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NIMBUS-E SCMR DATA PROCESSING SYSTEM

October 1972

GODDARD SPACE FLIGHT CENTER

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NIMBUS-E SCMR DATA PROCESSING SYSTEM

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October 1972

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CONTENTS

		Page
I.	SCOPE	1
II.	INTRODUCTION	1
III.	RESPONSIBILITIES	9
IV.	PROCESSING SYSTEM	9
V.	QUALITY CONTROL REQUIREMENTS	11
VI.	PRODUCTION REQUIREMENTS	25
APPENDIX A - QUALITY CHECK OF DIGITIZED SCMR DATA		A-1

ILLUSTRATIONS

Figure		Page
1	NIMBUS E SCMR Data Format and Sampling Strategy	3
2	A-3 System: NIMBUS E SCMR Data Processing Front End Block Diagram	6
3	A-3 Computer System Block Diagram	7
4	Format of NIMBUS E SCMR Data, Time, and Scan Period Data	8
5	Pass I	10
6	NIMBUS E Processing	11
7a	NIMBUS E Output Format	12
7b	NIMBUS E Output Format	13
7c	NIMBUS E Output Format	14

ILLUSTRATIONS (Continued)

Figure		Page
8	Tape Layout	15
9	NIMBUS E Quality Control	16
10	Equations for Computing Mean & Std Dev	19
11	Equation for Computing. 1) % Linearity, 2) % Resolution, and 3) % Frm Recovery	21
12	Quality Card Content (Preliminary)	22
13	Calibration Card Content	23
14	SCAN Equations	24
15	Guardband	25
16	Example of a Plot from the Calcom Plotter	25
17	NIMBUS E Work Request	26
18	Buffer Analog to Digital Summary	28
19	Edit Release Form	30

TABLES

Table		Page
1	Range of Values for Calibrations	17
2	Sample Strategy	18
3	Example of Computing the MEAN and STD DEV (Step 1 Used as Example)	20

NIMBUS-E SCMR DATA PROCESSING SYSTEM

I. SCOPE

NIMBUS-E is a research and development meteorological satellite leading to advanced operational weather satellites for global sounding of the atmosphere from earth orbit.

The Information Processing Division (IPD) is responsible for digitizing selected SCMR data as requested by the NIMBUS Project. The request will be handled as a special request and normal turn around is expected to be about 2 weeks. Within IPD, Code 564 will be responsible for providing the analog to digital conversion, evaluation and quality checking of all digitized data prior to being released to the NIMBUS Project.

II. INTRODUCTION

This document defines the A-3 system equipment requirements for the data processing of the NIMBUS-E SCMR experiment. The functions of the system will be to receive the multiplexed SCMR signal from a wideband tape recorder channel, to demultiplex and demodulate the signal to the baseband SCMR data, time code and time base error signals, to process the signals and to provide a digital output tape which will be sent to the experimenter for further processing. In addition, the data on the output tape will be quality checked by the system and the results sent to the experimenter.

NIMBUS-E SCMR Data Signal Characteristics

The data source will be from a 7200 foot tape recorded on an Ampex FR-1900 multiband tape unit using Wideband I electronics at 120 ips (Maximum of 12 minutes of data per pass, per track). The proposed track assignments are:

Track	Signal	
1	Servo	Pass #1
2	Servo	Pass #2
3	SCMR Composite	Pass #1
4	SCMR Composite	Pass #2
5	SCMR Composite	Pass #3
6	None	
7	Servo	Pass #3

The SCMR composite will be a FM-multiplexed signal with the following characteristics:

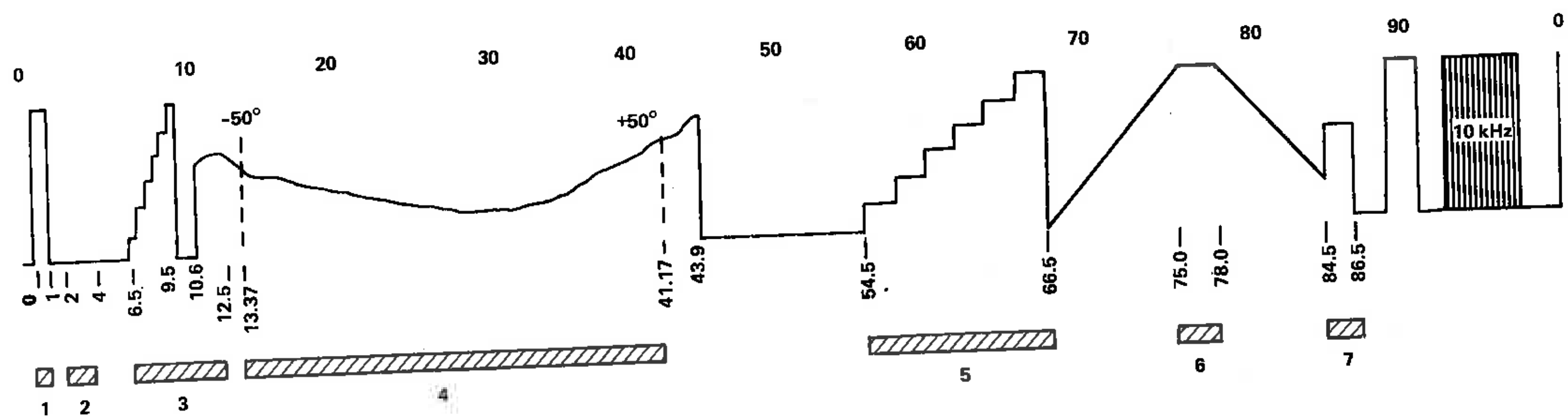
Data Channel 1 - 480 kHz ± 80 kHz
Data Channel 2 - 800 kHz ± 80 kHz
Time Base Error - 200 kHz ± 7.5%
Time Code - 70 kHz ± 7.5% 100 pps NASA 36 dc level shift

Data 1 and Data 2 are repetitive 100 millisecond scans having the waveform characteristics shown in Figure 1. The bandwidth of the earth scan data is 50 kHz with 30 db per octave (fifth order) assymptotic rolloff above 50 kHz. The expected signal-to-noise ratio of the received signal as presented to the standards committee by the NIMBUS Project is 48.5 db (peak-to-peak to RMS). The time base error signal will not be used in the digitizing. The time code is the 100 pps NASA 36 dc level shift code generated in the spacecraft from the spacecraft clock. It is a pulse-width-modulated signal with no carrier. The time corresponds to the date and time of the earth scan signals and will be related by ephemeral data to geographical identification. In addition to the FM multiplexed signal, the system will also use the 200 kHz servo frequency, which is recorded on an adjacent track at the station for tape speed compensation.

Processing Requirements

The A-3 System will digitize the two 50 kHz data channels of SCMR data to a resolution of 8 bits (experimenter requires resolution of 1 part in 200 or 46 db), decode the spacecraft time, determine the scan period (the time between successive frame sync pulses) and write the data and flags onto digital tape. Due to the 50 kHz bandwidth of the earth scan data, a sampling rate of 125 K samples per second per channel will be used. Since the difference between the two channels is of paramount importance, the data channels will be simultaneously sampled and held for digitizing by the A/D converter. Due to the high number of samples of the earth scan data (6950), the other portions of the scan to be digitized will be sampled at appropriate lower rates which will lower the overall throughput requirement on the hardware and make the volume of data more manageable. The sampling strategy is shown in Figure 1. The output tape must be compatible with IBM Model 75 tape units (9-track, 1600 cpi PE). One such tape could hold a maximum of 8 minutes of digitized NIMBUS SCMR data.

The system will also perform quality checking of the output data. This will be accomplished during a second pass.



1. SYNC.	31.250 kHz —	31 SAMPLES
2. SPACE	31.250 kHz —	62 SAMPLES
3. INT. CAL & HORIZON . . .	31.250 kHz —	187 SAMPLES
4. EARTH SCAN.	125.000 kHz —	3475 SAMPLES
5. EXT. CAL	15.625 kHz —	187 SAMPLES
6. HOUSING SCAN	62.500 kHz —	187 SAMPLES
7. BLACK BODY TEMP.	15.625 kHz —	31 SAMPLES

4160 TOTAL SAMPLES (8 BIT) PER CHANNEL
X2 8320 CHANNELS
\+ 8 CHARS (8 BIT): TIME, FLAGS, SCAN PERIOD
8328 CHARACTERS PER DATA RECORD

Figure 1. NIMBUS E SCMR Data Format and Sampling Strategy

Hardware System Description

Figure 2 is a block diagram of the NIMBUS-E SCMR Data Processing Front-End of the A-3 System. The hardware consists of off-the-shelf commercial equipment and analog and digital circuitry designed and built by IPD personnel.

The analog tape units to be used are Ampex FR-1900 multiband instrumentation recorders with the Wideband I electronics necessary to reproduce the NIMBUS-E SCMR experiment signals. The signal-to-noise ratio of the Ampex Wideband I electronics at 120 ips for a data bandwidth of 50 kHz specified is 47 db peak-to-peak to RMS. Refer the appropriate Ampex literature on the FR-1900 tape recorder for complete specifications.

The four EMR Model 4130 subcarrier discriminators are configured as shown in Figure 2 to demultiplex/demodulate the input signal. For complete specification, refer to the EMR literature on the Model 4130 or the "Performance Specification of the Ground Station Equipment Requirements for the SCMR Data System NIMBUS-E Program", NIT 7817, General Electric Company. The nominal output voltages of the data demodulators are 0, +3.0, and +6.0 volts for zero, mid- and full-scale respectively.

The Sync Detector Unit, provided by the NIMBUS Project, will accept the data signal output of either SCMR data subcarrier discriminator and extract the synchronization pulse. The detected sync pulse will have less than ± 2 microsecond-2 sigma peak jitter with a 34 db SNR input. The positive going edge of the sync pulse will be coincident with the signal sync pulse, e.g., the actual sync pulse is gated out of the detector.

