

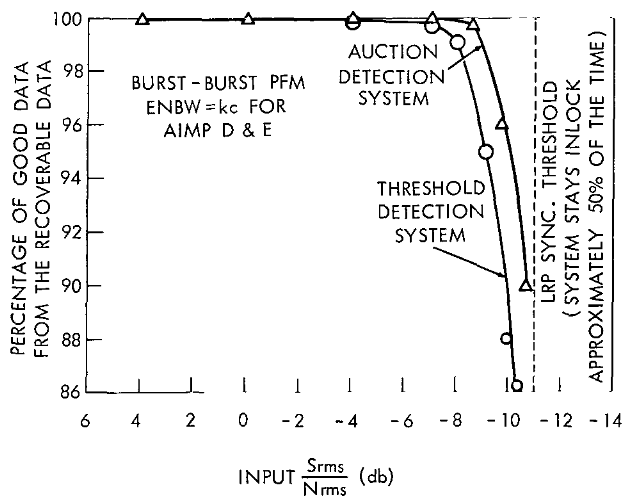

Figure 9—Actual F-8 PFM data-processing line performance for low-resolution processing data recovery.

Evaluation Using Actual Satellite Data

The editing, time, and statistical (E, T, and S) analysis programs, written for AIMP D and E for purposes of tabulating the pertinent data quality indicators, were used to evaluate the performance of the dual detection system. Ten data files (satellite passes)—recorded 5 weeks after AIMP D launch and originally processed with the threshold detection system—were reprocessed using the dual detection system. The files for weeks represent a wide range of performance for AIMP D. Test results on the reprocessed data have shown a definite improvement in the "file quality index"—an indicator of data recovery (Table 1) defined near the end of this section.

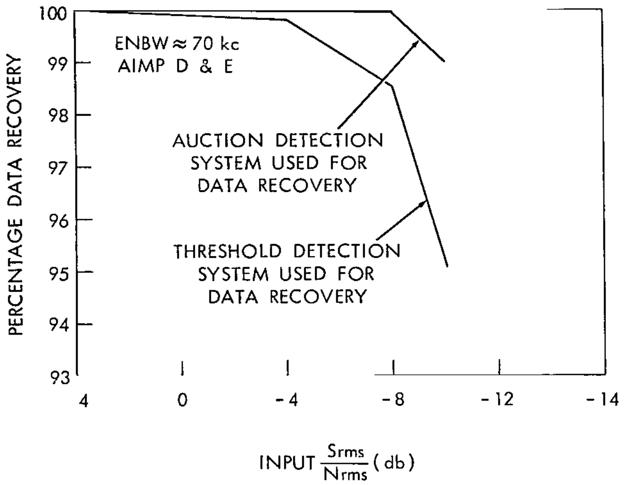

Figure 10—F-8 line performance with and without the auction detection system based on daily line test.

Table 1

Comparison of All Data of Week 5 for AIMP D

Before = Threshold Detection System
After = Dual Detection System

Analog Tape No.	File Quality Index (percent)	Average Data Missing Per Sequence	Average Detected System Errors Per Sequence
08-42 Before	98.693	6.94	0.01
After	99.998	0.28	0.00
08-43 Before	95.785	24.50	0.00
After	99.347	3.52	0.33
08-44 Before	95.858	24.57	0.01
After	99.446	3.06	0.49
08-45 Before	95.357	28.08	0.00
After	99.563	2.09	0.74
21-63 Before	98.670	8.20	0.02
After	99.962	0.45	0.05
21-64 Before	98.471	9.78	0.01
After	99.959	1.39	0.05
21-65 Before	99.313	6.07	0.01
After	99.997	2.14	0.03
87-65 Before	99.646	6.76	0.02
After	99.998	0.00	0.02
21-67 Before	99.926	2.24	0.00
After	100.000	1.95	0.00
16-69 Before	99.959	4.67	0.01
After	100.000	2.29	0.07

These reprocessed files were sent to three experimenters for their evaluation: Dr. N. F. Ness of NASA, GSFC (Digital Telemetry Data), Dr. D. S. Colburn of NASA, AMES (Analog Telemetry Data), and Dr. E. F. Lyon, MIT (Analog Telemetry Data).

