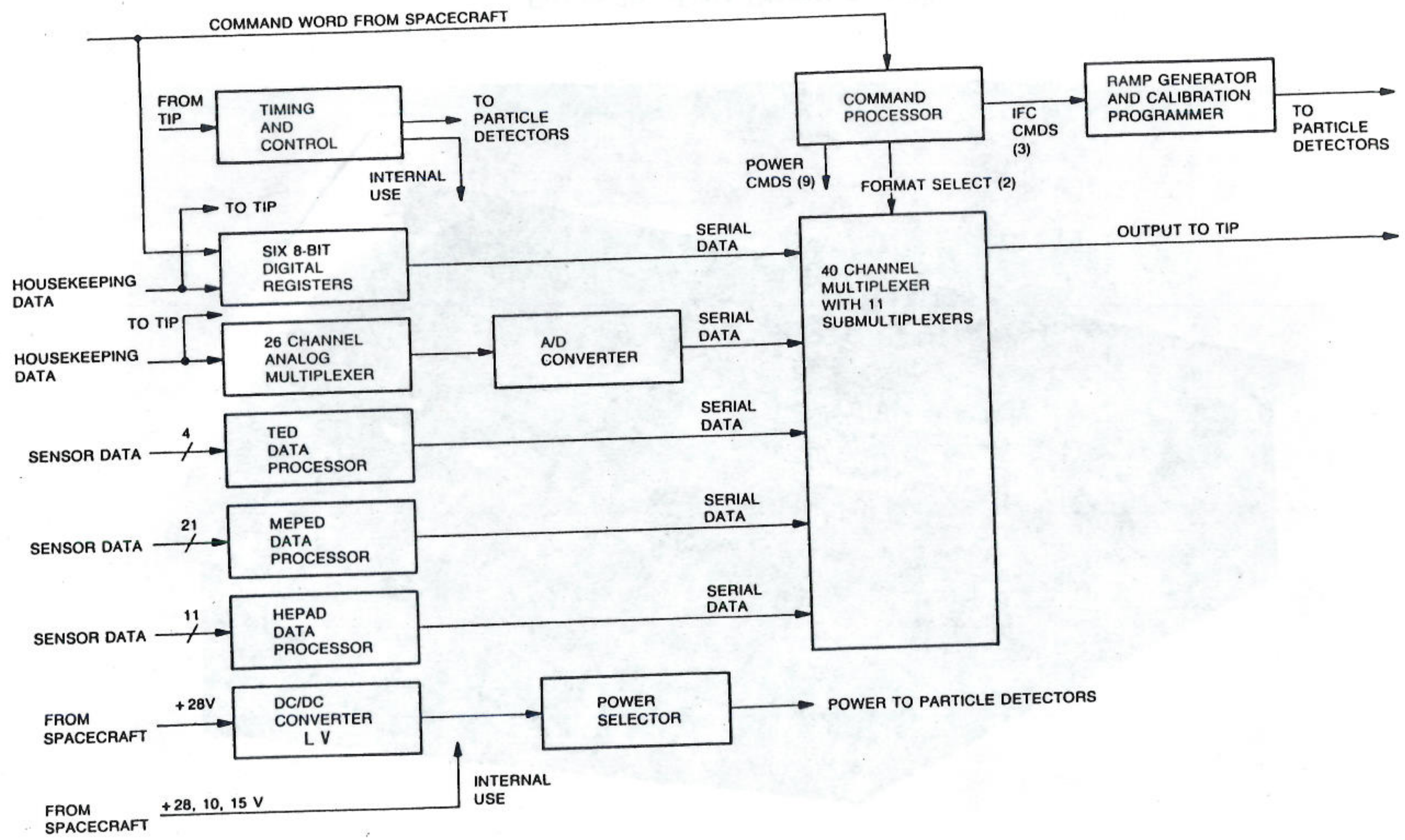


Figure 30.—DPU Block Diagram

minor frame (2 s). Signal c is used as the basic clock in all the circuits and is also the rate at which data are being transmitted to TIP. Signal d determines the time in a TIP frame of 100 ms when data from DPU are being transmitted. This signal is received only when TIP wants DPU data.

b. The Analog and Digital Multiplexer receives analog and digital housekeeping data from the particle detectors. The DPU handles this data in two ways:

1. The DPU has 26 analog and 48 digital channels available at a sampling rate of once in 32 s. It converts each analog word into 8 bits and inserts the converted data together with the digital data into Digital "A" Output to the TIP.

2. Some of the housekeeping data are connected directly to the spacecraft. Each source is on a separate line.

c. The pulses from the particle detectors are random pulses, counted in a special compression counter, the 623C. On command, this counter converts the 19-bit binary count into an exponent y and mantissa x; y and x having four bits each. The eight-bit number from each detector channel has a time slot assigned to it in the frame format as listed in Appendix H.

d. The A/D converter changes analog signals to digital form for insertion into Digital A. (Digital B is created in the spacecraft from analog signals from the SEM and other subsystems.)

e. The data from particle detectors and the housekeeping data are formatted into a major frame of 640 8-bit words. The data rate to the TIP is 160 bits/s. Data are sent only when an Al-select signal is received.

f. The DPU receives 12 command lines from the spacecraft. Eight of these are "level commands" which stay at the commanded level until changed from the ground by another command. The four remaining are "pulse commands" which stay on various short times (60 ms for NOAA-G). The DPU decodes these inputs and performs the following functions:

1. Switches the Power ON/OFF to each of the three particle detectors.

2. Establishes Mode 1 or Mode 2 of data transmission.

3. Starts calibration of the particle detectors.

4. Terminates the calibration.

5. Switches ON/OFF power to the LV power supply in the DPU.

The command processor also buffers and sends to the TED six level and one pulse command lines and to the HEPAD seven level and one pulse command lines.

g. The Ramp Generator and IFC Programmer, in response to a received command, generates a linear 0-8V ramp and corresponding timing signals necessary to perform the calibration of each particle detector.

The calibration sequence is self-terminating and may also be terminated on command before it runs its full course.

h. Low Voltage (LV) Power Supply

This module supplies power to the DPU and to each of the sensors. A DC/DC converter generates the following voltages from the spacecraft 28 volt main bus.

+6 volts	1610 mW
-6 volts	1150 mW
+12 volts	1430 mW
-12 volts	760 mW
+5 volts	3060 mW
+30 volts	880 mW
+350 volts	35 mW
	8925 mW

6.3 Symbols & Data Conversion

This section defines the data channel names and explains the data conversion from telemetered logarithmic compressed format to true count.

a. Data Coding. The following notation is used to refer to the various data channels:

channel names abc

where a = 0, 30, 90

b = see table

c = see table

For some channels a and c are not used.

Symbol a = view direction

0 = -X

30 = 30° from -X axis in -X, -Z plane

90 = 90° from -X axis along +Z *.

* In the case of the MEPED, this is only approximate to the angle from the -X axis.

Various alternate forms of these codes are used which include spaces, hyphens, and subscripts.

Symbol b

Symbol	Type	Function/Source
I	LOG	Ions/MEPED
P	LOG	Protons/MEPED, HEPAD
P	LOG**	Positive Ions/TED
E	LOG**	Electrons/MEPED, TED
S	LOG	Coincidence Counters/HEPAD
S	LOG	Singles Counters/HEPAD
A	LOG	Alpha Particles/HEPAD
DE	LOG	Diff. Energy, Electrons/TED
DP	LOG	Diff. Energy, Protons/TED
EF	LOG/Prescaled	Total Flux, Electrons/TED
PF	LOG/Prescaled	Total Flux, Protons/TED

** Except for EM, PM, see below.

Symbol c

1-8	Channel Number
m	With E or P, an integer identifying the channel in which max counts appeared.
M	With DE or DP, count in max channel
D	Directional
BK	Background
FD	Directional flux

b. Data Conversion

1. The particle counts are log compressed into a two part (y, x) floating point hexadecimal format by the several Type 623 Floating Point Processors in the SEM, all of which work in the 19-8 mode. Conversion from hexadecimal to actual count may be done using either Table 6 or 7 for all channels except EFD and PFD. (Note: the bit numbering is assigned in reverse order from that in Table 14.) The count listed is the lowest actual count fed into the 623 which results in the y,x listed.

TABLE 6. Algebraic Conversion of Log Function to Count

MSB							LSB
7	6	5	4	3	2	1	0

where, for any log function,

y = Bits 7, 6, 5, and 4,

x = Bits 3, 2, 1, and 0.

Use the following equations with y and x decimal:

a) If y = 0 to 8:

$$\text{Count*} = [(x + 16)\ 2^{(y + 6)}] + 1$$

Except: If $y = 8$ and $x = 15$, Count = 0.

* This conversion holds for all "log" functions except EFD and PFD see 2. below

b) If y = 9: Count = x + 1.

c) If y = 10: Count = x + 17.

d) If y = 10 to 15: $\text{Count} = [(x + 16)\ 2^{(y - 10)}] + 1$.

The telemetered hexadecimal values can be converted into a monotonic format by adding binary seven to all y values, binary one to all x values, and adding any resulting carrys to the y values.

TABLE 7. Look-up Conversion of Log Function to Count

y \ x	0	1	2	3	4	5	6	7	y
0	1025	1089	1153	1217	1281	1345	1409	1473	0
1	2049	2177	2305	2433	2561	2689	2817	2945	1
2	4097	4353	4609	4865	5121	5377	5633	5889	2
3	8193	8705	9217	9729	10241	10753	11265	11777	3
4	16385	17409	18433	19457	20481	21505	22529	23553	4
5	32769	34817	36865	38913	40961	43009	45057	47105	5
6	65537	69633	73729	77825	81921	86017	90113	94209	6
7	131073	139265	147457	155649	163841	172033	180225	188417	7
8	262145	278529	294913	311297	327681	344065	360449	376833	8
9	1	2	3	4	5	6	7	8	9
10	17	18	19	20	21	22	23	24	10
11	33	35	37	39	41	43	45	47	11
12	65	69	73	77	81	85	89	93	12
13	129	137	145	153	161	169	177	185	13
14	257	273	289	305	321	337	353	369	14
15	513	545	577	609	641	673	705	737	15

y \ x	8	9	10	11	12	13	14	15	y
0	1537	1601	1665	1729	1793	1857	1921	1985	0
1	3073	3201	3329	3457	3585	3713	3841	3969	1
2	6145	6401	6657	6913	7169	7425	7681	7937	2
3	12289	12801	13313	13825	14337	14849	15361	15873	3
4	24577	25601	26625	27649	28673	29697	30721	31745	4
5	49153	51201	53249	55297	57345	59393	61441	63489	5
6	98305	102401	106497	110593	114689	118785	122881	126977	6
7	196609	204801	212993	221185	229377	237569	245761	258953	7
8	393217	409601	425985	442369	458753	475187	491521	0	8
9	9	10	11	12	13	14	15	16	9
10	25	26	27	28	29	30	31	32	10
11	49	51	53	55	57	59	61	63	11
12	97	101	105	109	113	117	121	125	12
13	193	201	209	217	225	233	241	249	13
14	385	401	417	433	449	465	481	497	14
15	769	801	833	865	897	929	961	993	15

2. Conversion of Log Functions EFD and PFD To Count for the TED Flux Measurements

For the TED total flux measurements (only) a five-bit prescaler is used in the instrument to scale the count as the high voltage changes on the deflection plates, and the counting registers are preset to 1 (instead of 0 as for other channels). Correction for the additional count is not significant for counts above 33. The bits of the prescaler are not included in the readout except for cases where the true count is less than 8 (i.e., y = 9 and x < 7). In these cases the prescaler bits are included and the value of y is modified to overlay the normal (very high) range of y = 6, 7, 8, giving a "double valued" table. The correct value must be determined from EFM or PFM values.

a. If y = 9 and x = 4, 5, 6, or 7, generate a new "x" by shifting the "x" bits left one position and entering the MSB of the prescale in the LSB position of x; make the new value of y = 6, (e.g., If x = 6 (0990), shift the bits to make the new value of x = 110 P where P is the MSB of the prescale).

b. If y = 9 and x = 2 or 3, generate a new "x" by shifting the "x" bits left two positions and entering the two MSB's of the prescale in the 2 LSB positions of x; make the new value of y = 7.

c. If y = 9 and x = 1 or 0, generate a new "x" by putting this "x" bit in the MSB position of x and entering the 3 MSB's of the prescale in the 3 LSB of x; make the new value of y = 8.