The spacecraft tape unit time base error signal may be used by the system for tape speed compensation. It will be determined at a later date if it will be required. It is not planned to provide for this at the present time.

The output of the time code demodulator will be the NIMBUS 100 pps NASA 36 dc level shift time code generated in the spacecraft from the spacecraft clock. The time decoder interface will contain a 1 kHz modulator that will modulate the time code so that it can be decoded by standard methods in the commercial time decoder. The interface will also provide time checking, flywheeling, flag generation, and a computer interface. See Figure 4 for the output format of the time. The time decoder flags and their meaning are as follows:

Flag	"0"	"1"	
1	Good	Bad	Least Significant Comparison
2	Good	Bad	Most Significant Comparison

3	Normal	Low	Input Low (Flywheel Mode)
4	In	Out	Time Decoder Sync
5	Normal	Reset	Output Register Reset
6			Spare

The output of the scan period counter is the accumulated 100 kHz pulses between scan sync pulses. The incoming scan sync pulse initializes the counter each scan. The normal output count is 10,000 for a perfect period of 100 milliseconds. The counter (15 bit) has a range of 0 to 32767 and therefore will count through three missing scan sync pulses. Bit 15 of the scan sync word is used to indicate that a scan sync pulse was not detected in the previous frame and no data was processed through the system. See Figure 4 for format.

The general purpose A/D converter system, which includes control, sample and hold, multiplexing, and a 14-bit plus sign A.D converter, will be configured as shown in Figure 2 to digitize the two-simultaneously sampled channels of SCMR data to a resolution of 8 bits. The data will be sampled at the rates and periods shown in Figure 1. Sampling will start with scan sync and proceed as shown in the figure. If the scan sync pulse is not detected within a preset window of ±1.0 milliseconds, the sampling will not start, i.e., there is no flywheel for digitizing since it would produce meaningless data.

The basic system timing will come from a 1.0 MHz clock that will be either a synthesized signal (generated from the 200 kHz servo reference frequency) or the output of a stable crystal oscillator. It will be determined later which signal will be used. The 1.0 MHz clock will be counted down to produce the specified sampling rates and other needed timing signals for the system.

The function of the hardware channel interface and control logic is to provide the necessary interfaces between the computer automatic buffered input channel, the programmed interface, and the necessary control and timing signals needed to set up the front end and input the data and time to the computer. The output of the A/D is read into the computer under control of the Buffer Interlace Controller option (BIC). This provides for block transfers of a full frame of data automatically using "cycle steal" and frees the CPU to perform other program functions, such as, outputting the data to magnetic tape which will also be accomplished using a BIC. The time and scan period counter output are read into the computer using a "programmedI/O" interface since only 4 input cycles are required. The format of the data is shown in Figure 4. More specific information on the input and output data formats is contained in the program specification.

Figure 3 is a simplified block diagram of the A-3 computer system. The available options are shown on the diagram. Detailed information on the