The following is an excerpt from an evaluation report for the reprocessed satellite data, received from K. W. Behannon, GSFC AIMP magnetometer experimenter staff, representing experimenter Dr. N. F. Ness:

"The AIMP-D magnetic field data that were run on the F-8 line with the new auction technique have been processed and compared with the previously processed data from the same analog tapes. The percentage of magnetic field data points that have been digitized per file is computed in the analysis. A definite improvement in this statistic is found when the results from the most recently processed data are compared with the old results, the improvement being greatest when the previous recovery percentage was low.

"A breakdown of these percentages by file is given below:

TAPE	OLD %	NEW %	INCREASE %
8-42	90	98	8
8-43	64	91	27
8-44	70	93	23
8-45	61	92	31
21-63	90	99	9
21-64	90	99	9
21-65	94	96	2
87-65	93	99	6
21-67	98	98	0
16-69	96	96	0

"As would be expected the recent data are in general noisier, as determined from the standard deviations (RMS) computed in each sequence, but the increase in noise is not proportional to the increase in data recovery. In some individual sequences there is a significant increase in the number of data points digitized (in some cases the number is doubled) but no increase in the RMS. As far as the magnetic field experiment is concerned, the small general increase in noise is acceptable as a tradeoff for a substantial increase in data recovery."

The following is an excerpt from an evaluation report, for the reprocessed data, sent by Dr. D. S. Colburn of AMES November 6, 1967:

"As I outlined to you in our recent telephone conversation, we have compared the Ames magnetometer data on Explorer 33 Quick Look Tape 50 with similar data on the earlier week tape for week 5 to assess the new method for analog to digital conversion. The new method in our opinion is at least as good as the older method but it was difficult to make an accurate comparison since the older tape was edited and we were not necessarily comparing data from identical files. Our comparison was based on the relative absence of noisy data points in the analog portion of the data. We also noticed that the newer tape gave a smoother rendition of the analog calibration flag which is digital data; this improved the quality of our data reduction. Your efforts to maintain and possibly improve the data quality are appreciated."

The following is an excerpt, from an evaluation report, for the reprocessed satellite data, sent by Dr. E. F. Lyon of MIT October 31, 1967:

"I have examined in detail portions of the MIT analog data for AIMP-D using both the "pre" front-end change and the "post" front-end change data. Data processed before the change was contained on MIT tape number 8390 processed at Goddard December 13, 1966. Data processed after the change was contained on the special 11 file tape numbered 0417 which was processed at Goddard September 7, 1967.

"The enclosed table tabulates some of the results obtained by comparing pre and post data plots from three files. Less detailed comparisons for other files seems to support the same conclusions.

Files		Points Missing	Wild Shots	Changed Values (1 or 2 CFN's)
21063	before	120/2700 = 4.4%	1	112/1026 = 11%
and				new CFN > old CFN 25/112 = 22%
21064	after	4/2700 = 0.15%	0	old CFN > new CFN 87/112 = 78%
21064	before	60/1377 = 4.4%	0	83/891 = 9%
and				new CFN > old CFN 18/83 = 22%
21065	after	0/1377 = 0%		old CFN > new CFN 65/83 = 78%

NOTES:

1.) Not all the above columns apply to the same range of data

2.) This wild shot was off greater than 50 CFN's

"The general conclusions are: 1) There is an increase in analog data recovery rate of from about 95% to essentially 100%; 2) The frequency of occurrence of "wild-shots" does not seem to have increased and may have gone down; 3) There are slight re-adjustments (one or two comb filter numbers) in about 10% of the data."

"All in all, I feel that there has been considerable improvement in the overall quality of the data as a result of the data-line front end change."

