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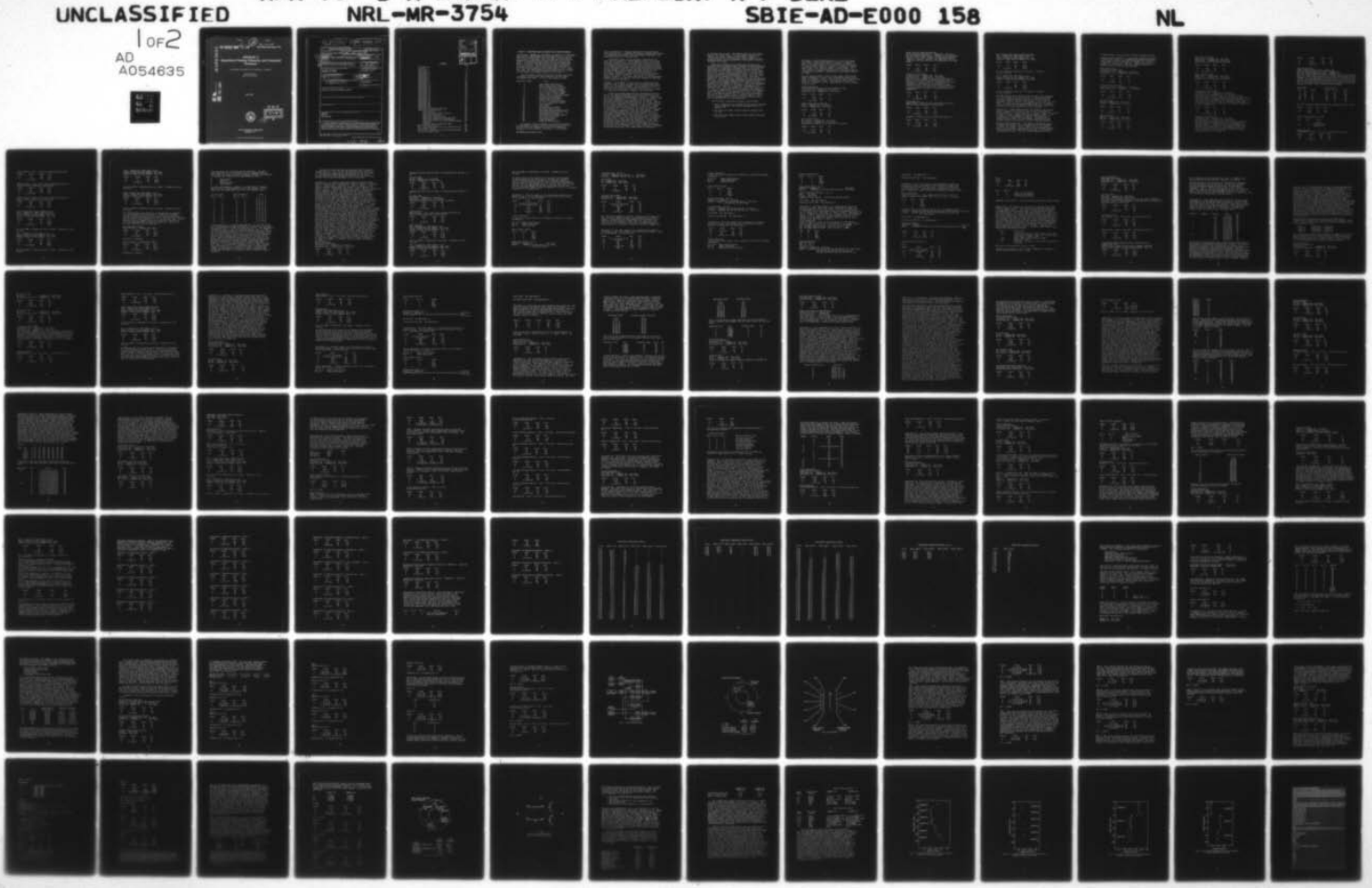