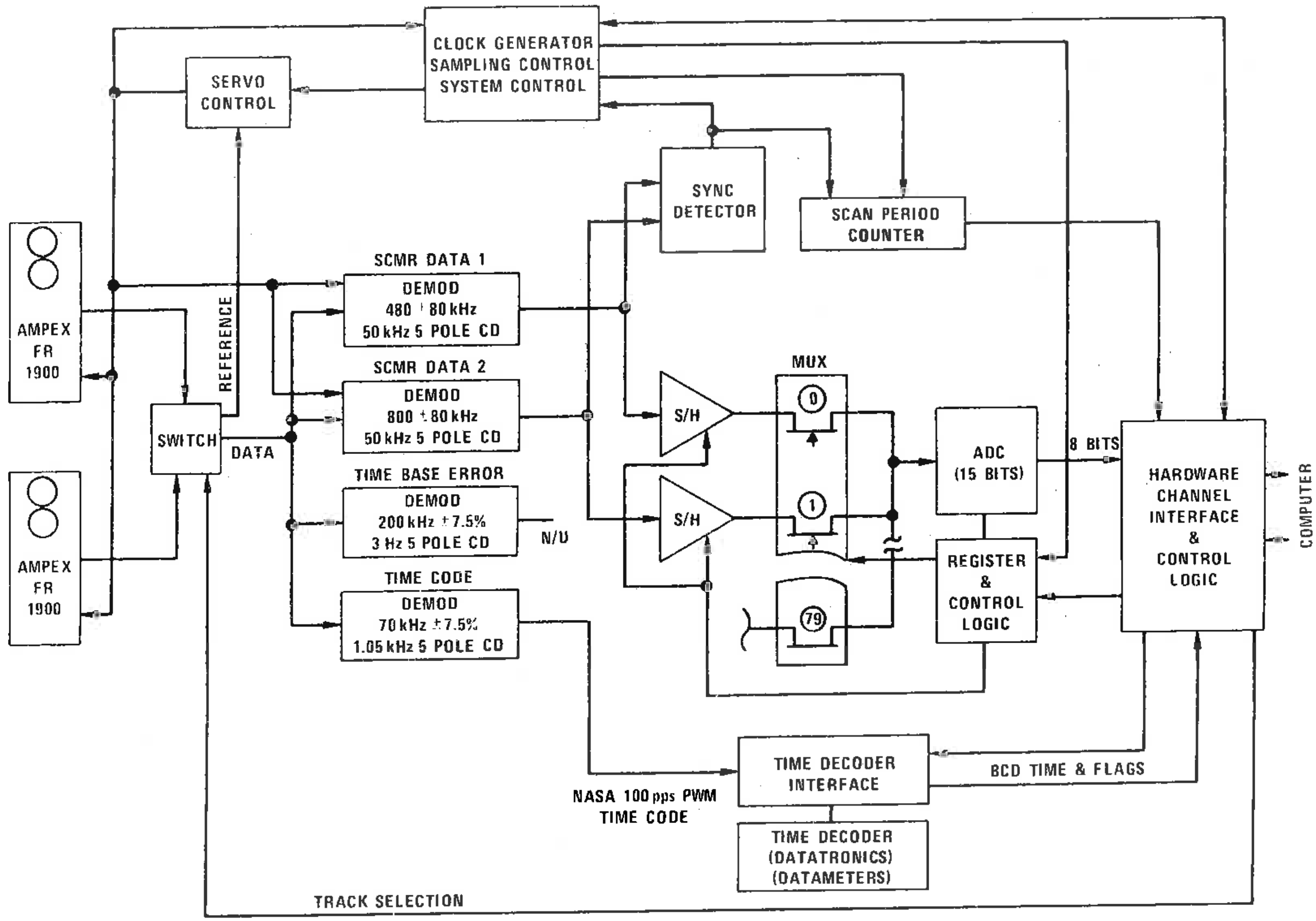


Figure 2. A-3 System: NIMBUS E SCMR Data Processing Front End Block Diagram

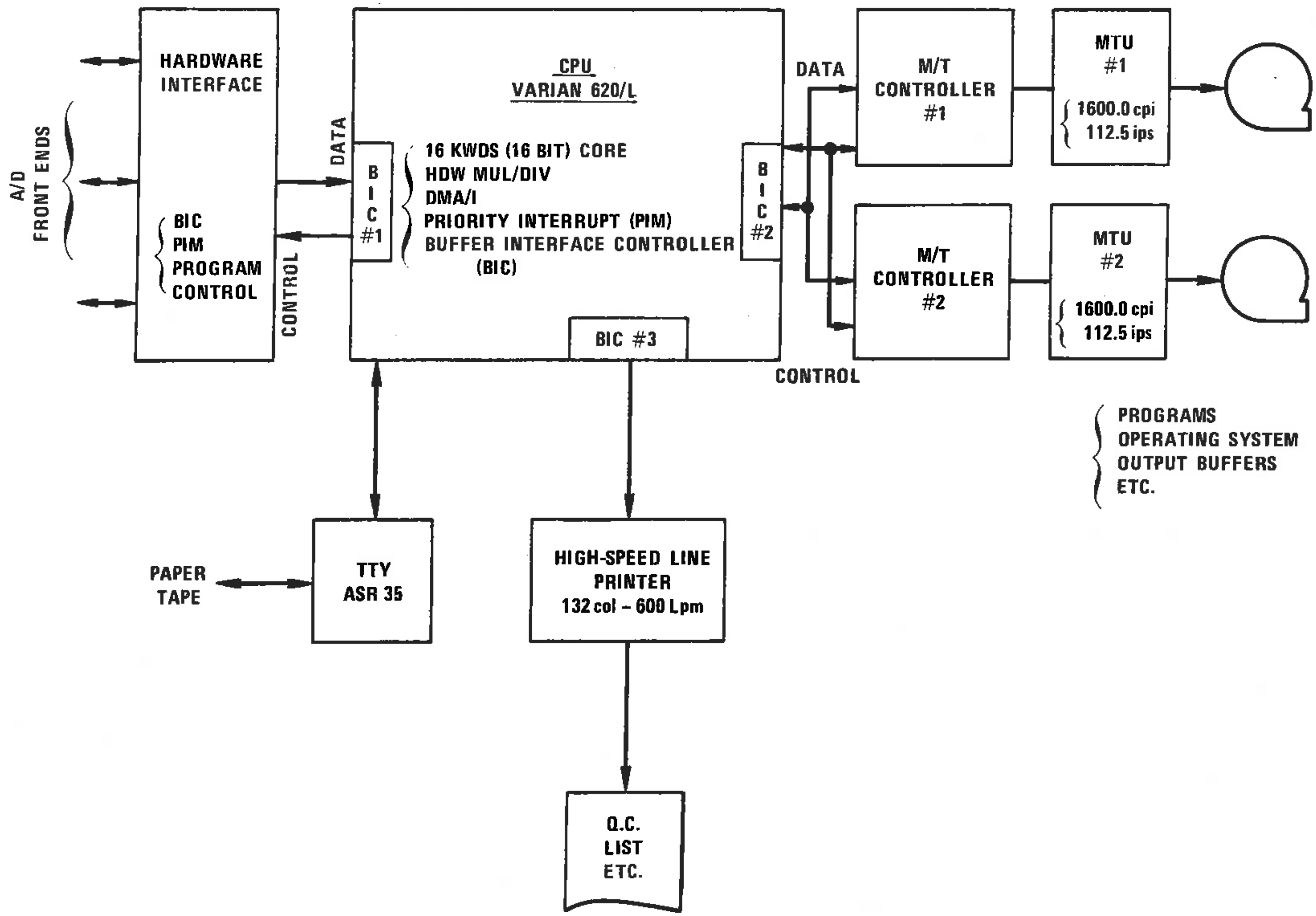


Figure 3. A-3 Computer System Block Diagram

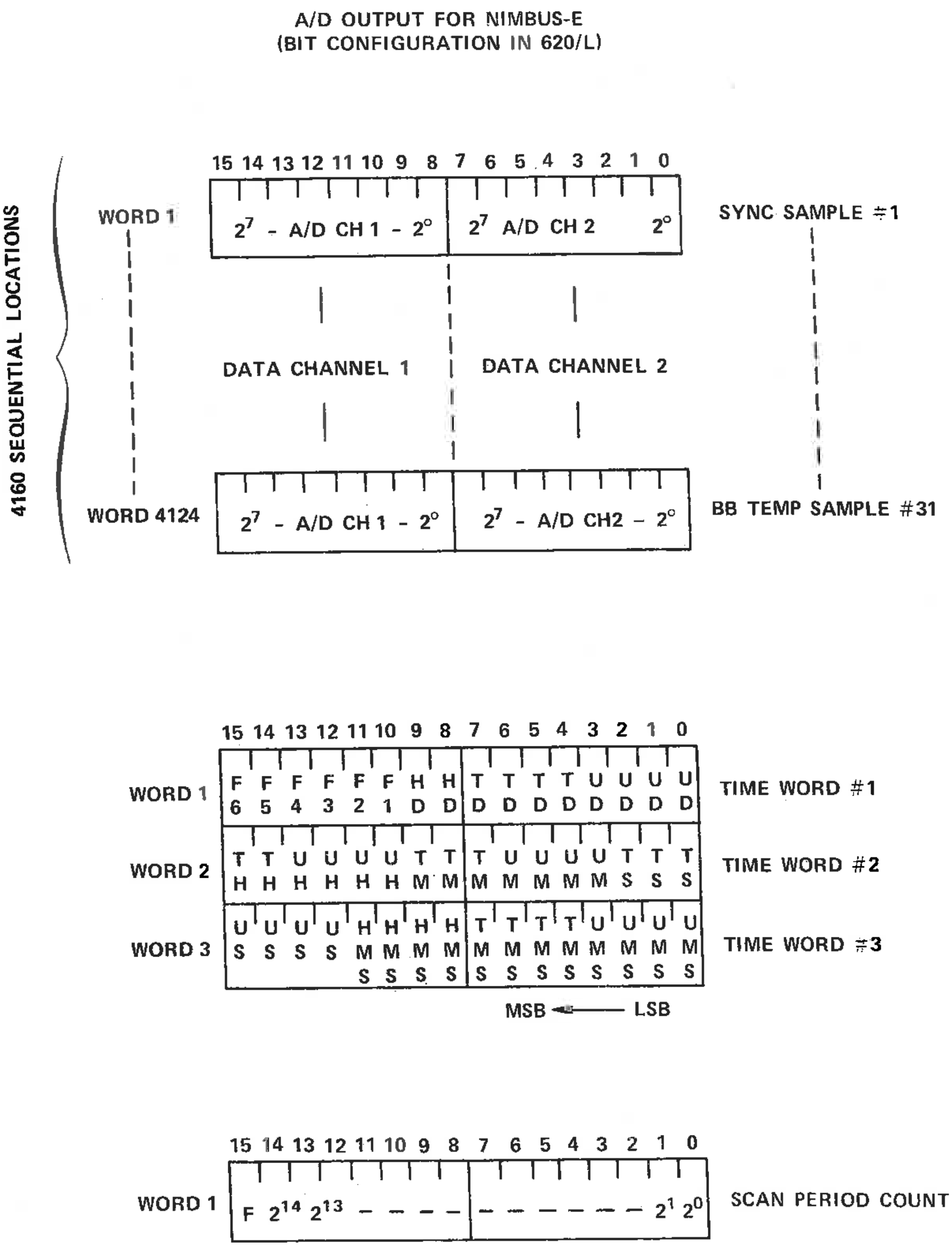


Figure 4. Format of NIMBUS E SCMR Data, Time, and Scan Period Data

computer system can be obtained from Varian literature. The program specification describes the operation of the computer system for NIMBUS-E SCMR data processing.

III. RESPONSIBILITIES

The Operational Programming Section is responsible for developing the required software to perform the A/D conversion and the quality checking.

The Processing Operations Section will control the accounting and production scheduling of all data digitizing requests.

The Performance Evaluation and Analysis Section will provide initial quality control specifications and will evaluate the data before releasing it.

The Operational Engineering Section will provide special test tapes and will provide the equipment necessary to accomplish this task.

IV. PROCESSING SYSTEM

The NIMBUS-E SCMR Data Processing System is being developed as a two pass system. Pass I will digitize the selected portions of the analog tape and will format the output onto magnetic tape (See Figure 1); Pass II will read the output magnetic tape from Pass I and will perform quality control checks. Upon completion, Pass II will generate a Q.C. report and will record this report on the line printer as well as the output magnetic tape.

To accomplish this basic task the system is considered to be four functional phases. The phases are as follows:

1. Hardware
2. Software
3. Production Scheduling
4. Quality Control

System Flow Chart

The flow chart in Figures 5 and 6 depicts the general operational flow of the basic two pass data processing system.

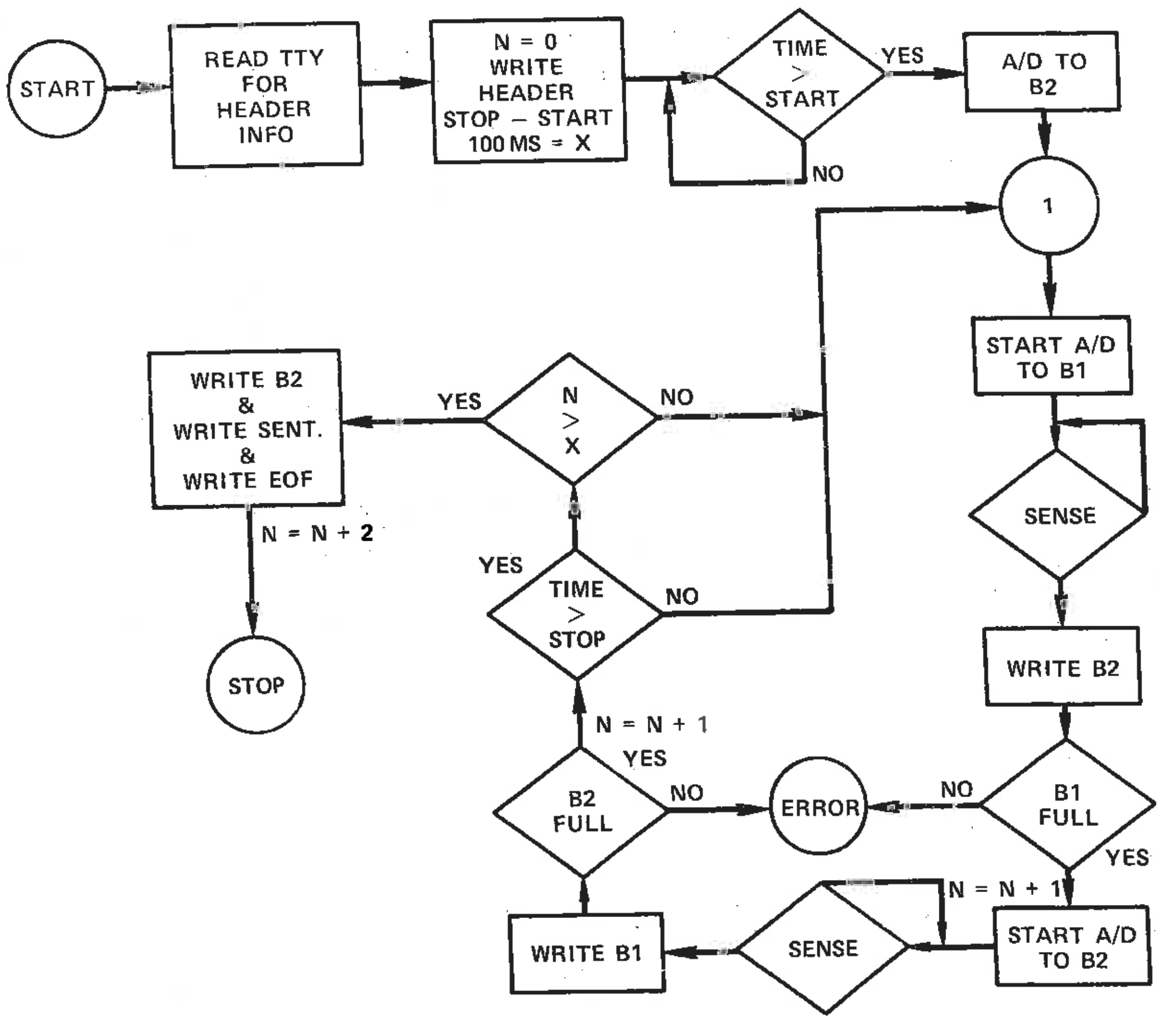


Figure 5. Pass I

Input

The NIMBUS-E basic input is analog tape with two channels of data being recorded simultaneously. The signals are recorded on a one-half inch wide, one and one-half mil thick, 7200 ft. long, 14 inch reel of mylar tape and will be recorded in either direction at 120 ips.