The alternate output in true count, where x and y are the newly generated values of x and y, then becomes:

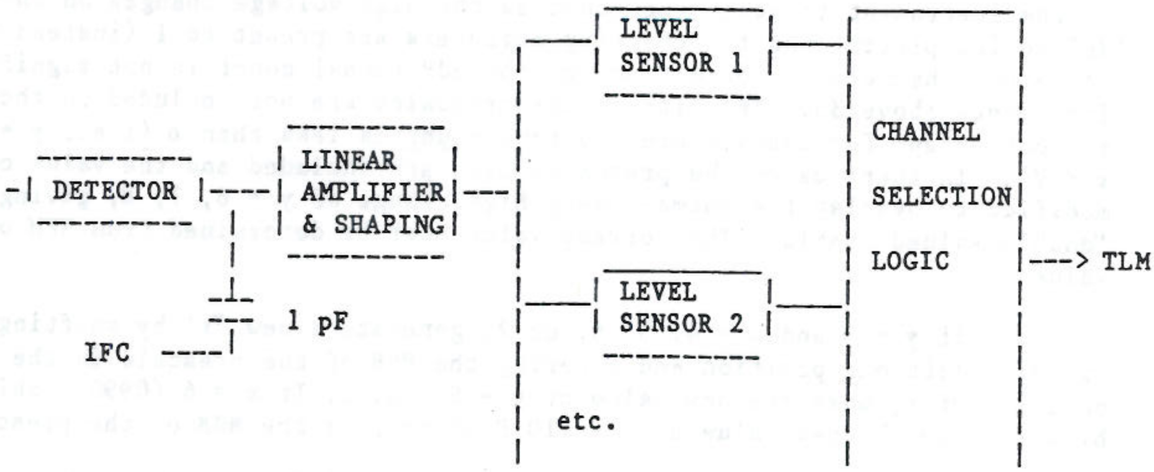
TABLE 8. TED Prescaler True Count

	x = 0	1	2	3	4	5	6	7
y = 6	THE HIGH VALUE							
y = 7	THE HIGH VALUE							
y = 8	0	1/8	1/4	3/8	1/2	5/8	3/4	7/8
y = 9	INVALID FOR THESE TED WORDS							

	x = 8	9	10	11	12	13	14	15
y = 6	4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2
y = 7	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4
y = 8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8
y = 9	8	9	10	11	12	13	14	15

7. INFLIGHT CALIBRATION IFC

a. The HEPAD and MEPED are of the form



For each incident particle the detector produces a quantity of charge which is proportional to the energy deposited in the detector. This charge is converted to a voltage pulse and amplified until it is at a suitable level to apply to a Level Sensor each of which puts out a logic level pulse when the level is exceeded. It is usual to refer to the level in terms of the energy deposited in the detector. This is measured in electron volts (eV).

To calibrate, the electronic portion of the system is stimulated by injecting known quantities of charge at the input of each preamplifier in parallel with the detector using a small coupling capacitor driven from a low impedance source of "tail pulses". These are pulses with a fast rise and slow exponential decay. During the fast rise, a known charge ($Q = CV$) is injected and processed by the electronics exactly as if a particle had entered the detector.

The scale is established by the transfer scale of the detector w, the charge on one electron q and the capacitance of the IFC capacitor C.

w = 3.62 eV per charge pair released in the detector. (Ortec, 1985)
q = 1.6021773 E-19 coulombs.
C = approximately 1 pF.

$$\text{The scale is } \frac{q}{w\,C} = \frac{1.6021773\text{ E-19}}{3.62 \times 1\text{ E-12}} = 44.259\text{ mV/MeV}$$

The scales in the appendices are based on 45 mV/MeV.

The pulses are amplitude modulated by a ramp (actually a stair-case of 1024 steps) which rises from zero to full scale in 192 seconds. The 192 s period is made by dividing the spacecraft 8320 Hz clock by (13 x 8 x 15 x 1024).

Levels for the level sensors are found by analysis of the output data on the ground. The analysis also checks system noise and long-term stability.

Upon receipt of the IFC ON command, the calibration generator in each of the instruments generates a sequence of calibration pulses, synchronized to the telemetry format. During the sequence, which is long compared to the read-out cycle of the instruments, the calibration pulse amplitude (and the equivalent energy) is linearly increased from zero to a peak value. By examining the sequence of readouts from an output channel during the calibration, it is possible to calculate the threshold energy level for that channel.

In the absence of noise in the channel, the simplest read-out sequence observed would be of the form

0 0 0 0 0 P C C C C C C C

where C is a constant called the "complete count" which depends on the tail pulse frequency (8.32 kHz) and the accumulation time. The energy level of the channel is calculated by linear interpolation between zero and the ramp peak energy. One intermediate value P, where $0 < P < C$, will occur if the level sensor turn-on occurs during an accumulation period. In most cases, because of sharing of accumulators, accumulation is not continuous so it is possible that P may not occur. If an intermediate value P is present, it is used to interpolate between telemetry word levels. If it is not present, then the accuracy of the interpolation is limited to word interval quantization.

In the MEPED, the calibration pulses are gated on and off on alternate readouts. So, out of 96 values telemetered in 192 s 48 contain IFC values. This is done to measure the ambient particle background, which is significant in orbit and must be subtracted from the calibration. On the ground, this background will normally be zero. Thus, on the ground the following sequence will appear

0 0 0 0 0 C 0 C 0 C 0 C 0, etc.

where again P may or may not appear.

In the lower energy channels of the MEPED and the singles channels of the HEPAD, the noise, which is due to the sum of noise from the detector and electronic noise from the preamplifier, is sufficiently large compared with the level sensor thresholds that it is necessary to keep track of the noise as a quantitative performance parameter. An increase of noise is of concern because in the extreme, it would cause one or more level sensors to trip continuously and render a channel or channels inoperative.

The noise performance of each detector-preamplifier chain can be measured by observing the calibration telemetry sequence from the lowest energy level sensor connected to that detector. The effect of the noise is to broaden the turn-on of the level sensor so that instead of one possible intermediate value we expect to see several, e.g.,

0 0 0 0 0 h i j k C C C C, etc.

where h, i, j, and k are partial values intermediate between 0 and C. Assuming gaussian noise statistics, the slope of the turn-on curve can be represented by a single parameter, the Full Width, Half Maximum (FWHM) value. This is the full width at half maximum amplitude of the resolution function which is the differential of the turn-on curve we measure with the calibrator. Note that only one meaningful noise (FWHM) measurement is possible for each detector, using the lowest energy level. In some cases (the high energy omnidetectors in the MEPED, for instance), the the calibration data do not resolve the noise level. However, since the noise may be increased by a degraded detector or EMI, the value for FWHM should be monitored routinely.

b. The TED functions somewhat differently, although the interpretation of the calibration is similar.

Using the total count channels 0EFD, 0PFD, 30EFD, and 30PFD, the thresholds are determined in the same way as described for the other instruments. The thresholds have 4 different values which are selected on command, and cycled automatically during the calibration sequence. The variable threshold is used in orbit as a means of limit checking the channeltron performance, which is subject to degradation with time and radiation, to determine when operating voltage adjustments are required.

The IFC sequence also cycles the levels without applying artificial pulses so that the amplitude distribution of the detector outputs is obtained using natural events.

c. There are two major subdivisions of analysis, real time and non-real time. Because of time constraints, real time analysis of the raw data (conducted on all data at the telemeter rate) is limited to limit checks.

Non-real time analyses (conducted at a slower-than-telemeter rate) are done off-line for the following:

	Thresholds	FWHM	Coincidence Efficiency
TED	X		
MEPED	X	X	
HEPAD	X	X	X

d. Determination of Threshold

Table 9 lists the number of channels and number of data points per channel.

TABLE 9. IFC DATA

Phase	1 NC	1 ND	2 NC	2 ND	3 NC	3 ND	4 NC	4 ND
TED	4	96	4	96	4	96	4	96
MEPED	7	48	15	48	11 2	48 12	NA	NA
HEPAD	7	48	7	48	7	48	7	48

NC = Number of channels. ND = Number of data points per channel.

These values are examined in non-real time to determine the number of minor frames from the start of the IFC phase with zero counts (0_1), the number of subsequent minor frames with partial counts (Y_1), and the number of subsequent minor frames with complete counts (X_1). If subsequent to a minor frame with a complete count, a minor frame appears with either a zero or partial count, an additional set of 0, Y, X is generated. For example:

Minor frame #	1	2	3	4	5	6	7	8	9	10
Count	0	0	P	C	C	C	0	P	C	C

0 - Zero
P - Partial
C - Complete

0_1	Y_1	X_1	0_2	Y_2	X_2
2	1	3	1	1	2

The count required in a minor frame for a complete count, which depends on the particular channel being observed, is listed in Table 10. In addition to keeping the 0, X, Y values, keep the data channel readout for all partial counts. The following is a format:

0_1, Y_1, X_1 0_2, Y_2, X_2 — — —
Data 1   Data 2

A checksum of 0_1, Y_1, X_1 should equal the number of data points shown in Table 9. Note that in Phase 3, the MEPED has two channels 0I, 90I which have only 12 data points.

TABLE 10. Complete Counts

Data Channel	Actual Count
TED	
abFD	8320
MEPED	
0I, 90I	33280
P6, P7, P8	16640
All Others	8320
HEPAD	
P1,P2,P3,P4,A1,A2	33280
S1, S2, S3	782
S4	20800
S5	9984

e. Determination of Full Width Half Maximum

Data for FWHM calculation varies in size per Table 11. Each has 48 data points per set.