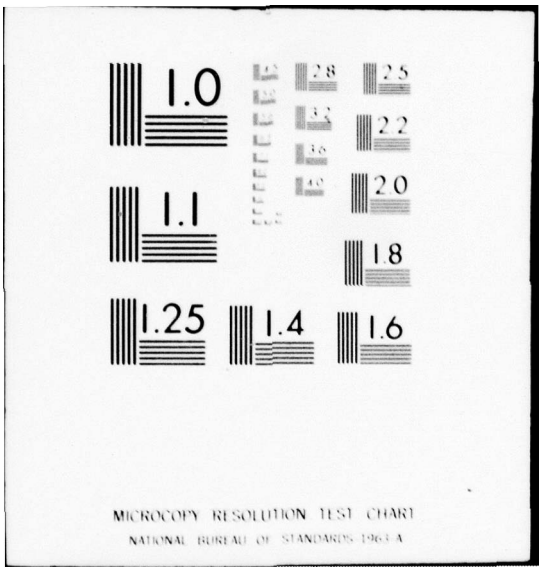
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SOLRAD 11
Experiment Timing, Telemetry and Command Summary

D. M. HORAN, R. W. KREPLIN, K. P. DERE and C. Y. JOHNSON

Upper Air Physics
Space Science Division

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Detailed information on the command, telemetry and data sampling sequences associated with each experiment aboard the SOLRAD 11 satellites is presented so that telemetered information can be properly interpreted. Information for interpreting telemetry from the satellites orientation sensors is presented so that the locations of sources of experiment data can be determined. It is assumed that the reader has a complete knowledge of the design and operation of the experiments.

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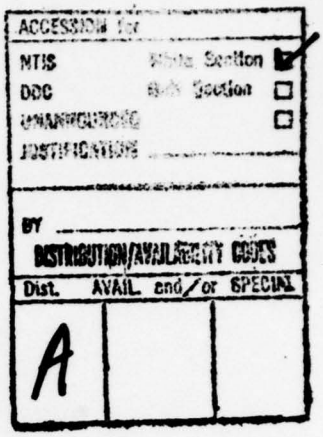

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SOLRAD 11 — EXPERIMENT TIMING, TELEMETRY AND COMMAND SUMMARY

Introduction: SOLRAD 11A (1976-023C) and SOLRAD 11B (1976-023D) were launched from the Eastern Test Range by a Titan IIIC at 0125 UT on 15 March 1976. The Titan launch vehicle carried its payload to synchronous orbit altitude and ejected the two SOLRAD 11 spacecraft and two kick motors as a unit at that point. The kick motors were fired to raise the SOLRAD payload to a circular, 120,000 km orbit inclined approximately 6° to the ecliptic. The two spacecraft were separated on 22 March 1976 and caused to move slowly apart in their orbit until they were stabilized at the 180° phasing point in early July 1976. The 180° phasing was maintained until the failure of the SOLRAD 11A telemetry system on 13 June 1977.

Each spacecraft carried essentially the same complement of sensors to monitor the sun's radiation and the space environment near Earth. A list of the sensors follows:

Experiment Number	Name
1	High Energy X-Ray Monitor
2	X-Ray Proportional Counter
3	Mg XI and Mg XII Line Monitor
4	1 to 8 A Ionization Chamber
5	8 to 16 A Ionization Chamber
6	44 to 60 A Ionization Chamber
7	170 to 1050 A - Three Bands
8	1080 to 1350 A Ionization Chamber
9	Ultraviolet Spectrometer
10	Thomson X-Ray Polarimeter
11	Bragg X-Ray Polarimeter
12	0.5 to 3 A Ionization Chamber
13	2 to 10 A Ionization Chamber
14	Solar Protons
15	Solar Wind
16	Stellar/Auroral X-Rays
17	Omnidirectional Protons
18	Geocoronal-Extraterrestrial EUV
19	Geocoronal-Extraterrestrial EUV
20	Proton-Alpha Telescope
21	Low Energy Proton Spectrometer
22	Solar Flare Electrons
23	Anti-Solar Protons
24	X-Ray Background
25	Gamma Ray Burst Monitor