Pass I scans the incoming times searching for the start time. When the start time is reached, the analog to digital conversion process is started. The process is continued until the stop time has been reached and/or the expected number of frames has been read. When conditions are satisfied, the final frame is written and a sentinel record is written plus an EOF mark onto the magnetic tape.

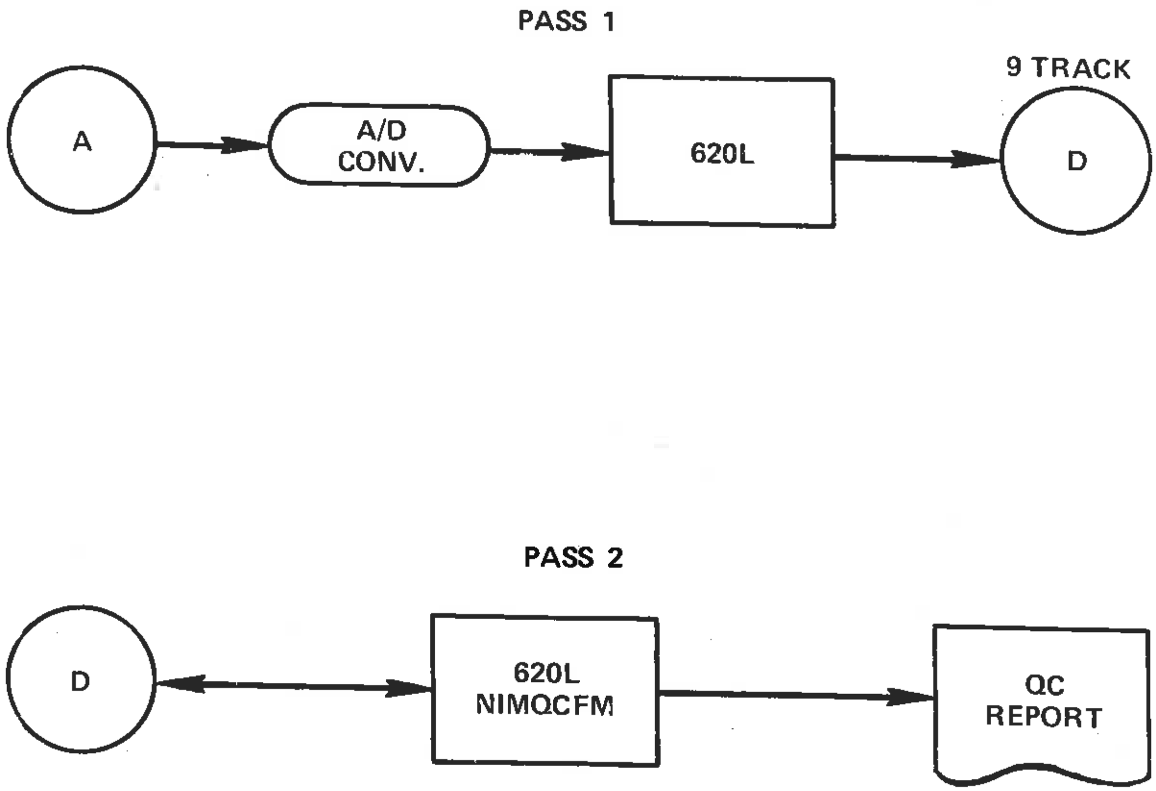


Figure 6. NIMBUS E Processing

Figure 1 depicts the signal and sampling strategy of a single channel. Analog and Digital Tape accounting information will be keyed in on the teletype input station of the 620L. Input for Pass II consists of the digital tape generated by Pass I. This is depicted as shown in Figure 7. Both Pass I and Pass II require teletype key-ins that are under operator control.

Output

The format of the output tape is depicted in Figure 7 and is 1600 BPI 9-track digital tape. Pass II output will consist of a 9-track 1600 BPI magnetic tape with the format as shown in Figure 8. Figure 7 depicts the format of the data records. Pass II output will consist of a Quality Control report.

V. QUALITY CONTROL REQUIREMENTS

Q.C. Listing Items - each item listed below is numbered and this number is used to identify the corresponding item in Figure 9.

(1) File ID - defined by the NIMBUS-E D.P. Team (See Figure 4 in cover section).