This readjustment of one or two comb-filter numbers (that is, resolution improvement) observed by Dr. Lyon is a direct result of the narrowing crossover detection region due to the auction detection system near the overlapping points of the filter elements. Figure 11 shows 2 cps and 20 cps crossover uncertainty regions for the auction and threshold detection systems respectively. The 20-cps uncertainty region for the threshold detection system is caused by inability to adjust, align, and maintain each of the 128 amplifiers and Schmitt Triggers in the comb filter. Whereas the auction detection system requires only that the center frequency and bandwidths of the crystals filters maintain their tolerances, once the auction circuit is aligned to the comb filter, one threshold (not a critical adjustment) determines the lower operating range in all 128 auction circuits.

In Figure 11, assume that the signal-to-noise ratio is high and that the distribution of the input frequency data burst is equally likely to occur anywhere in the 100-cps filter bandwidth. Then, for the auction detection system, 98 percent of the time filter number B will detect this frequency and 2 percent of the time filter numbers A, B, or C will be detected. For the threshold detection system, 80 percent of the time filter number B will detect this frequency and 20 percent of the time filter number A, B or C will be detected. Hence, up to 18 percent of the data can be resolved (readjusted) into the correct filter card when results of the threshold and auction detection systems are compared.

Figure 12 shows the envelope response of two filters when excited by a PFM 10-millisecond data burst with input frequency F1, F2, and F3. When the input frequency falls in the center of filter A, with high signal-to-noise ratios, filter number A responds (Schmitt Trigger A turns on). Note, if the gain of filter element B were misadjusted (high), then when point 4 was higher than point 3, filter B would respond. The auction system detects the greatest signal near the peak of the burst; thus there is an improvement in resolution (distance between points 1 and 2 compared to points 3 and 4) as the input frequency moves away from the filter overlapping points. With medium signal-to-noise ratios, points 3

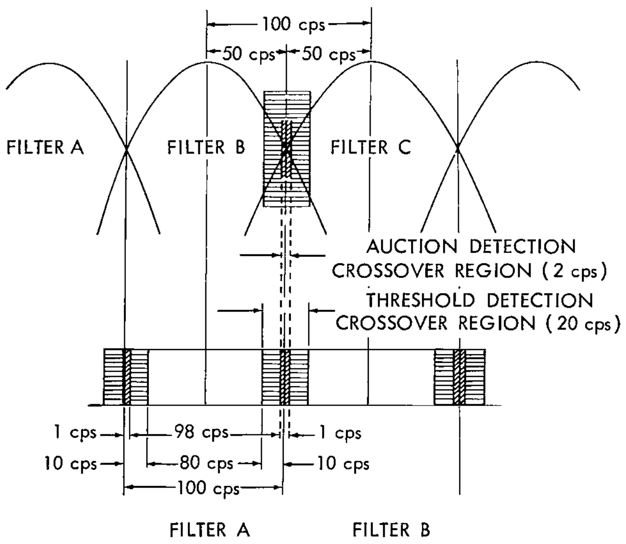

Figure 11—Auction and threshold detection filter crossover detection uncertainty regions.