TABLE 11. FWHM Data

	Data Channels	Divide Data by	IFC Phase	Remarks
MEPED	0P1 0E1 90P1 90E1	8,320	1	1/
	P6 P7 P8	16,640	1	
HEPAD	S1 S2	782	1-4	2/
	S3	782	3,4	3/

1/ 0P1 and 90P1 channels have 2 FWHM Values--1 when the counts are increasing, the second when the counts are decreasing.

2/ There are 4 sets of 48 data points/channel (1 set/IFC phase). The average of the four values in each data time slot are used to calculate the FWHM.

3/ There are 2 sets of 48 data points for this channel (IFC Phase 3,4). The average of the 2 values in each data time slot are used to calculate the FWHM.

Let the data be identified by a step number I in the telemetered sequence. I varies from 1 to 48. For channels with more than one set, average the values which have the same I (see footnotes in Table 11). Divide all data by the numbers specified in Table 11 while maintaining the step number I for the resultants. Each new value is the fraction F(Z,I), the area under the normal curve based on the assumption of a gaussian distribution of noise. Find values of Z from the table of F vs. Z, in Appendix A, page 93. Ignore values of F which exceed the range of the table.

Form a set of numbers Z,I. Because the counts include fluctuations, Z contains errors. Accordingly we make a least-square fit of the form $Z = a + b\ I$. However, the fit we need is $I = A + B\ Z$ where the intercept A is the threshold level and the slope B is the standard deviation, both in units of I. Solve for A and B using a and b. Convert from units of I to energy by multiplying by the end energy of the IFC ramp (given in Appendixes D and E) and dividing by the number of steps (typically 48) in the full sequence I to reach that end energy. All of the scales are based on 45 mV per MeV dissipated in the detector. The FWHM is analytically defined as 2 times the square root of (2 ln 2) times the standard deviation, so convert to FWHM by multiplying by 2.35482004.

Check this value of FWHM to see if it exceeds the limit (not listed here).

Example: MEPED Data Channel 0P1 IFC Phase 1

Data from NOAA6 in orbit, 1986 June 19 day 170 start IFC 12:02:57Z.
The count listed is the middle of the intervals listed in Table 7.
Divide Count by 8320.

Count	F	Z	I
1	.000120		7
4	.000481		8
18	.002163		9
75	.009014		10
265	.031851		11
785	.094351	-1.314483	12
1889	.227043	-.748657	13
3393	.407813	-.233185	14
5249	.630889	+.334222	15
6785	.815505	+.898380	16
7553	.907813	+1.327472	17
8065	.969351		18
7753	.931851		19

We make the least-square fit $Z = a + b\,I$ and solve for $I = A + B\,Z$.

$A = -a/b \qquad B = 1/b$

We find that $A = 14.417917$, $B = 1.867308$ and $r^2 = 0.998652$

Threshold $= A \times 75$ keV / 48
$= 14.417917 \times 75 / 48 = 22.53$ keV cut-in

FWHM $= B \times (75$ keV $/ 48) \times 2.35482$
$= 1.867308 \times (75 / 48) \times 2.35482 = 6.871$ keV

End of example.

f. Determination of Coincidence Efficiency.

For IFC phases 1 and 2, note the 48 values of A1, A2, P4 and S5. Convert all values to actual count.

For each of the following cases find I for the count nearest to the number listed here:

	increasing	decreasing
A1	8320	16640
A2	16640	--
P4	12979	16640

The A1 observation time is at a value halfway between the increasing and decreasing time determined above. For P4, as well as for A2, it is halfway between the I and 48.

Determine the efficiencies using Table 12.

TABLE 12. COINCIDENCE EFFICIENCY

Data Channel	Double Coincidence Efficiency Observe S5 at I_0	Triple Coincidence Efficiency Observe Data Ch. at I_0
A1	(S5 @ I_0)/9982	(A1 @ I_0)/33280
A2	not used	(A2 @ I_0)/33280
P4	not used	(P4 @ I_0)/33280

Since Phase 2 is a repeat of Phase 1, there are two values determined for each of the efficiencies above. Average these values and report them as the double and triple coincidence efficiencies for those data channels.

For Phases 3 and 4, note the 48 values from each of the data channels P1, P2, P3, and S5.

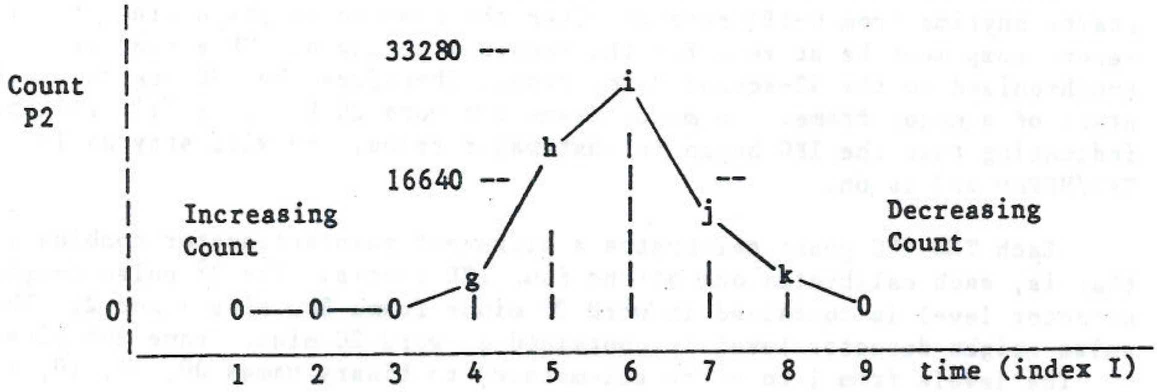
Use the same technique as in Phases 1 and 2 except pick I nearest these numbers (Table 13):

Table 13

Count	Increasing	Decreasing	Efficiency
P1	8320	16640	(P1 @ I_0)/33280
P2	16640	16640	(P2 @ I_0)/33280
P3	16640	16640	(P3 @ I_0)/33280

Each data channel has two I values where the count is near the listed number because as the IFC ramp is increased, the cut-on threshold is passed and subsequently the cut-off threshold is passed. The values desired are at the points h and j shown on the following example:

Example



I for P2 near 16640 increasing is 5

I for P2 near 16640 decreasing is 7

The I halfway between these two is 6. Therefore the value of P2 for I = 6 is used in the equation to determine the triple coincidence efficiency.

End of example.

TED IFC

The TED IFC consists of 4 phases of 192 seconds each. See Appendix C. A 0-4 V ramp is put in. The threshold of the discriminator is determined for each of 4 channels at 4 attenuator settings; one for each phase. The TED stays in IFC Mode for 102.4 minutes after completion of the 4 phases (see note 2, p. 88).

Strobe #1 with SEM LINE 1 TRUE starts the TED/HEPAD IFC. The calibration starts anytime from 0-192 seconds after the command is given since the 192-second ramp must be at zero for the sequence to begin. This ramp is synchronized to the 32-second major frame. Therefore the IFC starts at the start of a major frame. In minor frame 285 word 20 bit 1, a "1" will appear indicating that the IFC began in that major frame, and will stay as long as TED/HEPAD IFC is on.

Each TED IFC phase calibrates a different gain/attenuator combination, that is, each calibrates one of the four TED levels. The 0^{o} pulse height detector level is contained in word 20 minor frame 265 bits 1 and 2. The 30^{o} pulse height detector level is contained in word 20 minor frame 265 bits 3 and 4. The levels from 1 to 4 are telemetered as binary names 00, 01, 10, 11. See p. 76, p. 89.

MEPED IFC

The MEPED IFC consists of three phases of 192 seconds each. The various ramp amplitudes are specified in Appendix D. IFC measures thresholds for 15 level sensors and FWHMs for 9 solid state detectors.

Strobe #1 with SEM LINE 2 True starts MEPED IFC. Bit 2 in minor frame 285 word 20 will go high in the major frame in which the IFC began.

Note: If the TED/HEPAD IFC is in progress do not send the "Start MEPED IFC" command. However, it is allowable to command both starts simultaneously.

HEPAD IFC

The HEPAD IFC consists of 4 phases of 192 seconds each. The ramp size in either energy or photoelectrons is specified in Appendix E. There are three values which must be calculated in non-real time for the HEPAD; thresholds for 10 level sensors, FWHM for 2 detectors and the photo multiplier tube (PMT) and double and triple coincidence counting efficiency for the electronic coincidence gates.

8. TELEMETRY

8.1 Data Transmission and Processing

The SEM data, which utilize two full words (8 bits each) in each 100 ms TIP minor frame, are dumped from tape in the spacecraft to the NOAA NESDIS CDA stations along with all other TIP data. It is then transmitted to Washington, D.C., by communication circuits. The SEM data stream is separated out along with relevant Digital B spacecraft analog data. Orbit information is added in the NESDIS computer system and the resultant data are transmitted to the SESC SELDADS II (Space Environment Laboratory Data Acquisition and Display System) computer in Boulder, Colorado where the data are stored for immediate operational use. Our present experience is that the most recent data we receive is about 100 minutes old.

SELDADS II archives on magnetic tape the raw data as received from NESDIS. These raw tapes are processed off line to produce the archive tapes as described in NOAA Technical Memorandum ERL SEL-71. SELDADS II presently (1986) keeps on line the most recent 8 days of raw data, as well as the most recent 32 days of certain processed data sets. Daily plots and status reports allow SEL staff to monitor the NOAA SEM.

8.2 Data Formats

Analog signals and digital data move from the SEM to the TIP in three different ways.

The Digital A data are sent as a serial data stream which contains all data and SEM housekeeping information. Digital B data are transmitted from the DPU to the spacecraft over parallel Digital B data lines where they are sub-multiplexed into the spacecraft Digital B data. The analog housekeeping is sent over parallel analog lines to the spacecraft where it is sub-multiplexed into the spacecraft analog words.

Appendix H gives the SEM Digital A output format. Also listed are the changes to this format for different modes.

The next several pages list the minor frame numbers where each datum appears in Digital A.

Table 14 shows the digital subcom words in digital A. Table 15 shows the analog words in digital A.