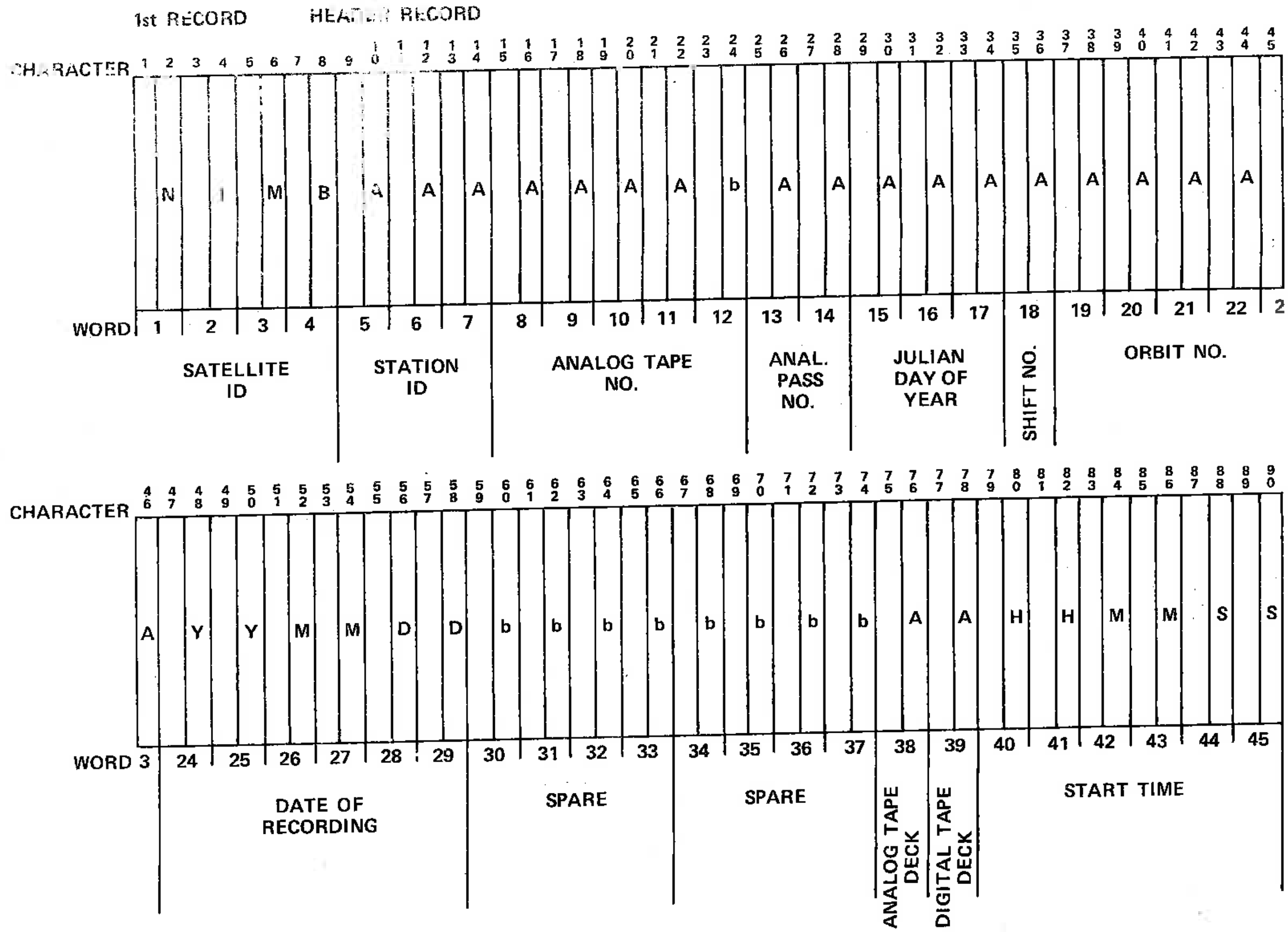


Figure 7a. NIMBUS E Output Format

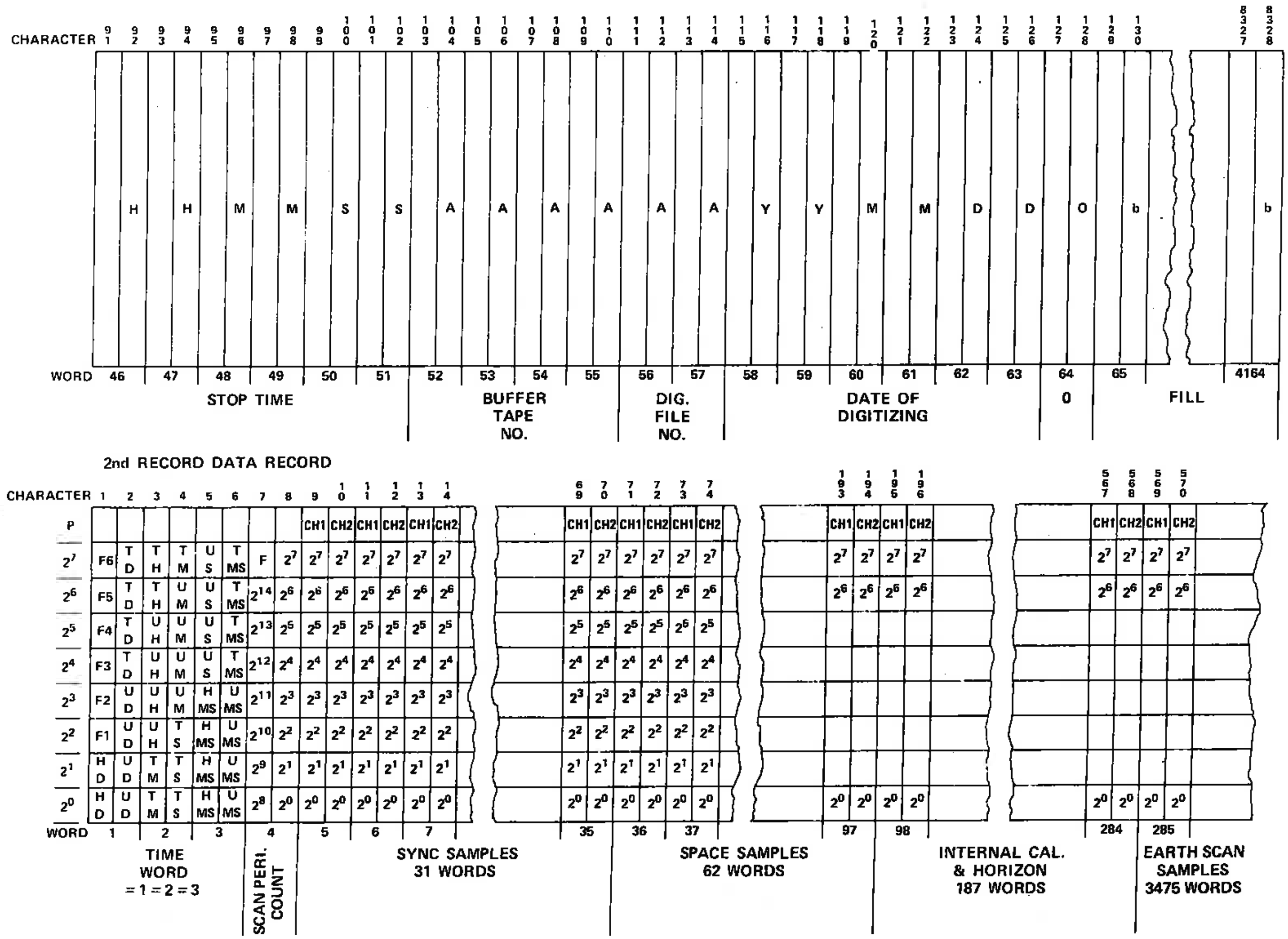


Figure 7b. NIMBUS E Output Format

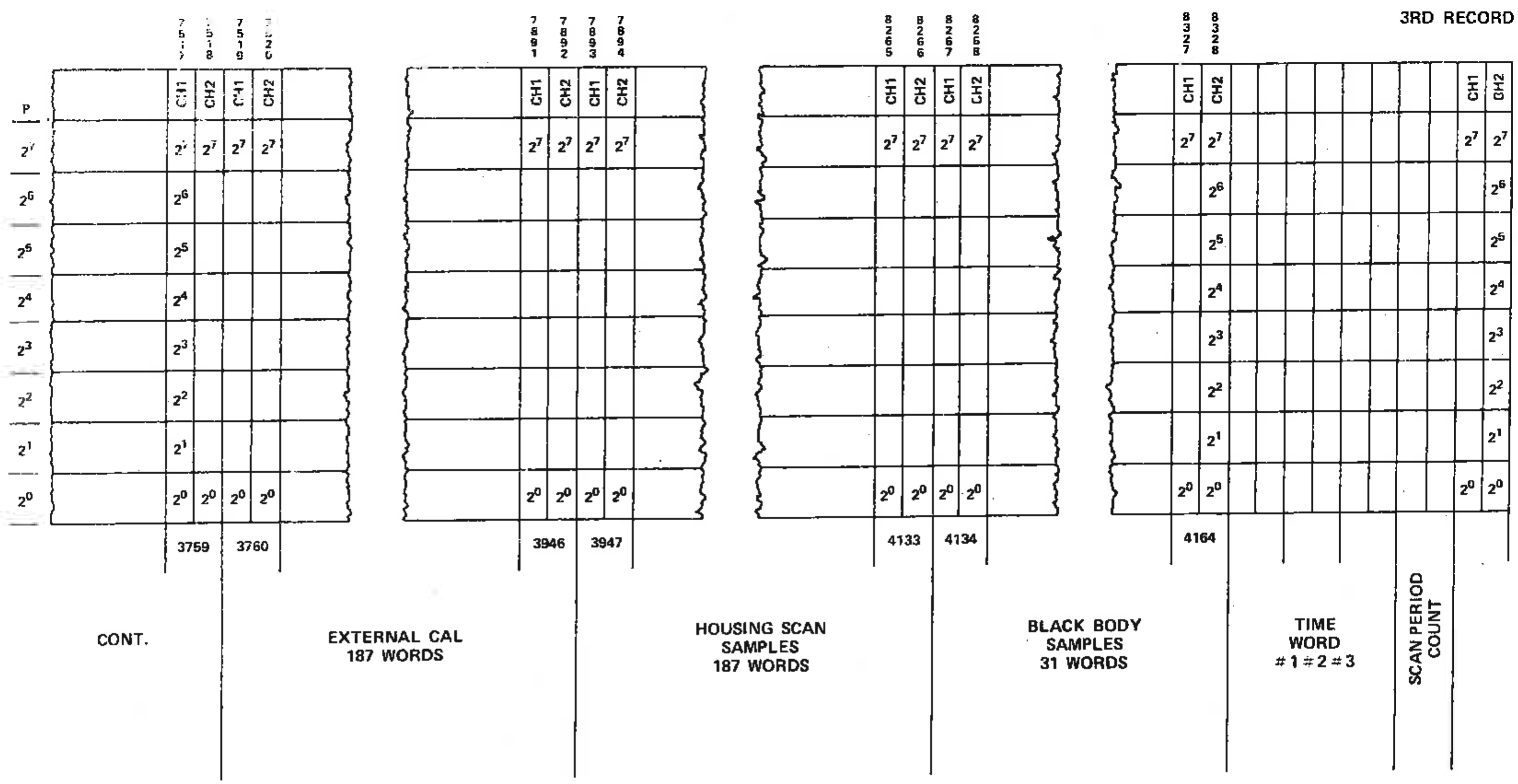


Figure 7c. NIMBUS E Output Format

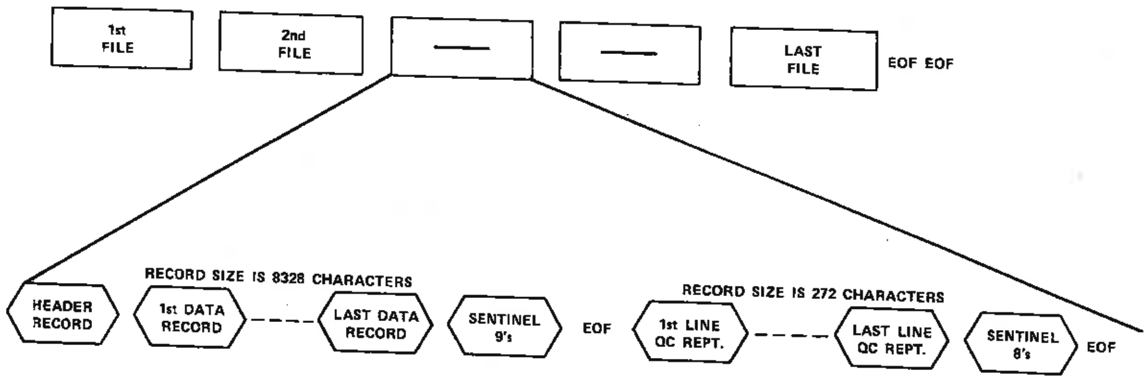


Figure 8. Tape Layout

(2a) Determine the number of samples for each channel at each step, and
(2b) determine the total number of samples for each channel.

(3a) Tabulate the number of out-of-range samples for each step, and
(3b) determine the total out-of-range values for each channel. Table 1 displays the range of values for the calibrations. An out-of-range value for step N is a value that is not within $\pm\Delta$ of the center of step N. The "Δ" has initially been assigned a tolerance of 8 counts and is subject to change.

(4a) Tabulate the number of off-scale samples for each channel at each step, and
(4b) tabulate the total for each channel. A sample is off-scale if its value equals 000_8 or 377_8.

(5) The mean and standard deviation will be computed for steps 1-6. The sampling strategy utilized for NIMBUS-E (See Table 2) should ensure 1) that the mean and standard deviation will be computed over a complete step and 2) the wild points possible at transition will not be sampled. Figure 10 displays the formulas for calculating mean and standard deviation. Table 3 is an example of computing the mean and Std. Dev. for Step 1 based on a 5 frame sample.

(6) Percent linearity and percent resolution will be calculated using the formulas in Figure 11.

(7) Number of frames recovered and percent frame recovery will be provided. The formulas for calculating recovery rate is displayed in Figure 11.