The purpose of this document is to provide information on the command, telemetry, and data sampling sequences associated with each experiment so that the telemetered information can be properly interpreted. It is assumed

Note: Manuscript submitted February 28, 1978.

that the reader has a complete knowledge of the experiments from other sources. A document containing a complete description of the SOLRAD 11 spacecraft, their experiment complement, and supporting systems is in preparation.

Preliminary copies of this document, dated March-June 1976, were circulated in limited numbers so that its accuracy could be verified by use. A serious error discovered in the preliminary copies was a 22.5° mistake in the location of the roll reference sensors and the solar aspect sensors referenced to the spacecraft coordinate system and the experiment sensors. Figures on pages 73 and 84, text on pages 82 and 88, and tables on pages 86-88 of this document have been revised to show the correct information. The preliminary copies also erroneously identified the MSB for the visible and infrared Earth sensor select indicators. The correct information appears on page 71. All other modifications to the preliminary document were for the sake of consistent wording or additional clarity and were very minor.

Telemetry: Each SOLRAD 11 satellite has a single real-time telemetry link to carry all experiment and housekeeping data. There are five telemetry formats. Each consists of 32 frames containing 32 twelve bit words. The information rate is 102.4 bits per second and it requires 3.75 seconds to transmit one frame and two minutes to transmit one format page.

Format one contains data from all experiments except 18, 19 and 25, complete experiment status and housekeeping information, and spacecraft housekeeping information. Format one will be the normally selected format. Format two replaces some data from experiments 4, 5, 12 and 13 and some spacecraft information with data from experiments 18, 19 and 25. Experiments 18 and 19 were excluded from format one because they are not turned on continually. Experiment 25 was excluded because it has a memory which can be read out at intervals. Format three devotes about two-thirds of the telemetry capability to experiment 15. It is only used for short intervals because it excludes data from most of the other experiments. Format four is primarily devoted to spacecraft housekeeping and experiment housekeeping and status information. It is used to provide a rapid check on the condition of the spacecraft and the experiments. Very little experiment data is contained in format four. Format five provides spacecraft orientation information with a very high time resolution. It was used extensively during transfer from synchronous to final orbits but is rarely used now. Five charts which identify the contents of every telemetry word in each format are attached to the back of this document. Each chart represents a complete two-minute format page. The format number is identified

in the upper left corner. The numbers along the left margin identify the frames (rows), and the numbers along the top identify the words (columns) of each frame. Blanks in columns indicate that the information pattern shown in the non-blank spaces in the top portion of the column is repeated throughout the column.

Data and information are encoded into the twelve-bit telemetry words in several ways. Analog data from experiments and monitors is converted to digital form. In most cases the analog data is converted to 8 digital bits and transmitted most-significant-bit (MSB) first using the first eight transmitted bits of the twelve bit telemetry word. The last four bits of the telemetry word sometimes contain status and housekeeping information and sometimes are blank. In a few cases analog data is converted to 12 digital bits. This data occupies an entire twelve-bit telemetry word and is transmitted MSB first. Digital data from experiments is sometimes encoded by letting the telemetry words carry the output of linear accumulators and transmitted MSB first. Most often the digital data from the experiments is encoded by letting the telemetry words carry the output of a twelve-bit floating point accumulator (FPA). The FPA information is provided in the form of a four bit exponent and an 8 bit mantissa. The exponent is transmitted MSB first in the first four bits of a telemetry word. The mantissa is carried MSB first in the last eight bits of the same telemetry word. An equation for evaluating the FPA from the telemetry word is given on page 65. Data from a few experiments is treated in special ways and these will be described as they are encountered.

The following conventions are used in this document:

1. In all cases the first transmitted bit in each telemetry word is numbered 1 and the last transmitted bit is numbered 12.