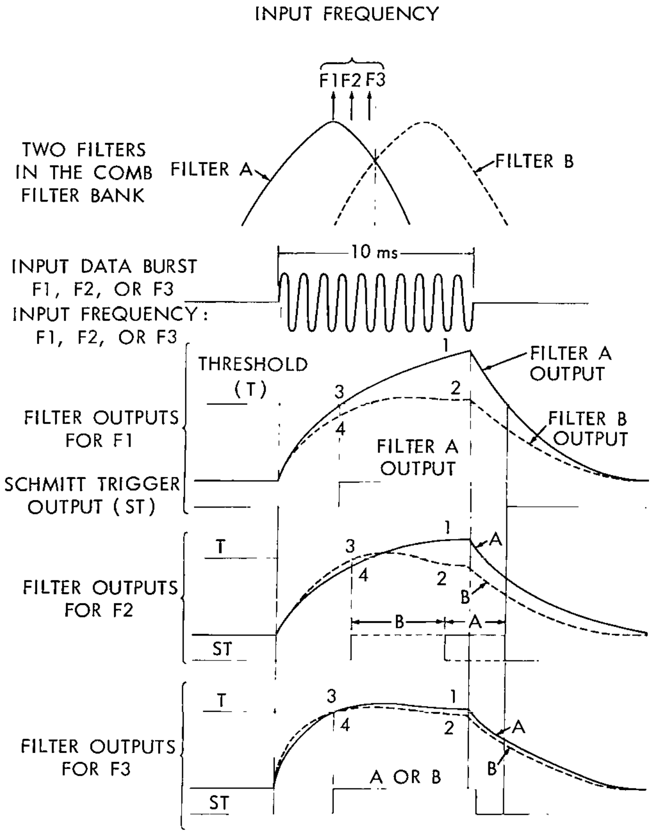

Figure 12—Filters A and B outputs for input frequencies F1, F2, and F3.

and 4 indicate nearly equal amplitudes; hence, either will trigger its Schmitt Trigger, resulting in a one-card (1-percent) error.

The daily line test described previously under "Evaluation Using Simulated Data," performs a detailed evaluation on each of the 128 filter elements in the comb filter. A weekly line test, using an actual satellite tape, is processed on the F-8 line in order to exercise the line and the E, T, and S analysis programs. Tables 2 and 3 are the E, T and S analysis printout obtained by processing the actual satellite tape with the old and new systems respectively. The dual detection system proves to have a file quality index (data recovery) 1.17 percent higher than the threshold detection system.

The line processed 52 sequences (one sequence contains 32 channels or data points per frame with 16 frames per sequence) labeled "FN" (see middle of both tables). The horizontal tabulation "0, 1, 2 . . . 23, GT" (near the bottom) represents missing data points; "GT" means 24 or more missing data points. The following row, labeled "DM," represents the number of sequences. For example, in Table 2, out of 52 sequences processed, only 1 sequence had zero missing data points, 5 sequences had one missing data point, 3 sequences had two missing data points, and so on. Table 3 indicates 52 sequences processed with 52 sequences that contain no missing data points.

The file quality index (FQI) is computed as follows:

$$FQI = \left(1 - \frac{DM}{DP(FN-GT)}\right) \times 100 \quad \text{percent,}$$

Table 2

Statistical Analysis of an Actual Satellite
Tape Processed With the Threshold Detection System.

```
SAT=58   DAY=[illegible]   [illegible]   [illegible]   [illegible]   ADLINE=[illegible]   MDT=[illegible]234

HOURS AFTER LAUNCH=  6806.5

SUFFIX DEFINITIONS

IC=ILLEGAL CHARA COUNT / SEQUENCE
DM=MISSING DATA PTS    / SEQUENCE
EP=ERR PRESENT DATA PTS/ SEQUENCE
DS=DATA SAMP HAS STOPPED DATA PTS   / SEQUENCE
GB=THE NUMBER OF CFN THAT FELL INTO THE GUARDBAND / SEQUENCE
CFN128=THE NUMBER OF CFN OVER 128 / SEQUENCE
AVGIC=        .06   AVGDM=      5.61   AVGEP=       .00   AVGDS=      .00   AVGGB=      [illegible]   AVGCFN128=    [illegible]

VARIC=        .00   VARDM=     11.61   VAREP=       .00   VARDS=      [illegible]   VARGB=      [illegible]   VARCFN128=    [illegible]

SDVIC=        .06   SDVDM=      3.40   SDVEP=       .00   SDVDS=      [illegible]   SDVGB=      [illegible]   SDVCFN128=    [illegible]

FN=     52.   FN5=     52.

AVGSQR= 81.8109   VARSQR=   .0001   SDVSQR=   .0105
FNSQR=      50.
```

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	GT
DM	1.	5.	3.	4.	8.	9.	4.	6.	4.	1.	2.	.	2.	2.	.	1.	.	.	.	.	.	.	.	.	.
EP	52.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
GB	49.	3.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

```
FILE QUALITY INDEX=   98.8301
COV=  100.00
```