NIMBUS-E QUALITY CONTROL

(1)

DIGITAL TIME
START 898989
STOP 898989

	CHANNEL 1					CHANNEL 2				
	INTERNAL		EXTERNAL			INTERNAL		EXTERNAL		
STEP	MEAN	STD DEV	MEAN	STD DEV	DIFF	MEAN	STD DEV	MEAN	STD DEV	DIFF
1	123.4	1.23	123.4	1.23	1.23	123.4	1.23	123.4	1.23	1.23
2	123.4	1.23	123.4	1.23	1.23	123.4	1.23	123.4	1.23	1.23
3	123.4	1.23	123.4	1.23	1.23	123.4	1.23	123.4	1.23	1.23
4	123.4	1.23	123.4	1.23	1.23	123.4	1.23	123.4	1.23	1.23
5	123.4	1.23	123.4	1.23	1.23	123.4	1.23	123.4	1.23	1.23
6	123.4	1.23	123.4	1.23	1.23	123.4	1.23	123.4	1.23	1.23

(5) (5) (5) (5)

INTERNAL CALS

	TOTAL SAMPLES (2a)		OUT OF RANGE SAMPLES (3a)		OFF SCALE SAMPLES (4a)	
STEP	CH1	CH2	CH1	CH2	CH1	CH2
0	999999	999999	99999	99999	9999	9999
1	999999	999999	99999	99999	9999	9999
2	999999	999999	99999	99999	9999	9999
3	999999	999999	99999	99999	9999	9999
4	999999	999999	99999	99999	9999	9999
5	999999	999999	99999	99999	9999	9999
6	999999	999999	99999	99999	9999	9999
TOTAL	9999999	9999999	999999	999999	99999	99999

(2b) (3b) (4b)

REFERENCE SCAN

	MEAN	STD DEV (CH1)	MEAN	STD DEV (CH2)
(11a) SYNC	123.45	1.23	123.45	1.23
SPACE	123.45	1.23	123.45	1.23
HOUSING	123.45	1.23	123.45	1.23
BBTEMP	123.45	1.23	123.45	1.23
HORIZON	123.45	1.23	123.45	1.23

BLOCK DURATION SUMMARY

DDD HH MM SS TO DDD HH MM SS
789 89 89 89 789 89 89 89

TIME JUMPS
789

DROP LOCKS
789

PARITY ERRORS
789

EXTERNAL CALS

	TOTAL SAMPLES		OUT OF RANGE SAMPLES		OFF SCALE SAMPLES	
STEP	CH1	CH2	CH1	CH2	CH1	CH2
1	999999	999999	99999	99999	9999	9999
2	999999	999999	99999	99999	9999	9999
3	999999	999999	99999	99999	9999	9999
4	999999	999999	99999	99999	9999	9999
5	999999	999999	99999	99999	9999	9999
6	999999	999999	99999	99999	9999	9999
TOTAL	9999999	9999999	999999	999999	99999	99999

	INTERNAL CALS CH1	INTERNAL CALS CH2	EXTERNAL CALS CH1	EXTERNAL CALS CH2
PCT LINEARITY	123.4	123.4	123.4	123.4
(6) PCT RESOLUTION STEPS 2	123.4	123.4	123.4	123.4
4	123.4	123.4	123.4	123.4
6	123.4	123.4	123.4	123.4

(9) TIME FLAGS

	FRAMES	PCT
F1	99999	123.4
F2	99999	123.4
F3	99999	123.4
F4	99999	123.4
F5	99999	123.4

(10) DELTA TIME CHECK

DOY	HH	MM	SS	MSS	DOY	HH	MM	SS	MSS	DIFFERENCE DOY	HH	MM	SS	MS
789	89	89	89	789	789	89	89	89	789	789	89	89	89	789
789	89	89	89	789	789	89	89	89	789	789	89	89	89	789
789	89	89	89	789	789	89	89	89	789	789	89	89	89	789
789	89	89	89	789	789	89	89	89	789	789	89	89	89	789
789	89	89	89	789	789	89	89	89	789	789	89	89	89	789
789	89	89	89	789	789	89	89	89	789	789	89	89	89	789
789	89	89	89	789	789	89	89	89	789	789	89	89	89	789
789	89	89	89	789	789	89	89	89	789	789	89	89	89	789
789	89	89	89	789	789	89	89	89	789	789	89	89	89	789
789	89	89	89	789	789	89	89	89	789	789	89	89	89	789

(7) NO. FRMS EXPECTED 99999
NO. FRMS RECOVERED 99999
PCT FRMS RECOVERED 123.4

(11b) SCAN PERIOD
MEAN 123.45
STD DEV 12.34
ERRORS 6789
DELTA P (PERCENT) 00.10

(8) Quality Card ______
Calibration Card ______

Figure 9. NIMBUS E Quality Control

Table 1

Range of Values for Calibrations

Step	Center - Δ Lower Limit	Center	Center + Δ Upper Limit
0	14_8	24_8	34_8
1	60_8	70_8	100_8
2	124_8	134_8	144_8
3	170_8	200_8	210_8
4	234_8	244_8	254_8
5	300_8	310_8	320_8
6	344_8	354_8	364_8
Range of values for Calibrations ($\Delta = \pm 10_8$)*			

*Note 1: The tolerance "Δ" shall be easily changed in the program. The range of Δ is as follows $1 \leq |\Delta| \leq 18_{10}$

Note 2: Guardband a) Lower 0 to 23_8 (nominal) (See Attachment 2)
b) Upper 355_8 to 377_8 (nominal)

(8) The content of the Quality card and the Calibration card is displayed in Figure 12 and Figure 13 respectively. The actual format will be defined at a later date.

(9) Time flags (Reference Hardware description).

(10) "Δ" T check will be a list of the first 10 occurrences of time jumps. A time jump is defined as a time difference (ΔT) between frames of 100 MS ± 1 MS*, i.e., take two consecutive frames of data with time T_1 + T_2 respectively with their difference "ΔT" outside the tolerance, then the Q.C. listing would reflect T_1 - DOY, hours, minutes, seconds, and milliseconds; T_2 - DOY, hours, minutes, seconds, milliseconds; and ΔT - their difference. However, if a drop lock should occur; the ΔT will not be computed "across" the data gap.

*Perform this check so that a change in the 1 ms tolerence can easily be accomplished.

Table 2

Sample Strategy

Data Type	Total Samples		Sample Number
Sync Pulse	31		1 thru 31
Space	62	Step 0	1 thru 62
Internal Cals & Horizon	187	Step 1	4 thru 13
		2	19 thru 28
		3	19 thru 44
		4	50 thru 59
		5	66 thru 75
		6	81 thru 90
		Horizon	95 thru 187
Earth Scan	3475		1 thru 3475
External Cals	187	Step 1	8 thru 26*
		2	39 thru 57*
		3	70 thru 88*
		4	101 thru 119*
		5	132 thru 150*
		6	163 thru 181*
Housing	187		41 thru 100
BB temp.	31		1 thru 15
	4160 (Total Samples per channel)		

*Take 1st value & then every other value, i.e., Step 1, sample 8,10,12,14,16, 18,20,22,24,26. Step 6, sample 163,165,167,169,171,173,175,177,179.

*Mean

$$\text{Mean for step N} = M(n) = \frac{1}{10m}\sum_{j=1}^{j=m}\sum_{i=n_1}^{i=n_2} S(n)_{i,j}$$

M_n = mean value of step n, m = number of frames examined, n_1, n_2 = lower and upper limits of sampling range for step n (shown in Table 1), $S(n)_i$ = value of a sample in step n.

example: m = 5 frms, step 1, internal cals, $n_1 = 5$ $n_2 = 14$
$S(n)_i$ = (Table 3)

$$M(1) = \frac{1}{50}\sum_{J=1}^{J=5}\sum_{i=5}^{i=14} S(1)_{i,j} = \frac{1}{50}(2980) = 59.6$$

*Standard Deviation

$$\text{Std Dev for step m} = \sigma(n)\left[\left(\frac{1}{10m}\sum_{J=1}^{J=m}\sum_{i=n_1}^{i=n_2} S(n)^2_{i,j}\right) - M(n)^2\right]^{1/2}$$

$$\sigma(1)\left[\left(\frac{1}{50} \times 216{,}752\right) - 3552\right]^{1/2} = 27.98$$

*Mean & Std Dev for the Cals are calculated as follows: mean of the A/D outputs for each step based on the frame (scan) i.e. average the output by channel by frame;
Compute the Std Dev of all the averages for the pass.

Figure 10. Equations for Computing Mean & Std Dev

Table 3

Example of Computing the MEAN and STD DEV (Step 1 Used as Example)

Samples (i) / Frame (J)		.....	2	3	4	5	6	7	8	9	10	11	.....			
	1		*255	**65	54	54	53	53	52	→	→	→		742	$\sum_{2}^{11} S(1)_{i,1}$	J = 1
	2		55	55	→	→	→	→	→	→	→	→		550	↓	J = 2
	3		55	56	56	→	→	→	→	→	→	→		559	↓	J = 3
	4		56	56	→	→	→	→	→	→	→	→		560	↓	J = 4
	5		(57)	56	57	→	→	→	→	→	→	→		569	$\sum_{2}^{11} S(1)_{i,5}$	J = 5
m = 5		$S(1)_{2,5}$												2, 980	$\sum_{J=1}^{5} \sum_{2}^{11} S(1)_{i,j}$	
						$S(1)^2_{i,j}$										
	1		65025	4225	2916	2916	2809	2809	2704	→	→	→		91, 516	$\sum_{2}^{11} S(1)^2_{i,1}$	J = 1
	2		3025	→	→	→	→	→	→	→	→	→		30, 250	↓	J = 2
	3		3025	3136	3136	→	→	→	→	→	→	→		31, 249	↓	J = 3
	4		3136	→	→	→	→	→	→	→	→	→		31, 360	↓	J = 4
	5		3249	3136	3249	→	→	→	→	→	→	→		32, 377	$\sum_{2}^{11} S(1)^2_{i,5}$	J = 5
														216, 752	$\sum_{J=1}^{5} \sum_{2}^{11} S(1)_{i,j}$	

*This would be an off-scale sample.

**This would be an out-of-range sample.

Percent Linearity (L)

$$L = \left[\frac{(m_6 + m_2)}{2m_4} \right] x\ 100$$

Where M_2, M_4 & M_6 are the means for Steps 2, 4 & 6 respectively.