2. The thirty-two words of each frame are numbered from 0 to 31.

3. The thirty-two frames of each format page are numbered from 0 to 31.

Experiment 1: Normal Sampling Mode: If i is an even frame, data samples taken during words 0 through 31 of frames i-2 and i-1 are telemetered in word 10 of frame i (Channel 2), word 26 of frame i (Channel 1) word 10 of frame i+1 (Channel 3), and word 26 of frame i+1 (Channel 4) in formats 1 and 2. Sample time is two complete frames - 7.500 seconds. All four channels are sampled simultaneously even though they are telemetered in sequence. Floating point accumulators (FPA's) are used.

Optional Sampling Mode: Channel 2 data sample taken during words 0 through 15 of frame i are telemetered in word 26 of frame i in formats 1 and 2. Channel 2 data sample taken during words 16 through 31 of frame i are read out in word 10 of frame i+1 in formats 1 and 2. Sampling time is 1.875 seconds. An FPA is used.

Status Indicators:
Electronics On-Off Relay Position Indicator (RPI)
Electronics On - Command 73 - One State
Electronics Off - Command 135 - Zero State

Format	Frame	Word	Bit
1,2	0,16	31	9
3	16	25	9
4	0,8,16,24	5	9

High Voltage (HV) On-Off RPI:
HV On - Command 104 - One State
HV Off - Command 135 - Zero State

Format	Frame	Word	Bit
1,2	0,16	31	10
3	16	25	10
4	0,8,16,24	5	10

HV 1-2 Select RPI:
HV 1 Select - Command 74 - One State
HV 2 Select - Command 105 - Zero State
Experiment HV must be on for this RPI to function.

Format	Frame	Word	Bit
1,2	0,16	31	11
3	16	25	11
4	0,8,16,24	5	11

Normal-Optional Sampling Mode RPI:
Normal Sampling Mode Select - Command 75 - One State
Optional Sampling Mode Select - Command 106 - Zero State
This relay will change position as soon as the proper command is received. However, the experiment will not change its sampling mode until the beginning of the next frame 0.

Format	Frame	Word	Bit
1,2	0,16	31	12
3	16	25	12
4	0,8,16,24	5	12

Calibration On-Off RPI:
Calibration On - Command 136 - One State
Calibration Off - Command 137 - Zero State
Once the proper command is received calibration will begin and this relay will change position at the beginning of the next frame 0. Calibration will then automatically terminate at the beginning of the subsequent frame 0 and this relay will also revert to the off position at that time. Calibration can be terminated prior to automatic termination by use of Command 137.

Format	Frame	Word	Bit
1,2	26	25	12
3	22	26	12
4	6,14,22,30	9	12

Analog Monitors:
High Voltage: 0.00-5.10 volts, 20 millivolts per bit
Monitor values correspond to selected HV.

Format	Frame	Word	Bit
1,2	0	25	1-8
3	0	26	1-8
4	0,8,16,24	7	1-8

Ratemeter: 0.00-5.10 volts, 20 millivolts per bit

Format	Frame	Word	Bit
1,2	12,28	17	1-8
3	9	27	1-8
4	1,9,17,25	12	1-8

High Voltage Power Supply (HVPS) Settings:
HV1 - Command H=1, XXXX (MSB on left)
Lowest voltage setting command: H=1, 1111
Highest voltage setting command: H=1, 0000

Format	Frame	Word	Bits
1,2	0	25	9-12
3	0	26	9-12
4	0,8,16,24	7	9-12

Bit 12 is MSB of telemetered 4 bit group. Telemetry is also inverted.

HV2 - Command H=2, XXXX (MSB on left)
Lowest voltage setting command: H=2, 1111
Highest voltage setting command: H=2, 0000

Format	Frame	Word	Bits
1,2	4	25	9-12
3	1	26	9-12
4	1,9,17,25	7	9-12

Bit 12 is MSB of telemetered 4 bit group. Telemetry is also inverted.