TED Data Location in Digital A

The TED data location within the TIP TLM format is shown in the following list:

Data Channel	Minor Frame	Word
0DE1	5, 85, 165	20
30DE1	25, 105, 185	20
0DP1	45, 125, 205	20
30DP1	65, 145, 225	20
0DE3	6, 86, 166	20
30DE3	26, 106, 186	20
0DP3	46, 126, 206	20
30DP3	66, 146, 226	20
0DE5	7, 87, 167	20
30DE5	27, 107, 187	20
0DP5	47, 127, 207	20
30DP5	67, 147, 227	20
0DE7	8, 88, 168	20
30DE7	28, 108, 188	20
0DP7	48, 128, 208	20
30DP7	68, 148, 228	20

Data Channel	Minor Frame	Word
0EBK	245	20
0PBK	246	20
0EM	9, 29, 49, 69, 89, 109, 129, 149, 169, 189, 209, 229, 249, 269, 289, 309	21 *
0PM	same as 0EM	21 *
30EBK	247	20
30PBK	248	20
30EM	10, 30, 50, 70, 90, 110, 130, 150, 170, 190, 210, 230, 250, 270, 290, 310	20 *
30PM	same as 30EM	20 *
0EFD	16, 36, 56, 76, 96, 116, 136, 156, 176, 196, 216, 236, 256, 276, 296, 316	20
0PFD	same as 0EFD	21
30EFD	17, 37, 57, 77, 97, 117, 137, 157, 177, 197, 217, 237, 257, 277, 297, 317	20
30PFD	same as 30EFD	21
0DEM	18, 38, 58, 78, 98, 118, 138, 158, 178, 198, 218, 238, 258, 278, 298, 318	20
0DPM	same as 0DEM	21
30DEM	19, 39, 59, 79, 99, 119, 139, 159, 179, 199, 219, 239, 259, 279, 299, 319	20
30DPM	same as 30DE	21

* The "E" data are the first 4 bits of the word and the "P" data the second 4 bits.

MEPED Data Location in Digital A

Data Channel	Minor Frame	Word
0P1	0, 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300	21
0P2	1, 21, 41, 61, 81, 101, 121, 141, 161, 181, 201, 221, 241, 261, 281, 301	20
0P3	same as 0P2	21
0P4	2, 22, 42, 62, 82, 102, 122, 142, 162, 182, 202, 222, 242, 262, 282, 302	20
0P5	same as 0P4	21
0E1	3, 23, 43, 63, 83, 103, 123, 143, 163, 183, 203, 223, 243, 263, 283, 303	20
0E2	same as 0E1	21
0E3	4, 24, 44, 64, 84, 104, 124, 144, 164, 184, 204, 224, 244, 264, 284, 304	20
90P1	10, 30, 50, 70, 90, 110, 130, 150, 170, 190, 210, 230, 250, 270, 290, 310	21
90P2	11, 31, 51, 71, 91, 111, 131, 151, 171, 191, 211, 231, 251, 271, 291, 311	20
90P3	same as 90P2	21
90P4	12, 32, 52, 72, 92, 112, 132, 152, 172, 192, 212, 232, 252, 272, 292, 312	20
90P5	same as 90P4	21
90E1	13, 33, 53, 73, 93, 113, 133, 153, 173, 193, 213, 233, 253, 273, 293, 313	20
90E2	same as 90E1	21

Data Channel	Minor Frame	Word
90E3	14, 34, 54, 74, 94, 114, 134, 154, 174, 194, 214, 234, 254, 274, 294, 314	20
P6	same as 90E3	21
P7	15, 35, 55, 75, 95, 115, 135, 155, 175, 195, 215, 235, 255, 275, 295, 315	20
P8	same as P7	21
0I	0, 160	20
90I	20, 180	20

HEPAD Data Location in Digital A

Data Channel	Minor Frame	Word
P1	4, 44, 84, 124, 164, 204, 244, 284	21
P2	5, 45, 85, 125, 165, 205, 245, 285	21
P3	6, 46, 86, 126, 166, 206, 246, 286	21
P4	7, 47, 87, 127, 167, 207, 247, 287	21
A1	8, 48, 88, 128, 168, 208, 248, 288	21
A2	9, 49, 89, 129, 169, 209, 249, 289	20
S5	24, 64, 104, 144, 184, 224, 264, 304	21
S4	25, 65, 105, 145, 185, 225, 265, 305	21
S1	26, 66, 106, 146, 186, 226, 266, 306	21
S2	27, 67, 107, 147, 187, 227, 267, 307	21
S3	28, 68, 108, 148, 188, 228, 268, 308	21

TABLE 14. DIGITAL A SUBCOM WORDS		
Bit	Frame 265 Word 20 D1	Frame 266 Word 20 D2
(MSB) 1	TED (0E-0P)PHD bit 0	Level Command 0, (DCB 1)
2	TED (0E-0P)PHD bit 1	Level Command 1, (DCB 2)
3	TED (30E-30P)PHD bit 0	Level Command 2, (DCB 3)
4	TED (30E-30P)PHD bit 1	Level Command 3, (DCB 4)
5	TED Mode Status bit 0	Level Command 4, (DCB 5)
6	TED Mode Status bit 1	Level Command 5, (DCB 6)
7	TED On/Off	Level Command 6, (DCB 7)
(LSB) 8	MEPED On/Off	Level Command 7, (DCB 8)
Bit	Frame 285 Word 20 D3	Frame 286 Word 20 D4
1	TED/HEPAD IFC On/Off	Pulse Command PC1 SEMDP
2	MEPED IFC On/Off	Pulse Command PC2 SEMTD
3	Low Voltage On/Off	Pulse Command PC3 SEMHD
4	HEPAD Power On/Off	Pulse Command PC4 SEMPS
5	Zero	Telemetry Mode 1 or 2
6	Zero	Zero
7	Zero	Zero
8	Zero	Zero

Frame 305 Word 20 = Sync Pattern 1111 0011 = f3H D5 [illegible]

Frame 306 Word 20 = Sync Pattern 0101 0000 = 50H D6 80

Status of "bit 0" is determined by status of DCB 4, and status of "bit 1" is determined by status of DCB 5, when the affected variable was last addressed by a PC #2 strobe. (See "TED Commands", p. 88 and list p. 89.)

Pulse Command bits are "1" for one or two major frames after the corresponding pulse command is sent; otherwise they are "0".

In Table 14 PHD means pulse height detector referring to the setting of the TED level. D1 through D6 are names used in SEL printouts.

TABLE 15. HOUSEKEEPING SUBCOM in DIG A			
Minor Frame	Word	Cal Data Figure #	Signal Name
29	20	31-1	MEPED SSD Bias (Electron)
40	20	31-1	MEPED SSD Bias (Proton)
60	20	32	MEPED Omni Temperature
69	20	--	Spare
80	20	33	MEPED Electronics Temperature
100	20	32	MEPED Proton Telescope Temperature
109	20	--	Spare
120	20	32	MEPED Electron Telescope Temp.
140	20	32	DPU Temperature
149	20	--	Spare
189	20	--	Spare
200	20	--	Spare
220	20	31-1	TED Channeltron E HV
229	20	--	Spare
240	20	31-1	TED Channeltron P HV
260	20	32	TED Temperature
267	20	31-1	DPU +12V
268	20	31-1	TED Low Voltage Ramp
269	20	--	Spare
280	20	33	HEPAD HV PS
287	20	32	HEPAD Electronics Temperature
288	20	33	TED CEA
300	20	31-1	HEPAD SSD Bias
307	20	32	HEPAD PMT Temperature
308	20	31-1	DPU IFC Ramp
309	20	--	Spare

Typical telemetry values may vary from instrument to instrument. Test values for each instrument may be found in the End Item Data Package for that instrument.

The Digital B telemetry data provided by the SEM are shown in Table 16. All of the SEM Digital B data are also included in the SEM Digital A data.

TABLE 16. DIGITAL B TELEMETRY

Signal Name	State* Logic "1"	Logic "0"	Minor Frame	Ch. No.	Word 8 Bit no.	Output Circuit Figure 31
LV	Off	On	25	185	6	1
TED Power	Off	On	25	217	7	1
HEPAD Power	Off	On	25	249	8	1
MEPED Power	Off	On	26	26	MSB1	1
TED/HEPAD IFC On	Yes	No	26	58	2	2
MEPED IFC On	Yes	No	26	90	3	2
L D Cmd. LC0 (DCB-1)	1	0	26	122	4	2
L D Cmd. LC1 (DCB-2)	1	0	26	154	5	2
L D Cmd. LC2 (DCB-3)	1	0	26	186	6	2
L D Cmd. LC3 (DCB-4)	1	0	26	218	7	2
L D Cmd. LC4 (DCB-5)	1	0	26	250	LSB8	2
L D Cmd. LC5 (DCB-6)	1	0	27	27	1	2
L D Cmd. LC6 (DCB-7)	1	0	27	59	2	2
L D Cmd. LC7 (DCB-8)	1	0	27	91	3	2
Telemetry Format 1/2	1	2	27	123	4	3

* Logic "1" is a "True", "Low Voltage" state. All DIG B status bits are in Logic "1" state when the SEM is OFF.

Ch. No. refers to spacecraft telemetry channels, not to SEM DIG A channels.

The analog subcom telemetry data provided by the SEM are shown in Table 17. Equations relating values in engineering units to telemetered voltages are given in Table 18 (p. 80). Interface circuits for analog telemetry are shown in Figures 31 - 37. All of the SEM Analog Subcom Telemetry data are also included in the SEM Digital A data.

TABLE 17. ANALOG SUBCOM TELEMETRY
This is not Digital A or B

	Name	Output Fig.	Sub Com s	Minor Frame	Ch. No.	
ATET	TED Temperature *	32	32	214	214	
ACEA	TED CEA PS	34	32	222	222	**
AEPS	TED Channeltron E HV	34	32	119,279	119	**
APPS	TED Channeltron P HV	34	32	127,287	127	
AMPT	MEPED Proton Telescope Temperature *	32	32	135,295	135	
AMET	MEPED Electron Telescope Temperature *	32	32	230	230	
AMSS	MEPED Proton Detector Bias Voltage	35	32	143,303	143	
AHPT	HEPAD PM Tube Temp. *	32	32	151,311	151	
AHET	HEPAD Unit Temperature *	32	32	159,319	159	
AMPV	HEPAD PM Supply Voltage	34	16	111,271	286	
AHSS	HEPAD SS Detector Bias Voltage	35	16	4,164	294	
AIFC	DPU IFC Ramp	37	16	96,256	302	
ADPU	DPU Temperature *	32	16	97,257	310	
AMEL	MEPED Electronics Temp.	33	16	3,163	318	
ALVR	TED LV Ramp	36	16	2,162	326	

Notes:

* Indicates signals on the 28 V Analog Temperature Telemetry Bus. Temperature telemetry is available at all times when the +28V Analog Temperature Telemetry Bus is on, with one exception. MEPED electronics temperature, as well as all other non-temperature analog telemetry, is available only when the SEM is on.

** For NOAA-B through NOAA-G, these two telemetry signals are interchanged. (CEAPS MON is Channel 119, and CH E Bias Voltage is Channel 222).