Table 3

Statistical Analysis of an Actual Satellite
Tape Processed With the Dual Detection System.

```
SAT=58   DAY=100   YR=67   STAT=87   ATAPE=632   ADLINE=1   MDT=3523

HOURS AFTER LAUNCH=  6806.5

SUFFIX DEFINITIONS

IC=ILLEGAL CHARA COUNT / SEQUENCE
DM=MISSING DATA PTS    / SEQUENCE
EP=ERR PRESENT DATA PTS/ SEQUENCE
DS=DATA SAMP HAS STOPPED DATA PTS  / SEQUENCE
GB=THE NUMBER OF CFN THAT FELL INTO THE GUARDBAND / SEQUENCE
CFN128=THE NUMBER OF CFN OVER 128 / SEQUENCE
AVGIC=      .00   AVGDM=      .00   AVGEP=      .00   AVGDS=      .00   AVGGB=      .00   AVGCFN128=      .00

VARIC=      .00   VARDM=      .00   VAREP=      .00   VARDS=      .00   VARGB=      .00   VARCFN128=      .00

SDVIC=      .00   SDVDM=      .00   SDVEP=      .00   SDVDS=      .00   SDVGB=      .00   SDVCFN128=      .00

FN=     52.   FN5=     52.

AVGSQR= 81.8110    VARSQR=    .0000    SDVSQR=    .0097
FNSQR=     51.
```

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	GT
DM	52.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EP	52.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
GB	52.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

```
FILE QUALITY INDEX=  100.0000
CDV=  100.00
```

where

DM = the number of data missing points contained in sequences with 23 or less data missing points,

FN = the number of sequences recovered,

GT = the number of sequences recovered with more than 23 data missing points,

DP = 480 = the number of data points in a sequence.

There were 52 sequences processed and none of them contained any system errors (EP) for either detection system. System errors are generated and detected when: (1) two filter elements respond simultaneously and are both rejected, (2) two filter elements respond simultaneously and generate an illegal character.

The guard band (GB) row near the bottom of the tables represents the number of data points selected outside the one-filter card window set for digital data. Three sequences had one guard band count for the threshold detection system, whereas the auction detection system had none.

The test results in Table 3 have been repeated many times for this tape. Table 3, by this author's definition, is referred to as a "perfect" processed tape. AIMP D and E F-8 data processing, using the dual detection system, is currently producing approximately 25 percent and 35 percent perfect tapes for AIMP D and E respectively. Many other tapes could be categorized as perfect, but range, range rate, and occultation periods show up in the E, T and S statistics. There are 65- and 80-percent-perfect tapes when 100-percent coverage exists for AIMP D and E respectively.

The author received the following comment from Mr. David R. Camp, University of Iowa Project Manager for Dr. J. A. Van Allen's experiment on AIMP E:

"Since the new processing technique for the AIMP tapes was initiated, I have received no complaints on the quality of the data. It is difficult to demonstrate conclusively that the new comb filter has significantly improved the data; however, I believe you can take Dr. Van Allen's recent memorandum concerning the success of AIMP-E as an indication that this is true."

SUMMARY

An auction detection system has recently been designed, developed, and installed by Code 563.2 into the F-8 PFM data processing line for a sum of $5000. The line was modified so that two detection systems could operate in parallel; one for system synchronization and one for data recovery. The dual detection system is being used to process AIMP D and E PFM telemetry with great success; AIMP D data, starting 55 weeks after launch, will have been processed with this technique. This system copes with most of the problems that arise when the threshold detection system is used for data recovery. This system employs a true greatest-of-detection or auction system that practically eliminates all missing data at good signal-to-noise ratios and severe amplitude modulation and improves the resolution of the data, especially when the input frequencies lie near the crossover points of two filters. Tests have shown that an increase in data recovery is not being attained at the cost of more erroneous detections.

Future PFM data processing systems should use this dual detection system, to obtain optimum performance and data processing. The system synchronization threshold cannot be improved by this technique because line synchronization has remained unchanged.

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