One HVPS setting can be stored in the spacecraft for execution at the beginning of the next frame 0. If more than one HVPS setting is required during the two minute interval between successive frames 0, whether from only one or more than one experiment, only the last setting command can be of the form H=N, XXXX. All additional setting commands during that two minute interval must be of the form H=N, XXXX followed by command 150, and will be executed immediately by the spacecraft.

Experiment 2: Normal Sampling Mode: Data samples taken during words 0 through 31 of frames i-2 and i-1 are telemetered in words 11 and 27 of frame i and words 11 and 27 of frame i+1 (i even) in formats 1 and 2. Sample time is two complete frames - 7.500 seconds. All four channels are sampled simultaneously even though they are telemetered in sequence. Floating point accumulators are used. The data channel appearing in given telemetry words is controlled by the data crossing settings.

Optional Sampling Mode One: Data samples taken during words 0 through 31 of frame i-1 are telemetered in words 11 and 27 of frame i in formats 1 and 2. Sample time is one complete frame - 3.750 seconds. The channels are sampled simultaneously even though they are telemetered in sequence. Floating point accumulators are used. The data channel appearing in given

telemetry words is controlled by the data crossing settings.

Optional Sampling Mode Two: A data sample taken during words 0 through 15 of frame i is telemetered in word 27 of frame i. A data sample taken during words 16 through 31 of frame i is telemetered in word 11 of frame i+1. Sample time is 1.875 seconds. An FPA is used. The data channel telemetered is controlled by the data crossing settings.

Status Indicators:
Electronics A On-Off RPI:
Electronics A On - Command 76 - One State
Electronics A Off - Command 78 - Zero State

Format	Frame	Word	Bit
1,2	1,17	31	9
3	17	25	9
4	1,9,17,25	5	9

Electronics B On-Off RPI:
Electronics B On - Command 77 - One State
Electronics B Off - Command 78 - Zero State

Format	Frame	Word	Bit
1,2	1,17	31	10
3	17	25	10
4	1,9,17,25	5	10

HVA On-Off RPI:
HVA On - Command 107 - One State
HVA Off - Command 109 - Zero State

Format	Frame	Word	Bit
1,2	1,17	31	11
3	17	25	11
4	1,9,17,25	5	11

HVB On-Off RPI:
HVB On - Command 108 - One State
HVB Off - Command 109 - Zero State

Format	Frame	Word	Bit
1,2	1,17	31	12
3	17	25	12
4	1,9,17,25	5	12

HV1A - 2A Select RPI:
HV1A Select - Command 138 - One State
HV2A Select - Command 169 - Zero State
HVA must be on for this RPI to function.

Format	Frame	Word	Bit
1,2	2,18	31	9
3	18	25	9
4	2,10,18,26	5	9

HV1B - 2B Select RPI:
HV1B Select - Command 139 - One State
HV2B Select - Command 170 - Zero State
HVB must be on for this RPI to function.

Format	Frame	Word	Bit
1,2	2,18	31	10
3	18	25	10
4	2,10,18,26	5	10

Calibration A On-Off RPI:
Calibration A On - Command 79 - One State
Calibration A Off - Command 141 - Zero State
Once the proper command is received calibration will begin and this relay will change position at the beginning of the next frame 0. Calibration will then automatically terminate at the beginning of the subsequent frame 0 and this relay will also revert to the off position at that time. Calibration can be terminated prior to automatic termination by use of Command 141.

Format	Frame	Word	Bit
1,2	2,18	31	11
3	18	25	11
4	2,10,18,26	5	11

Calibration B On-Off RPI:
Calibration B On - Command 110 - One State
Calibration B Off - Command 141 - Zero State
Once the proper command is received calibration will begin and this relay will change position at the beginning of the next frame 0. Calibration will then automatically terminate at the beginning of the subsequent frame 0 and this relay will also revert to the off position at that time. Calibration can be terminated prior to automatic termination by use of Command 141.