1. The 32 and 16 second Analog Subcom data are read out in words 9, and 10 respectively, of each TIP Minor Frame.

2. See Table 18 (p. 80) for equations.

TABLE 18. EQUATIONS FOR ANALOG TELEMETRY

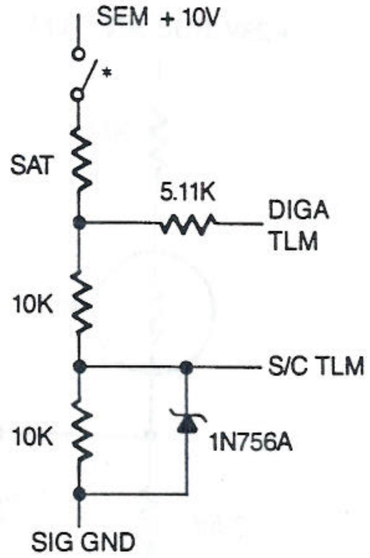
Channel Number	Name	Equation	typical
214	TED Temperature	$0.463V^5 - 7.01V^4 + 42.33V^3 - 126.47V^2 + 199.58V - 169.19$	
* 222	TED CEA PS	$313V + 178$	
* 119	TED Ch. E HV level	$5.303V - 11.515$	round
127	TED CH. P HV level	$5.385V - 9.88$	round
135	MEPED P Tel. Temp.	$0.463V^5 - 7.01V^4 + 42.33V^3 - 126.47V^2 + 199.58V - 169.19$	
230	MEPED E Tel. Temp.	$0.463V^5 - 7.01V^4 + 42.33V^3 - 126.47V^2 + 199.58V - 169.19$	
143	MEPED P Det. Bias V.	$884.15V$	
151	HEPAD PM Tube Temp.	$0.463V^5 - 7.01V^4 + 42.33V^3 - 126.47V^2 + 199.58V - 169.19$	
159	HEPAD Unit Temp.	$0.463V^5 - 7.01V^4 + 42.33V^3 - 126.47V^2 + 199.58V - 169.19$	
286	HEPAD PMT HV level	$88.29V - 110.07$	round :
294	HEPAD SS Det. Bias V.	$889.16V$	
302	DPU IFC Ramp	$1.6V$	
310	DPU Temperature	$0.463V^5 - 7.01V^4 + 42.33V^3 - 126.47V^2 + 199.58V - 169.19$	
318	MEPED Elect. Temp.	$0.235V^5 - 3.21V^4 + 18.09V^3 - 52.11V^2 + 89.98V - 103.97$	
326	TED LV Ramp	V	

V is the voltage passed from the SEM to the spacecraft which digitizes and telemeters the voltage to the ground. $V = 0.02\ n$ where n is the decimal value of the telemetered number. n ranges from 0 to 255 so V ranges from 0 to 5.10 volts.

See Table 17 (p. 79) for an output circuit list.

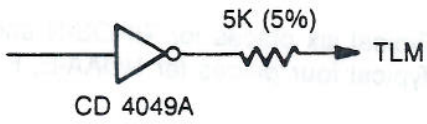
* For NOAA-B through NOAA-G, these two signals are interchanged.

1



* DigB 185 (LV conv) is connected directly to SEM + 10V (no switch)

2



3

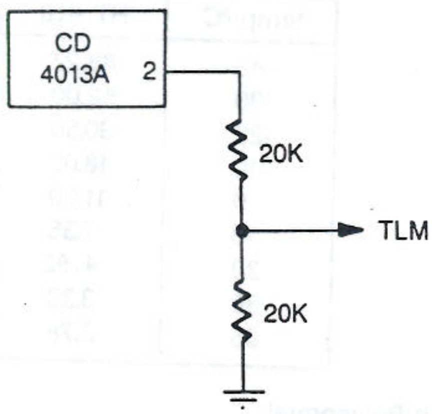
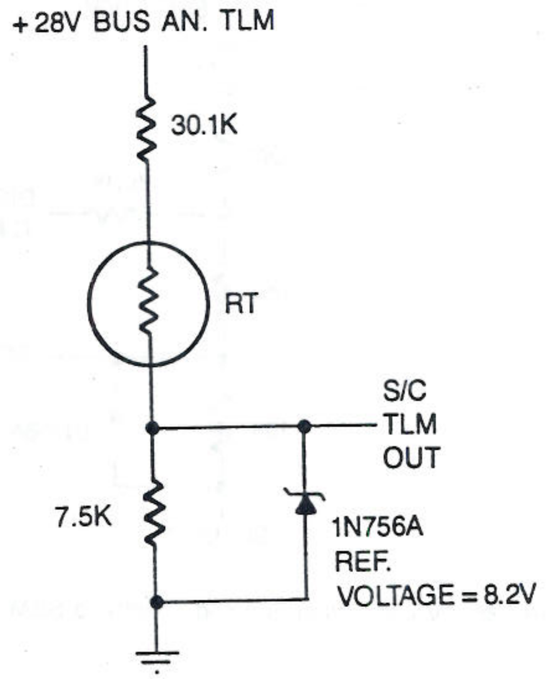


Figure 31.—Output Circuits

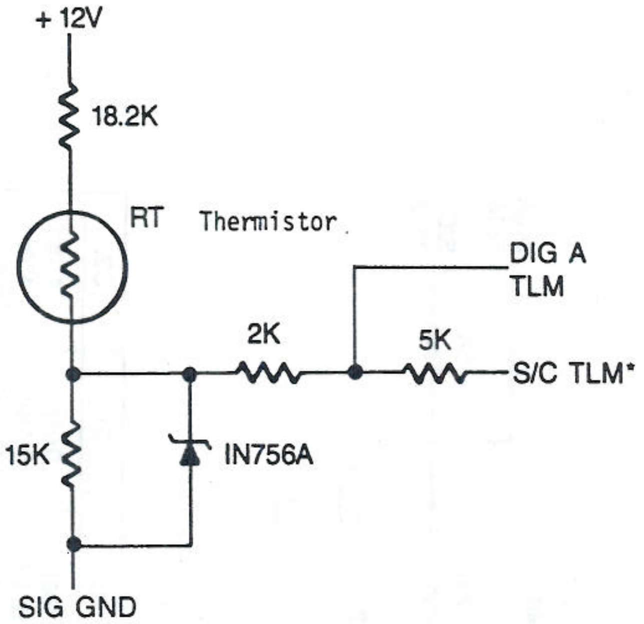


Typical six places for TIROS-N and NOAA-A to NOAA-D
Typical four places for NOAA-E, F & G

Temp-°C	RT -KΩ	Vout - V
-40	88.27	1.67
-30	52.00	2.34
-20	30.50	3.08
-10	18.00	3.78
0	11.00	4.32
10	7.35	4.67
20	4.92	4.99
30	3.30	5.13
35	2.78	5.20

Best fit Polynomial:
$$\text{Temperature} = 0.463V^5 - 7.01V^4 + 42.33V^3 - 126.47V^2 + 199.58V - 169.19$$

Figure 32.—Spacecraft-Powered Temperature TLM Output Circuit

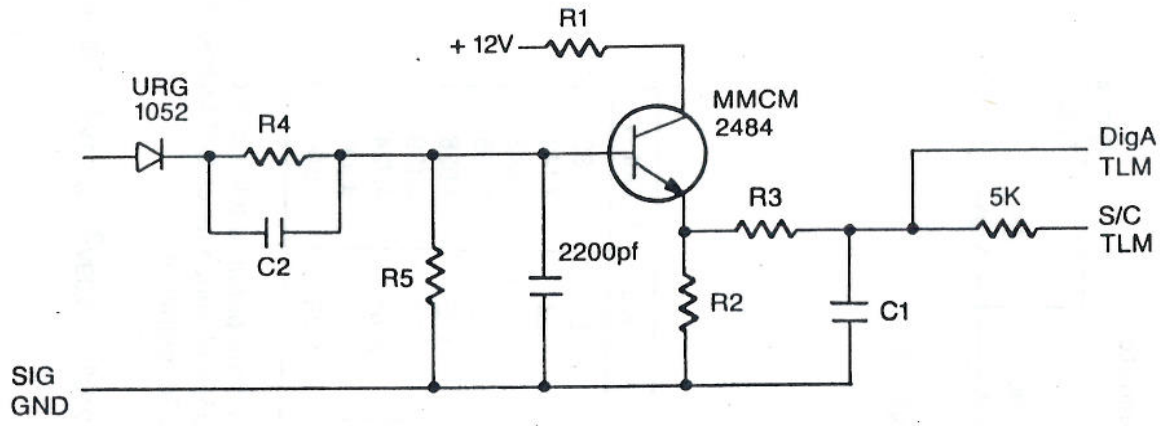


TEMP -°C	RT - KΩ	V Out -V
-40	88.27	1.482
-30	50.8	2.143
-20	30.0	2.848
-10	18.3	3.495
0	11.5	4.028
10	7.35	4.439
20	4.92	4.724
30	3.30	4.931
35	2.78	5.00

*The only SEM powered temperature telemetry contained in 16 second and 32 second subcoms of S/C telemetry is MEPED Electronics Temperature.

Best fit polynomial:
Temperature = $0.235V^5 - 3.21V^4 + 18.09V^3 - 52.11V^2 + 89.98V - 103.97$

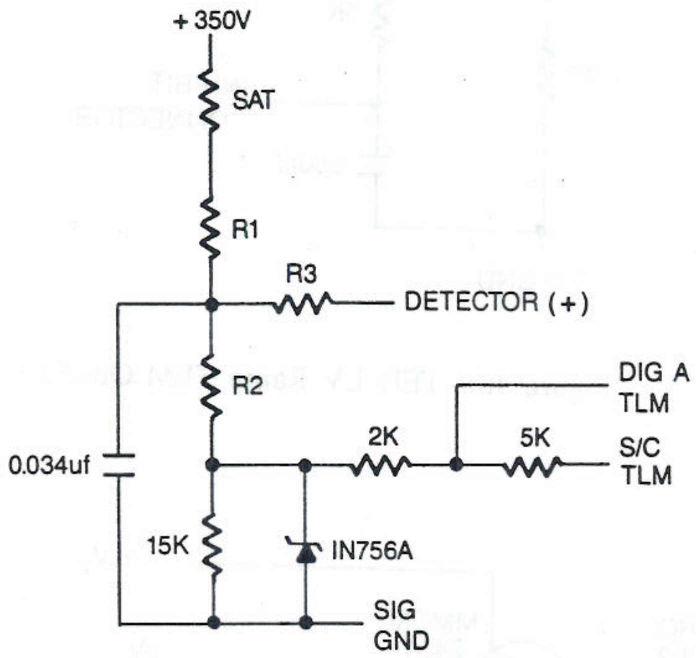
Figure 33.—SEM-Powered Temperature TLM Output Circuit



NAME	R1,R2	R3	R4	R5	C1	C2
E or P H V	100K	2.0K	1.17M	250K	0.01uf	470pf
CEA	51K	2.0K	590K	12.5K	0.47uf	470pf
HEPAD PMT	100K	9.1K	330K	250K	0.01uf	2200pf

Input is from a low-voltage point inside power supply before set-up transformer.