Percent Resolution (R) is calculated for each steps 2, 4, 6

$$R = \frac{2\sigma}{216} X\ 100 \text{ or } .93\sigma$$

Where σ 2 is the standard deviation for Step 2
σ 4 is the standard deviation for Step 4
σ 6 is the standard deviation for Step 6

Percent Frame Recovery

$$\%\ \text{Frm Rec} = \frac{\text{Frames output (computer)}}{\text{Frames expected}} X\ 100$$

$$\text{Frames Expected} = \left[(T_2 - T_1) \cdot \frac{10\ \text{Frm}}{\text{Sec}} \right] + 1$$

Where T_1 is the 1st time that Frame Sync is recognized, and
T_2 is the last time that Frame Sync is recognized.

Figure 11. Equation for Computing. 1) % Linearity, 2) % Resolution, and 3) % Frm Recovery

(11) Sync Pulse and Scan period: a) calculate the mean and standard deviation of the sync pulse amplitude, and b) calculate the mean and standard deviation of the scan period counts, and tabulate the number of scan period errors. The scan period count (P) is the number of 100 kHz clock periods between sync pulses. The nominal value is 10,000 counts for the 100 millisecond scan period. Scan period errors are based on a ΔP which is initially established at ± 10 counts (ΔP is subject to change and should be easily programmable). Figure 14 contains the formulas for calculating the mean and standard deviation for the sync pulse amplitude and the scan period.

Item	Source	Format
Satellite ID	Computer	AANN - NB05
Record Station Code	TTY	AAA
Analog Tape Number	TTY	NNNN
Analog Tape Pass Number	TTY	N
Buffer Tape Number	TTY	NNNN
Year, Month, Day Recorded	TTY	NN NN NN
Digitize Start Time DDD HR MM SS	Computer	NNN NN NN NN
Digitize Stop Time DDD HR MM SS	Computer	NNN NN NN NN
Scan Period Error	Computer	NNN
Time Flags (F_1)	Computer	NNN.N
Time Flags (F_2)	Computer	NNN.N
Date Digitized YY MM DD	TTY	NN NN NN
Shift	TTY	N
No. of Frames Recovered	Computer	NNNN
Percent Frames Recovered	Computer	NNN.NN
Number of Drop Locks	Computer	NN
Card Identifier	Computer	A - Q

Figure 12. Quality Card Content (Preliminary)

Item	Source	Format
Satellite ID	Computer	AANN - NB05
Record Station Code	TTY	AAA
Station Tape Number	TTY	NNNN
Station Tape Pass No.	TTY	N
Year Recorded	TTY	NN
DOY Recorded	TTY	NNNN
No. of Frames Recovered	Computer	NNNN
Percent Linearity ext & int	Computer	NNN.N
Percent Resolution ext & int for Steps 2, 4, & 6	Computer	NNN.N
Total Out-of-Range Samples Ch 1 & Ch 2 (Ext & Int)	Computer	NNNNN
Total Off-Scale Samples Ch 1 & Ch 2 (Ext & Int)	Computer	NNNN
Year Digitized	TTY	NN
DOY Digitized	TTY	NNNN
Card Identifier	Computer	A - C

Figure 13. Calibration Card Content

Figure 15 contains a diagram of the calibrations with the addition of a guardband. The A/D output resolution is one bit in 256 bits. The guardband will require 39 levels; the first 20 (0 through 19), and the last 19 (237 through 255). As a result, instead of having a dynamic range of 48 db available to the A-3 line, NIMBUS SCMR data will have a maximum of 46.6 db. This is within the NIMBUS-E SCMR requirement which is 40 db.

Mean (Space Scan)

$$M = \frac{1}{31m} \sum_{J=1}^{J=m} \sum_{i=1}^{i=31} S(n)_{i,J}$$

M = Mean value of the sync pulse, m = no. of frames examined, $S(N)_i$ = value of a sample. Each frame has 31 samples

STD DEV

$$\sigma = \left[\frac{1}{31m} \sum_{J=1}^{J=m} \sum_{i=1}^{i=31} S(n)^2_{i,J} - M^2 \right]^{1/2}$$

Mean (Scan Period)

$$M = \frac{1}{m} \sum_{i=1}^{i=m} S(n)_i$$

M = Mean value of the scan period, m = no. of frames examined, $S(N)_i$ = the period between sync pulses. Nominal value 100 ms ± 0.1%

STD DEV

$$\sigma = \left[\frac{1}{m} \sum_{i=1}^{i=m} S(n)^2_i - M^2 \right]^{1/2}$$

Figure 14. SCAN Equations

The final requirement is a plot program (for CALCOM plotter) which will display any record(s) selected by the PEAS via the use of control cards. The control cards will enable one to select one record or sets of records to be plotted. (Figure 16)

The programmer shall define the plot program control card. NOTE: It will be necessary to plot only every other 10 samples of the earth scan data.

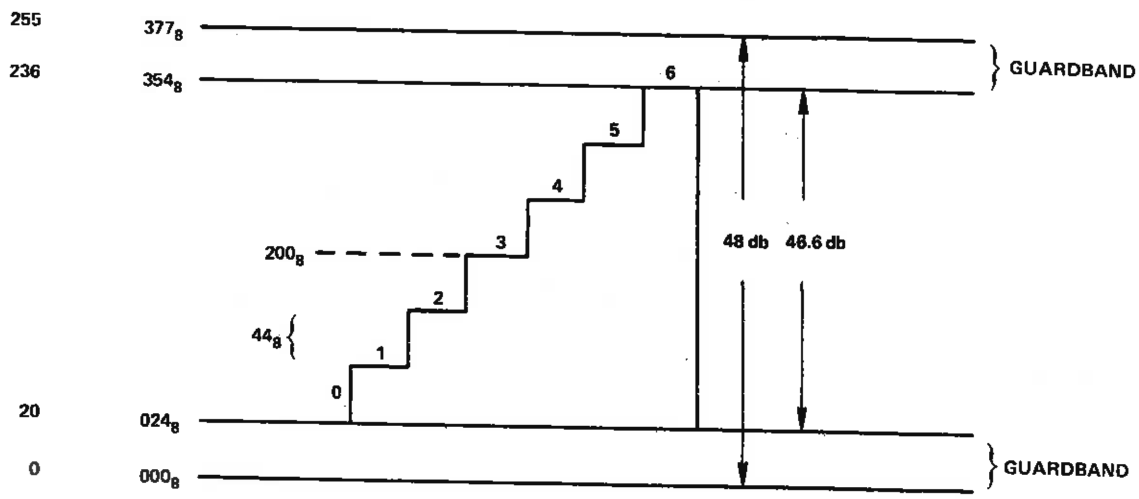


Figure 15. Guardband

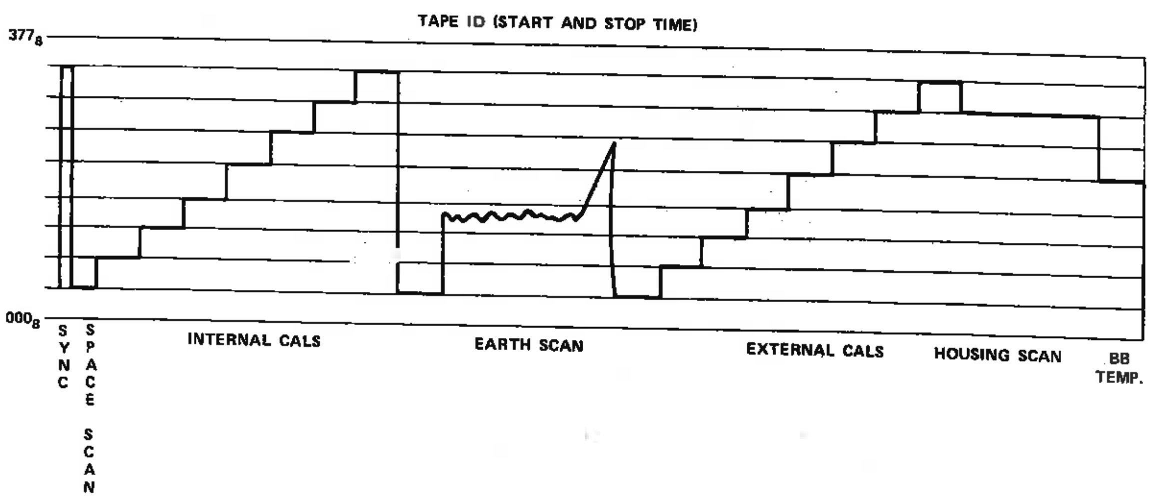


Figure 16. Example of a Plot from the Calcom Plotter

VI. PRODUCTION REQUIREMENTS

The following procedures are to be followed for processing NIMBUS-E data in the Data Processing Branch.

The request to process data will originate in the NIMBUS-E Project Office. The Project Office will request processing by using the "NIMBUS-E Work Request" form (Figure 17) supplied by the Data Processing Branch. For each tape requested on the work request form, the Project Office will provide the

NIMBUS-E WORK REQUEST

REQUEST NO. ______

Requested by: ______
Date: __/__/__

STA.	TAPE	DATE RECORD	TIME REQUIRED		DATE REC'VD. PCC	BUFFER NO.	INV. NO.	DATE SHIPPED	COMMENTS
			START	STOP					

Figure 17. NIMBUS E Work Request

three-letter tracking station code, analog tape number, date of recording, the start and stop time of data requested for processing, and the track location of data should be written in the comments portion of the form. The form also requires the name of the person making the request, the date of request and the request number. The requests will be numbered sequentially and may contain no more than ten analog tapes per request number. The second copy of the work request will be retained by the Project Office. The original and first copy, along with the analog tapes, will be sent to the Data Processing Specialist (DPS) in the Data Processing Branch.

Upon receipt of the work request and analog tapes, the DPS will enter the date the work request was received on the work request in the column labeled "Date Rec'vd PCC". The DPS will schedule the data for processing on the A-3 system in a way to assure a two-week turnaround to the Project Office. He may hold the request until there is enough work for an 8-hour shift or, depending on the workload and available time on the A-3 system, the DPS may schedule the data for processing as the requests are received.