Figure 34.—HEPAD and TED HV Power Supply Monitor Analog TLM Output Circuit



	HEPAD	MEPAD
R1	Short	14.4M
R2	13M	2.94M
R3	4.32M	20M

Figure 35.—HEPAD/MEPED Bias Voltage TLM Output Circuit

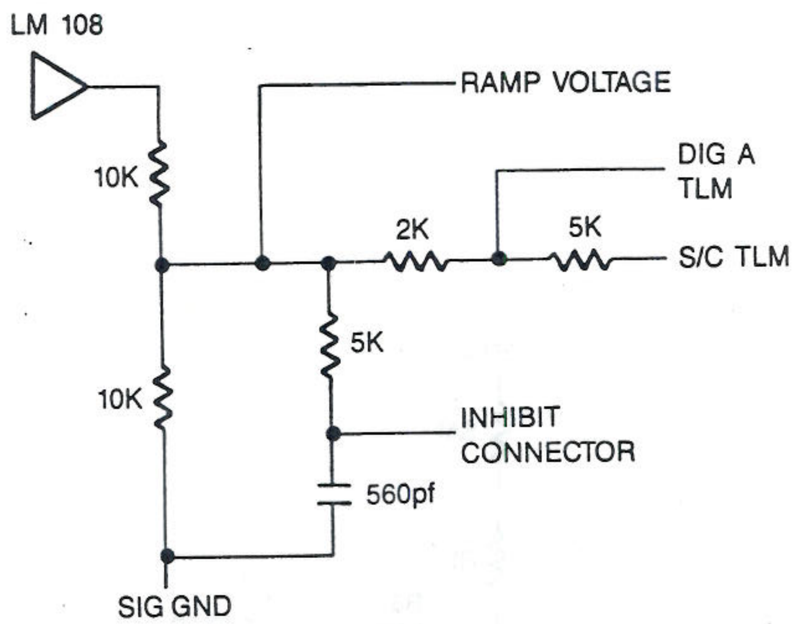


Figure 36.—TED LV Ramp TLM Output Circuit

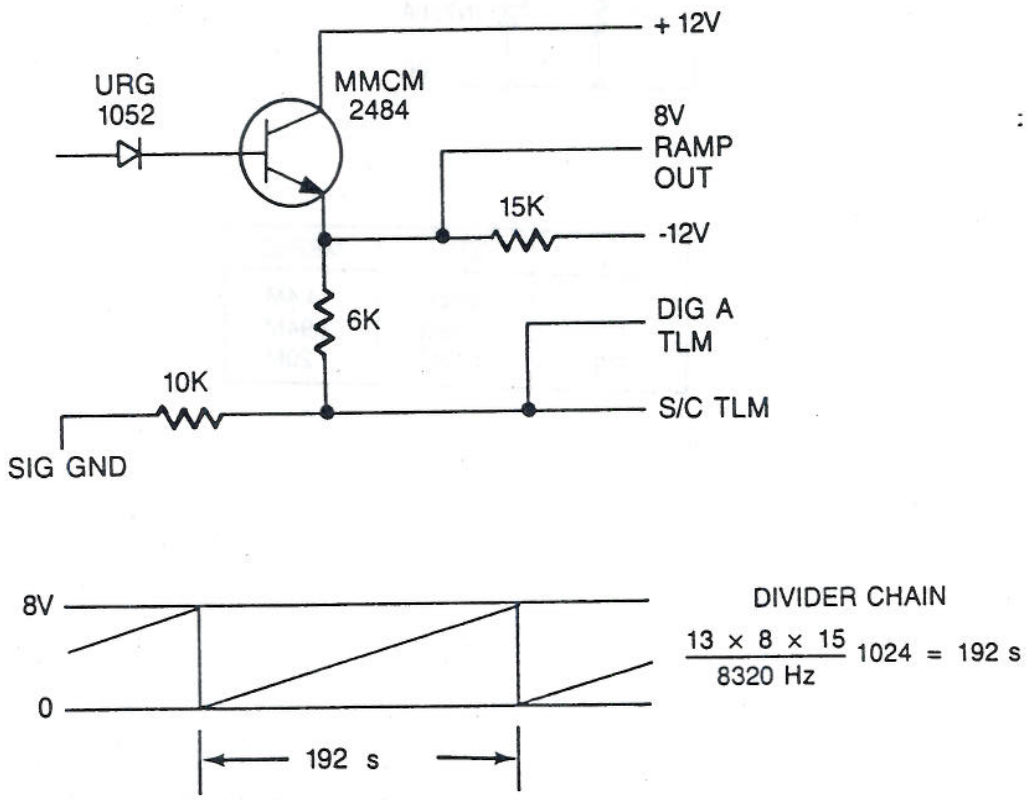


Figure 37.—DPU IFC Ramp TLM Output Circuit

9. COMMAND

9.1 General Information

The SEM command scheme consists of setting eight (8) two-state command lines from the spacecraft to the DPU to either "0" or "1". One of four two-state pulse command lines are then strobed which sets the command into the appropriate memory in the SEM.

All commands strobed with Pulse Command #4 (PC #4) operate latching relays. A "1" (0 volts) on the indicated Data Command Bit (DCB) line will set the state of the indicated relay. All other DCB lines should contain "0" unless the operator desires to change the state of more than one relay by means of a single PC #4 strobe. DCB lines have a second name "Level Command" (LC) as shown here with 0 to 7 numbers.

COMMANDS ACTIVATED BY A PC #4 STROBE SOCC name SEMPS

SOCC name	Command Bit	Meaning of state "1"	
SML1	DCB 1 (LC#0)	MEPED	ON
SML2	2 (LC#1)	MEPED	OFF
SML3	3 (LC#2)	TED	ON
SML4	4 (LC#3)	TED	OFF
SML5	5 (LC#4)	HEPAD	ON
SML6	6 (LC#5)	HEPAD	OFF
SML7	7 (LC#6)	LV	ON
SML8	8 (LC#7)	LV	OFF

NOTES:

1. The LV power must be turned on first, by setting DCB 7 to "1" (True). It is wise to set DCB 8 to "0" (False) before sending PC #4 Strobe, since the status of DCB 8 cannot be determined when the instrument is OFF. Other bits may be set to "1", but it is not possible to turn on sensors with the same strobe which turns on the LV.

2. DCB 7 and DCB 8 must be set to "0" (False) before a strobe sent to turn on any of the sensors will be effective.

3. Turning LV off (DCB 8 = "1", followed by PC #4 strobe) also leaves all three sensor relays in the "OFF" position.

9.2 IFC and Format Commands

The Pulse Command 1 (PC #1) strobe with DCB 1 thru 6 sets logic states in the DPU. Any functionally correct combination on Data Command Bit (DCB) lines 1 thru 6 may be executed with a single PC #1 strobe.

COMMANDS ACTIVATED BY A PC #1 STROBE SOCC name SEMDP

Command Bit	Meaning of state "1"
DCB 1 (LC#0)	Start TED/HEPAD IFC
2 (LC#1)	Start MEPED IFC Note 3
3 (LC#2)	don't care
4 (LC#3)	Terminate IFC
5 (LC#4)	Select TLM Format 1
6 (LC#5)	Select TLM Format 2
7 (LC#6)	don't care
8 (LC#7)	don't care

NOTES:

1. TED/HEPAD and MEPED may be calibrated separately by setting DCB 1 or DCB 2 to "1", or simultaneously by setting both DCB 1 and DCB 2 to "1". However, a second IFC command should not be sent during the following 16 minutes (except see Note 3), unless the "Terminate IFC" command is sent. Bad data may result.

2. When the TED/HEPAD IFC is commanded, the TED will continue in "IFC Mode" for 102.4 minutes after completion of the ramp calibration cycles. During this time, unless the "terminate IFC" command is sent, TED commands using PC #2 strobe (see page 89) will have no effect.

3. For correct results, MEPED IFC should not be commanded until the MEPED has been on for at least 20 minutes.

9.3 TED Commands

The Pulse Command #2 (PC #2) line is used to strobe six bits of the level commands (DCB lines 1 thru 6) into various holding registers in the TED. The three bits (DCB 3 thru 1) are used as a Register Address code and the remaining three (DCB 6 thru 4) as data bits. Two bits (DCB 8 and 7) are not used.

TED COMMANDS ACTIVATED BY A PC #2 STROBE * SOCC name SEMTD

Command Bit DCB 6 5 4 3 2 1		Commanded TED State
1 M N 0 0 0		Set 0° Level to Levels 1-4. (MN = 00 to 11) M is bit 1 N is bit 0
1 M N 0 0 1		Set 30° Level to Levels 1-4. (MN = 00 to 11)
x x x 0 1 x		Not used
L M N 1 0 0		Set Proton Channeltron HVPS -2635 V to -3850 V (Approx. -200 V steps). LMN = 000(min) to 111(max negative) binary.
L M N 1 0 1		Set Electron Channeltron HVPS +2900 V to +4200 V (Approx. 200 V steps). LMN = 000(min) to 111(max) binary.
E P C 1 1 0	E	Electron Channeltron HVPS ON/OFF 1 = ON Note 1
	P	Proton Channeltron HVPS ON/OFF 1 = ON Note 1
	C	CEA HVPS ON/OFF 1 = ON Note 1
x 0 x 1 1 1		Normal TED MUX
x 1 0 1 1 1		Electron Dwell
x 1 1 1 1 1		Proton Dwell

x = don´t care
See note 2 p. 88
* - See Note 3 for PC #4 on p. 87

(1) The three high voltage power supplies cannot be commanded independently. When commanding any of the supplies, the appropriate bit for each supply must be set for the desired status of that supply following the strobe command.

9.4 HEPAD Commands

The Pulse Command #3 (PC #3) (SOCC name SEMHD) strobe line is used together with level commands DCB´s 1 thru 7 to adjust the HEPAD PMT High voltage supply from 1500 volts to 2770 volts in 127 equal steps of 10 volts each.

The voltage is given by: $V = 1500 + 10A$

where A equals the decimal value of the bit setting of DCB´s 1 thru 7 (DCB 1 - LSB; DCB 7 - MSB); DCB 8 = don´t care.

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Those primarily concerned with reviewing the FACC design, monitoring the contract and assisting in instrument calibrations were:

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Dr. David Evans, SEL

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HEPAD - Dr. Herbert Sauer, SEL
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Dr. Bach Sellers, Panametrics Corp.

Currently the scientific responsibility within SEL for the operation of the SEM is:

Dr. David Evans - TED
Dr. Herbert Sauer - MEPED and HEPAD

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END Item Data Package: Flight Unit WDL-TR7773-1, 1 Apr 1978

END Item Data Package: Flight Unit WDL-TR7773-2, 21 Jul 1978

END Item Data Package: Flight Unit WDL-TR7773-3, 23 Sep 1978

END Item Data Package: Flight Unit WDL-TR7773-4, 26 Oct 1978

END Item Data Package: Flight Unit WDL-TR7773-5, Feb 1979

END Item Data Package: Flight Unit WDL-TR7773-6, Mar 1979

END Item Data Package: Flight Unit WDL-TR7773-7, 6 Jun 1979

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- Volume I: Data and Procedures
- Volume II: Drawings and Parts List

APPENDIX A

Table of the area F under the normal curve.

Used for Determination of Z in FWHM Calculation.

F(Z)	1-F(Z)	Z	F(Z)	1-F(Z)	Z
.500000	.500000	.00	.805105	.194895	.86
.507978	.492022	.02	.810570	.189430	.88
.515953	.484047	.04	.815940	.184060	.90
.523922	.476078	.06	.821214	.178786	.92
.531881	.468119	.08	.826391	.173609	.94
.539828	.460172	.10	.831472	.168528	.96
.547758	.452242	.12	.836457	.163543	.98
.555670	.444330	.14	.841345	.158655	1.00
.563559	.436441	.16	.846136	.153864	1.02
.571424	.428576	.18	.850830	.149170	1.04
.579260	.420740	.20	.855428	.144572	1.06
.587064	.412936	.22	.859929	.140071	1.08
.594835	.405165	.24	.864334	.135666	1.10
.602568	.397432	.26	.868643	.131357	1.12
.610261	.389739	.28	.872857	.127143	1.14
.617911	.382089	.30	.876976	.123024	1.16
.625516	.374484	.32	.881000	.119000	1.18
.633072	.366928	.34	.884930	.115070	1.20
.640576	.359424	.36	.888768	.111232	1.22
.648027	.351973	.38	.892512	.107488	1.24
.655422	.344578	.40	.896165	.103835	1.26
.662757	.337243	.42	.899727	.100273	1.28
.670031	.329969	.44	.903200	.096800	1.30
.677242	.322758	.46	.906582	.093418	1.32
.684386	.315614	.48	.909877	.090123	1.34
.691462	.308538	.50	.913085	.086915	1.36
.698468	.301532	.52	.919243	.080757	1.4
.705401	.294599	.54	.933193	.066807	1.5
.712260	.287740	.56	.945201	.054799	1.6
.719043	.280957	.58	.955435	.044565	1.7
.725747	.274253	.60	.964070	.035930	1.8
.732371	.267629	.62	.971283	.028717	1.9
.738914	.261086	.64	.977250	.022750	2.0
.745373	.254627	.66	.986097	.013903	2.2
.751748	.248252	.68	.991802	.008198	2.4
.758036	.241964	.70	.995339	.004661	2.6
.764238	.235762	.72	.997445	.002555	2.8
.770350	.229650	.74	.9986501	.0013499	3.0
.776373	.223627	.76	.9997674	.0002326	3.5
.782305	.217695	.78	.9999683	.0000317	4.0
.788145	.211855	.80	.9999966	.0000034	4.5
.793892	.206108	.82	.9999997	.0000003	5.0
.799546	.200454	.84			

For 1 - F(Z), Z is negative. From NBS 55 1964 p. 966

APPENDIX B

SEM IFC

Length: 4 phases.
Each phase consists of 6 major frames, 192 seconds.

IFC Ramp: 192 Seconds, 0 to 8 volts.

During spacecraft testing, it is assumed that both IFC commands are given simultaneously.

APPENDIX C

TED IFC Details

4 Phases--192 Seconds Each

1 Ramp 0 to 8.0 V divided down to 1 volt.

Each phase is run with a different attenuator setting.

1. Discriminator Thresholds--Determine the threshold on each of 4 channels during each IFC phase and limit check.

Channels with thresholds: 0EFD, 0PFD, 30EFD, 30PFD.

Channels with no threshold check but which probably have a complete count:

0DE1, 0DE3, 0DE5, 0DE7

30DE1, 30DE3, 30DE5, 30DE7

0DP1, 0DP3, 0DP5, 0DP7

30DP1, 30DP3, 30DP5, 30DP7

0EM, 30EM, 0PM, 30PM

0DEM, 0DPM, 30DEM, 30DPM

2. Background Check--Limit check the 0EFD, 0PFD, 30EFD, 30PFD channels for appropriate levels.

3. With ASE, check the DE, Em, and DEM channels.
Note: Use of ASE requires the TED to be in a vacuum.

APPENDIX D

MEPED IFC Details

3 Phases--192 seconds each. The 4th phase is not used.

Ramps: 0 to 8 V divided down to the amplitudes listed below.

Detector	Amplitude	Phase	Peak Energy
D1 D2 D3	0-3.375 mV	1	75 keV
D1 D3	0-144 mV	2	3.2 MeV
D1	0-450 mV		10 MeV
D2	0-1.35 V	3	30 MeV
D3	0-144 mV		3.2 MeV
D4, D5, D6	0-54 mV	1-3	1.2 MeV

1. Determine FWHM for 9 detectors during Phase 1 using data channels 0P1, 90P1, 0E1, 90E1, P6, P7, P8 limit check.

2. Limit check other channels for spurious counts.

3. Determine thresholds of 15 level sensors during three phases as follows and check limit. (Note: All channels except P6, P7, P8 are both 90° and 0°.)

Phase I

	Level Sensors	Data Channel
Proton	1, 7	P1
Electron	1	E1
OMNI	1-3	P6, P7, P8

Phase II

	Level Sensors	Data Channel
Proton	2-5	P2, P3, P4
Electron	1-4	E1, E2, E3
OMNI	1-3	P6, P7, P8

MEPED IFC (cont.)

Phase III

Proton	1, 8	P5
Ion	6	I
Electron	1-4	E1, E2, E3
OMNI	1-3	P6, P7, P8

4. Background limit check--During the IFC sequence, the DPU automatically gates the IFC pulses on/off at a 1/2 Hz rate so that the preamp alternately sees background and background plus calibration.

5. During periods with no IFC, check all channels for backgrounds which exceed limits.

APPENDIX E

HEPAD IFC Details

4 Phases--192 seconds each

3 Ramps

Detector	Amplitude	Phase	Energy
D1, D2	0 to 16, 0 to 9 mV	1-4	0-0.76 MeV
PMT		1, 2	0-800 photoelectrons
PMT		3, 4	0-320 "

1. Determine FWHM for 2 detectors and PMT and check limits.

Detector	Data Channel	IFC Phase	Remarks
D1	S1	1-4	Avg. of 4
D2	S2	1-4	Avg. of 4
PMT	S3	3, 4	Avg. of 2

2. Determine thresholds of 10 level sensors during 4 phases as follows and check limits.

Phase 1, 2 (High Gain)

Level Sensor	Data Channel	Remarks
1	S3	Avg. of 2 readings
7	S2	
9	S1	
4, 5	P4	*
5	S4	
10, 6	A1	*
6	A2	

* The first LS determines the cut on threshold; the second the cutoff.

APPENDIX E (cont.)

HEPAD PARAMETERS (CONT.)

Phase 3, 4 (Low Gain)

Level Sensor	Data Channel	Remarks
1	S3	Avg. of 2 readings
7	S2	
9	S1	
9, 2	P1	*
2, 3	P2	*
3, 4	P3	*
4, 8	P4	*

*The first LS determines the cut on threshold; the second the cutoff.

3. Determine the double and triple coincidence efficiency for six pairs of level sensors as follows and check limits.

Level Sensor	Data Channel
9, 2	P1
2, 3	P2
3, 4	P3
4, 5	P4
10, 6	A1
6	A2

4. During periods with no IFC, check all channels for backgrounds which exceed limits.

APPENDIX F

Detector and Level Sensor Cross Reference

Data Channel	Levels Used	Thresholds Determined Level Sensor Rising Slope	Falling Slope	IFC Phase	FWHM Detector Rising Slope	Falling Slope	IFC Phase	Remarks
MEPED								
OP1	1, 2, 7	1	7	1	OD1	OD2	1	
90P1	1, 2, 7	1	7	1	90D1	90D2	1	
OP2	2, 3, 7	2	3	2				1/
90P2	2, 3, 7	2	3	2				
OP3	3, 4, 7	3	4	2				
90P3	3, 4, 7	3	4	2				
OP4	4, 5, 7	4	5	2				
90P4	4, 5, 7	4	5	2				
OP5	5, 6, 8	5	8	2, 3				2/
90P5	5, 6, 8	5	8	2, 3				2/
OI	6	6		3				
90I	6	6		3				
P6	1	1		1,2,3	D4		1,2,3	
P7	2	2		1,2,3	D5		1,2,3	
P8	3	3		1,2,3	D6		1,2,3	
OE1	1, 4	1	4	1	OD3		1	
90E1	1, 4	1	4	1	90D3		1	
OE2	2, 4	2	4	2, 3				
90E2	2, 4	2	4	2, 3				
OE3	3, 4	3	4	2, 3				
90E3	3, 4	3	4	2, 3				

APPENDIX F (Cont´d)

Data Channel	Levels Used	Thresholds Determined: Level Sensor Rising Slope	Level Sensor Falling Slope	IFC Phase	FWHM: Detector Rising Slope	Detector Falling Slope	IFC Phase	Remarks
HEPAD								3/
S1	9	9		1-4	D1		1-4	
S2	7	7		1-4	D2		1-4	
S3	1	5		1,2				
S4	5	5		1,2				
P1	1,7,9,2, 8,10	9	2	3,4				
P2	1,7,9,2,3, 8,10	2	3	3,4				
P3	1,7,9,3,4, 8,10	3	4 5	3,4 1,2				
P4	1,7,9,4,5, 8,10	4	8	3,4				4/
A1	1,7,9,5,6, 8,10	10	6	1,2				
A2	1,7,9,6, 8,10	6		1,2				
TED								
OEFD								5/
OPFD								
30EFD								
30PFD								

1/ Level sensors 3, 4, and 5 can be determined from the cut on (rising slope) or cutoff (falling slope) in two adjacent data channels. It is only necessary that one or the other method be used.

2/ Channel P5 has an "or" logic condition of 1, 5, 7, 8. LS 5 is measured in IFC phase 2 with the 5, 6, 8 logic. LS 8 is measured in IFC phase 3 with the 1, 5, 7, 8 logic.

3/ Same note as 1/ except level sensors 2, 3, 4, 5, and 6 are involved.

4/ LS 5 is determined during phases 1 and 2. LS 8 is measured during phases 3 and 4.

5/ The TED has only one level sensor per channel; the level however can be set to 4 discrete values by gain and attenuator settings. Each IFC phase measures one gain/attenuator condition.

APPENDIX G

Integration Time

Channel		
TED	All Channels	1 s
MEPED	0I 90I	8 s
	All Other Data Channels	1 s
	see notes below	
HEPAD	All Primary Data Channels	4 s
	S1, S2, S3	94 ms
	S4	2.5 s
	S5	1.2 s

During MEPED IFC, the DPU alternately looks at MEPED background for 1 second and the IFC signal for 1 second while at the same time multiplexing between telescopes.

During MEPED IFC the integration time for 0I and 90I is 4 seconds.