The Data Processing Specialist will retain the original copy of the NIMBUS-E work request as a permanent record of work done by the Data Processing Branch. The first copy of the work request and the analog tapes will be sent to the A-3 system for processing. The work request will show the operator the order the analog tapes are to be processed, the times to be processed, and the track the data is located on. The operator will use operating procedures supplied by the Engineering group. The operator will also use the form "Buffer Analog to Digital Summary" (Figure 16) to provide the standard information required of all projects.

The A-3 system operator will generate one buffer tape for each start-stop time requested, using a combination of the request number and the number of digital tapes generated for that request the operator will assign the Buffer numbers. As an example, Request Number 122 had three analog tapes listed and three buffer tapes were generated. The Buffer numbers would be 122.1, 122.2, 122.3.

The distribution of the input and output from the A-3 system will be as follows: the analog tapes and a copy of the Buffer/Digital Summary will be returned to the DPS; the Buffer tapes, one copy of the Buffer/Digital Summary, the work request, and the quality listing will be sent to Dispatch.

Dispatch will hold the Buffer tapes, send the Buffer/Digital Summaries, the work request and quality prints to the Data Analysis Group.

BUFFER ANALOG TO DIGITAL SUMMARY

PROJECT ____________________ LINE ____________________ PRODUCTION TYPE ____________________

DATE ____________________ SHIFT ____________________ OPERATOR ____________________

BUFFER NUMBER	DIGITAL FILE NUMBER	BUFFER TAPE INV. NUMBER	STATION NAME	TAPE NUMBER	PASS NUMBER	DIGITAL			
						START	STOP		

SE0-15(11-67) GODDARD

Figure 18. Buffer Analog to Digital Summary

The Data Analysis group will make the necessary quality checks using quality information provided by PEAS. After the analysis is completed, files for redigitizing will be sent back through the system for reprocessing, info the DPS, by the Data Analysis Group. After successful completion of a whole request, the Buffers will be released to the DPS for shipment to the Project Office. In releasing data, the analyst will use the "Data Processing Branch Edit Release" form (Figure 19). Each request number should have a separate release form and all buffers should be clearly identified with the following information: satellite ID, date of release, buffer number, buffer inventory number, analog station, analog tape number, disposition, and if a redigitize, the reason.

Upon release of a request, the DPS will send the buffer tapes, the analog tapes and a copy of the Edit Release form to the Project Office by special messenger. Prior to shipping, the DPS will validate and enter the buffer numbers, inventory numbers, and the date shipped in the proper columns of the original copy of the NIMBUS work request form. The DPS will also be responsible for seeing that the buffer tapes shipped are charged to the NIMBUS-E Project Office.

Since the Information Processing Division does not have responsibility for receiving and storing analog tapes or for storing of buffer tapes from the Project, the services of the Telemetry Data Accounting Office will not be required.

The time on the A-3 system will be accounted for in the Line Utilization Report in the normal manner. Since the Date Processing Branch processes only the data requested by the Project Office, the number of files received, production hours used, and the files output will be the only information accounted for in the "Facility Status Report". The number of files in-house for more than two weeks will be added as a note.

DATA PROCESSING BRANCH EDIT RELEASE

PROJECT	DATE	EDIT NO.	FILE NO.	ID OF REJECTED FILE	START TIME	REASON FOR REJECTION	DATE SHIPPED	REMARKS

560-111 (1/70) GODDARD SPACE FLIGHT CENTER

Figure 19. Edit Release Form

APPENDIX A

QUALITY CHECK OF DIGITIZED SCMR DATA*

(REV A - Extend sampling of internal calibration to pick up leading earth horizon - to monitor roll deviations, extend sampling of external calibration.)

I. GENERAL

Selected SCMR Data will be digitized. Upon completion of the digitizing process, the magnetic tape containing the digitized data will require a check to ascertain,

1. That the data has been correctly processed and formatted.
2. That the spacecraft experiment, and related ground station hardware, has not experienced any malfunction.

By performing the quality checks specified herein, these objectives can be met.

It is assumed that all digitizing will be performed in the forward data direction only.

II. DATA CONTENT AND FORMAT

The digitized data will contain time tag information, plus sample pairs of the two (2) SCMR channels, extracted from various parts of the scan. The digitizing rate of each part of the scan depends on the data content.

The principal parts of the scan sampled are:

1. Sync Pulse
2. Input Internal Calibration Staircase
3. Output External Calibration Staircase
4. Space Scan Data
5. Housing Scan Data
6. Earth Scan Data
7. Blackbody Temperature (Internal Temperature Telemetry Value)

*For information only.

Specific parameters for extracting data, and the sampling rates have been specified elsewhere. Reference - Memo from R. SHAPIRO to R. TETRICK, "Nimbus 'E' Requirements" dated July 20, 1970.

The specific format of the tape is to be determined, but specific data content will correlate with specific locations within the format. Based on reference memo requirements (shown in Figure 1 and Table 1), Table 2 shows sample numbers to be extracted.

III. SPECIFIC QUALITY CHECKS

The following checks will be performed for each block of continuous data, as indicated by continuous time; i.e., each time jump defines the beginning of a new block.

A. SCAN PERIOD

The period between sync pulses of adjacent scans should be determined, each scan, during the digitizing process and the value included on the output magnetic tape each data record. This value should be the number of 125 KHZ clock periods between scan sync detections. (Nominal value = 12,500.)

During the QC check, note all scan sync periods that are outside the limits of 12,500 ± 5 clock periods, but within 12,500 ± 2500 clock periods. Report the total number of these scan periods errors per block.

B. COMPARISON OF INTERNAL TO EXTERNAL CALIBRATION STAIRCASE

The average values of each step of the external calibration staircase for each channel should be determined. The mean and standard deviations of these averages for each step over the number of scans available should be reported for each channel.

For each step, the difference between the average internal staircase value and the average external staircase value should be determined. A mean of this average difference for each step over the number of scans available should be reported for each channel.

C. SPACE AND HOUSING SCAN DATA AND BLACKBODY TEMPERATURE

A mean and standard deviation for 1) Space Scan Data; 2) Housing Scan Data, and 3) Blackbody Temperature should be determined and reported for each channel.

Location of this data should be based on nominal timing from the magnetic tape format.

IV. LISTING OPTION

Optionally, list the following data over a range of scans specified by input parameters (TIME = HH MM SS & SCANS = XX). Format data samples as three digit integers, one (1) space between samples within pairs (equivalent samples from both channels) and three (3) spaces between pairs of samples, giving 24 columns X 60 rows per printer page. Format scan time each scan DDD HH MM SS and scan period in number of 125 KHZ periods on a separate line.

Option (1) list all data

Option (2) list all data except Earth Scan Data.

IV. OUTPUT REPORT FORMAT (Typical)

ORBIT XXXX SCMR DIGITIZED DATA

CHANNEL 1 CHANNEL 2

BLOCK 1 SUMMARY

CALIBRATION STAIRCASES (COUNTS)

EXTERNAL			INTERNAL	EXTERNAL		INTERNAL
STEP	MEAN	STD DEV	DIFF	MEAN	STD DEV	DIFF
1	XXX.X	X.XX	X.XX	XXX.X	X.XX	X.XX
2	XXX.X	X.XX	X.XX	XXX.X	X.XX	X.XX
3	XXX.X	X.XX	X.XX	XXX.X	X.XX	X.XX
4	XXX.X	X.XX	X.XX	XXX.X	X.XX	X.XX
5	XXX.X	X.XX	X.XX	XXX.X	X.XX	X.XX
6	XXX.X	X.XX	X.XX	XXX.X	X.XX	X.XX

REFERENCE SCAN (COUNTS)

	MEAN	STD DEV	MEAN	STD DEV
SPACE	XXX.X	X.XX	XXX.X	X.XX
HOUSING	XXX.X	X.XX	XXX.X	X.XX
BB TEMP	XXX.X	X.XX	XXX.X	X.XX

SCAN PERIOD ERRORS XXXX

BLOCK 2 SUMMARY

(SAME FORMAT AS BLOCK 1 SUMMARY)

BLOCK N SUMMARY

(SAME FORMAT AS BLOCK 1 SUMMARY)

BLOCK DURATION SUMMARY

BLOCK 1 FROM DDD HH MM SS TO DDD HH MM SS
2 FROM DDD HH MM SS TO DDD HH MM SS
N FROM DDD HH MM SS TO DDD HH MM SS

TABLE 1

Item	Time Int, (ms)	Rate	Sample
Sync Pulse	0 - 1	31.25 kHz	31
Space	2 - 4	31.25 kHz	62
Input Cal	6.5 - 12.5	31.25 kHz	187
Earth	13.37 - 41.17 (±50°)	125 kHz	3475
Output Cal	54.5 - 66.5	15.625 kHz	187
Housing	75 - 78	62.5 kHz	187
BB TM	85 - 87	15.625 kHz	31
		TOTAL/CHANNEL	4160
		X2 CHANNELS	8320

(8-bits/sample)

SUMMARY

DATA	8320
TIME, Flags, Scan Period	8
	8328 Total Characters per Data Record

TABLE 2

Samples to be extracted based on samples listed in Table 1

Data Type	Total Samples		Sample Numbers
Space	62		1 Thru 62
Internal Cal (Input Cal)	187	Step 1	2 Thru 11
		2	18 Thru 27
		3	34 Thru 43
		4	49 Thru 58
		5	65 Thru 74
		6	81 Thru 90
			97 Thru 187
Earth Acquisition			
External Cal	187	Step 1	10 Thru 20
		2	41 Thru 51
		3	72 Thru 82
		4	103 Thru 113
		5	134 Thru 144
		6	165 Thru 175
Housing	187		41 Thru 100
Blackbody Temp	31		1 Thru 15

NOTE: Attached for reference is tape format as of May 31, 1972