APPENDIX H

Digital A Telemeter Assignments
Telemeter Data by Minor Frame Number

TED Mode 1 = normal   DPU Mode 1 = TLM format 1

0 OI OP1	20 90I Bias -	40 MEP P Bias -	60 MEP Omni T -	80 MEP El T -	100 MEP P Tel T -	120 MEP E Tel T -	140 DPU T -
1 OP2 OP3	21 - -	41 - -	61 - -	81 - -	101 - -	121 - -	141 - -
2 OP4 OP5	22 - -	42 - -	62 - -	82 - -	102 - -	122 - -	142 - -
3 OE1 OE2	23 - -	43 - -	63 - -	83 - -	103 - -	123 - -	143 - -
4 OE3 P1	24 - S5	44 - P1	64 - S5	84 - P1	104 - S5	124 - P1	144 - S5
5 ODE1 P2	25 30DE1 S4	45 ODP1 P2	65 30DP1 S4	85 ODE1 P2	105 30DE1 S4	125 ODP1 P2	145 30DP1 S4
6 ODE3 P3	26 30DE3 S1	46 ODP3 P3	66 30DP3 S1	86 ODE3 P3	106 30DE3 S1	126 ODP3 P3	146 30DP3 S1
7 ODE5 P4	27 30DE5 S2	47 ODP5 P4	67 30DP5 S2	87 ODE5 P4	107 30DE5 S2	127 ODP5 P4	147 30DP5 S2
8 ODE7 A1	28 30DE7 S3	48 ODP7 A1	68 30DP7 S3	88 ODE7 A1	108 30DE7 S3	128 ODP7 A1	148 30DP7 S3
9 A2 OEM OPM	29 MEP E B - -	49 A2 - -	69 spare - -	89 A2 - -	109 spare - -	129 A2 - -	149 spare - -
10 30EM 30PM 90P1	30 - - -	50 - - -	70 - - -	90 - - -	110 - - -	130 - - -	150 - - -
11 90P2 90P3	31 - -	51 - -	71 - -	91 - -	111 - -	131 - -	151 - -

12	32	51	72	92	112	132	152
90P4	-	-	-	-	-	-	-
90P5	-	-	-	-	-	-	-
13	33	53	73	93	113	133	153
90E1	-	-	-	-	-	-	-
90E2	-	-	-	-	-	-	-
14	34	54	74	94	114	134	154
90E3	-	-	-	-	-	-	-
P6	-	-	-	-	-	-	-
15	35	55	75	95	115	135	155
P7	-	-	-	-	-	-	-
P8	P8	P8	P8	P8	P8	P8	P8
16	36	56	76	96	116	136	156
0EFD	-	-	-	-	-	-	-
0PFD	-	-	-	-	-	-	-
17	37	57	77	97	117	137	157
30EFD	-	-	-	-	-	-	-
30PFD	-	-	-	-	-	-	-
18	38	58	78	98	118	138	158
0DEM	-	-	-	-	-	-	-
0PDM	-	-	-	-	-	-	-
19	39	59	79	99	119	139	159
30DEM	-	-	-	-	-	-	-
30DPM	-	-	-	-	-	-	-
	2 s	4 s		8 s			16 s

MEPED Code abc

a = 0, 90 for 0 and 90 degrees
b = E, P for electrons and protons
c = 1 to 3 for electron energy
1 to 6 for proton energy
BK for background

aE1	aE2	aE3	aP1	aP2	aP3	aP4	aP5
30	100	300 keV	30	80	250	800	2500 keV

if a is missing: b = P

P6	P7	P8
16	35	70 MeV

Energy numbers are the low ends of the ranges.
The list here does not indicate which signals are for a finite range and which are integral.

TED 1   DPU 1   This page fits at the right of page 102.

160	180	200	220	240	260	280	300
0I	90I	spare	TED E ch PS	TED P ch PS	TED T	HEP PMT PS	HEP Bias
0P1	-	-	-	-	-	-	-
161	181	201	221	241	261	281	301
0P2	-	-	-	-	-	-	-
0P3	-	-	-	-	-	-	-
162	182	202	222	242	262	282	302
0P4	-	-	-	-	-	-	-
0P5	-	-	-	-	-	-	-
163	183	203	223	243	263	283	303
0E1	-	-	-	-	-	-	-
0E2	-	-	-	-	-	-	-
164	184	204	224	244	264	284	304
0E3	-	-	-	-	-	-	-
P1	S5	P1	S5	P1	S5	P1	S5
165	185	205	225	245	265	285	305
0DE1	30DE1	0DP1	30DP1	0EBK	TED bits	bits	sync f3
P2	S4	P2	S4	P2	S4	P2	S4
166	186	206	226	246	266	286	306
0DE3	30DE3	0DP3	30DP3	0PBK	DCB 1-8	PC1-4	sync 50
P3	S1	P3	S1	P3	S1	P3	S1
167	187	207	227	247	267	287	307
0DE5	30DE5	0DP5	30DP5	30EBK	DPU12V	HEP ELT	HEP PMTT
P4	S2	P4	S2	P4	S2	P4	S2
168	188	208	228	248	268	288	308
0DE7	30DE7	0DP7	30DP7	30PBK	TED ramp	TED CEAPS	DPU ramp
A1	S3	A1	S3	A1	S3	A1	S3
169	189	209	229	249	269	289	309
A2	spare	A2	spare	A2	spare	A2	spare
0EM 0PM	- -	- -	- -	- -	- -	- -	- -
170	190	210	230	250	270	290	310
30EM 30PM	- -	- -	- -	- -	- -	- -	- -
90P1	-	-	-	-	-	-	-
171	191	211	231	251	271	291	311
90P2	-	-	-	-	-	-	-
90P3	-	-	-	-	-	-	-

TED 1 DPU 1 This page fits at the right of page 103.

172	192	212	232	252	272	292	312
90P4	–	–	–	–	–	–	–
90P5	–	–	–	–	–	–	
173	193	213	233	253	273	293	313
90E1	–	–	–	–	–	–	–
90E2	–	–	–	–	–	–	–
174	194	214	234	254	274	294	314
90E3	–	–	–	–	–	–	–
P6	–	–	–	–	–	–	–
175	195	215	235	255	275	295	315
P7	–	–	–	–	–	–	–
P8	–	–	–	–	–	–	–
176	196	216	236	256	276	296	316
0EFD	–	–	–	–	–	–	–
0PFD	–	–	–	–	–	–	–
177	197	217	237	257	277	297	317
30EFD	–	–	–	–	–	–	–
30PFD	–	–	–	–	–	–	–
178	198	218	238	258	278	289	318
0DEM	–	–	–	–	–	–	–
0PDM	–	–	–	–	–	–	–
179	199	219	239	259	279	299	319
30DEM	–	–	–	–	–	–	–
30DPM	–	–	–	–	–	–	–
			24 s				32 s

xxx minor frame number
yyyy data in word 20
zzzz data in word 21

– means same as at left.
Where data have two codes:
4 bits are used by each (frame 9, 10).

TED code abc
a = 0, 30 for 0 and 30 degrees
in b E = electrons
P = protons
In TED codes E and P do not appear alone.

TED Mode Proton Dwell DPU Mode 1 = TLM format 1

5 0DP1	25 30DP1	45 0DP1	65 30DP1	85 0DP1	105 30DP1	125 0DP1	145 30DP1
6 0DP3	26 30DP3	46 0DP3	66 30DP3	86 0DP3	106 30DP3	126 0DP3	146 30DP3
7 0DP5	27 30DP5	47 0DP5	67 30DP5	87 0DP5	107 30DP5	127 0DP5	147 30DP5
8 0DP7	28 30DP7	48 0DP7	68 30DP7	88 0DP7	108 30DP7	128 0DP7	148 30DP7
9 0PM 0PM	29 - -	49 - -	69 - -	89 - -	109 - -	129 - -	149 - -
10 30PM 30PM	30 - -	50 - -	70 - -	90 - -	110 - -	130 - -	150 - -
- - - - - - - - - - -							
16 0PFD 0PFD	31 - -	51 - -	71 - -	91 - -	111 - -	131 - -	151 - -
17 30PFD 30PFD	37 - -	57 - -	77 - -	97 - -	117 - -	137 - -	157 - -
18 0DPM 0DPM	38 - -	58 - -	78 - -	98 - -	118 - -	138 - -	158 - -
19 30DPM 30DPM	39 - -	59 - -	79 - -	99 - -	119 - -	139 - -	159 - -

continued on next page

TED Mode Electron Dwell is same as Proton Dwell except all P symbols listed here in rows beginning with 5 - 10, 16 - 19 are E.

This page fits at the right of page 106.

165 0DP1	185 30DP1	205 0DP1	225 30DP1	245 0PBK	265	285	305
166 0DP3	186 30DP3	206 0DP3	226 30DP3	246 0PBK	266	286	306
167 0DP5	187 30DP5	207 0DP5	227 30DP5	247 30PBK	267	287	307
168 0DP7	188 30DP7	208 0DP7	228 30DP7	248 30PBK	268	288	308
169 0PM 0PM	189 - -	209 - -	229 - -	249 - -	269 - -	289 - -	309 - -
170 30PM 30PM	190 - -	210 - -	230 - -	250 - -	270 - -	290 - -	310 - -

- - - - - - - - - - - - - -

176 0PFD 0PFD	196 - -	216 - -	236 - -	256 - -	276 - -	296 - -	316 - -
177 30PFD 30PFD	197 - -	217 - -	237 - -	257 - -	277 - -	297 - -	317 - -
178 0DPM 0DPM	198 - -	218 - -	238 - -	258 - -	278 - -	298 - -	318 - -
179 30DPM 30DPM	199 - -	219 - -	239 - -	259 - -	279 - -	299 - -	319 - -

TED normal DPU mode 2 = TLM format 2

45 0DE1	65 30DE1	125 0DE1	145 30DE1	205 0DE1	225 30DE1
46 0DE3	66 30DE3	126 0DE3	146 30DE3	206 0DE3	226 30DE3
47 0DE5	67 30DE5	127 0DE5	147 30DE5	207 0DE5	227 30DE5
48 0DE7	68 30DE7	128 0DE7	148 30DE7	208 0DE7	228 30DE7

APPENDIX I

Acronyms and Letter Groups

CDA	Command and Data Acquisition
CEAPS	Cylinderical Electrostatic Analyzer Power Supply
DCB	Data Command Bit also Digital Command Bit
DPU	Data Processing Unit
FACC	Ford Aerospace and Communications Corporation
GSFC	Goddard Space Flight Center of NASA
IFC	In-Flight Calibration
LC	Level Command
LD	Level Detector
HEPAD	High Energy Proton and Alpha Detector
HVPS	high voltage power supply
MEPED	Medium Energy Proton and Electron Detector
NESDIS	National Environmental Satellite Data and Information Service, NOAA
PC	Pulse Command
SAT	Select at Test (means choose value during manufacture)
S/C	Spacecraft
SEL	Space Environment Laboratory, NOAA, Boulder
SELDADS	SEL Data And Display System
SEM	Space Environment Monitor
SESC	Space Environment Service Center, SEL, NOAA, Boulder
SOCC	Satellite Operations Control Center of NESDIS, Suitland, Maryland
SSD	Solid State Detector
TED	Total Energy Detector
TIP	TIROS Information Processor
TLM	Telemeter

- - - - - - - - - - - - - - -