Format	Frame	Word	Bit
1,2	2,18	31	12
3	18	25	12
4	2,10,18,26	5	12

Sampling Mode RPI's:
Normal Sampling Mode Select - Command 140
Optional Sampling Mode One Select - Command 171
Optional Sampling Mode Two Select - Command 172
When the proper command is received the RPI's indicating sampling mode will immediately change but the actual sampling mode will not change until the beginning of the next frame 0. This means that the data sequence appearing in frames 0 and 1 will follow the new mode but the sampling time will initially be that of the old mode. The following table shows sampling times appropriate to data appearing in frames 0 and 1 after given mode changes.

Mode Change		Sampling Time			
From	To	F0,W11	F0,W27	F1, W11	F1,W27
N	01	N	N	01	01
N	02	N	02	02	02
01	02	01	02	02	02
01	N	01	01	01	01
02	01	02	02	01	01
02	N	02	02	02	02

The bits containing sampling mode RPI information are as follows:

Format	Frame	Word	Bits
1,2	Even	5	2,3
4	Every	2	2,3

The bit interpretation follows:

Bit 2	Bit 3	Mode
1	0	Normal
0	1	Optional One
0	0	Optional Two

Analog Monitors:
Low Voltage A: 0.00 - 5.10 volts; 20 millivolts per bit

Format	Frame	Word	Bits
1,2	8	25	1-8
3	2	26	1-8
4	2,10,18,26	7	1-8

Low Voltage B: 0.00 - 5.10 volts; 20 millivolts per bit

Format	Frame	Word	Bits
1,2	12	25	1-8
3	3	26	1-8
4	3,11,19,27	7	1-8

High Voltage A: 0.00 - 5.10 volts; 20 millivolts per bit
Monitor values correspond to selected HV.

Format	Frame	Word	Bits
1,2	24	25	1-8
3	6	26	1-8
4	6,14,22,30	7	1-8

High Voltage B: 0.00 - 5.10 volts; 20 millivolts per bit
Monitor values correspond to selected HV

Format	Frame	Word	Bits
1,2	28	25	1-8
3	7	26	1-8
4	7,15,23,31	7	1-8

High Voltage Power Supply (HVPS) Settings:
HV1A - Command H=3, XXXX (MSB on left)
Lowest voltage setting command: H=3, 0000
Highest voltage setting command: H=3, 1111

Format	Frame	Word	Bits
1,2	8	25	9-12
3	2	26	9-12
4	2,10,18,26	7	9-12

Bit 12 is MSB of telemetered four bit group. Telemetry is also inverted.

HV2A - Command H=4, XXXX (MSB on left)
Lowest voltage setting command: H=4, 0000
Highest voltage setting command: H=4, 1111

Format	Frame	Word	Bits
1,2	12	25	9-12
3	3	26	9-12
4	3,11,19,27	7	9-12

Bit 12 is MSB of telemetered four bit group. Telemetry is also inverted.

HV1B - Command H=5, XXXX (MSB on left)
Lowest voltage setting command: H=5, 0000
Highest voltage setting command: H=5, 1111

Format	Frame	Word	Bits
1,2	16	25	9-12
3	4	26	9-12
4	4,12,20,28	7	9-12

Bit 12 is MSB of telemetered four bit group. Telemetry is also inverted.

HV2B - Command H=6, XXXX (MSB on left)
Lowest voltage setting command: H=6, 0000
Highest voltage setting command: H=6, 1111

Format	Frame	Word	Bits
1,2	20	25	9-12
3	5	26	9-12
4	5,13,21,29	7	9-12

Bit 12 is MSB of telemetered four bit group. Telemetry is also inverted.

One HVPS setting can be stored in the spacecraft for execution at the beginning of the next frame 0. If more than one HVPS setting is required during the two minute interval between successive frames 0, whether from only one or more than one experiment, only the last setting command can be of the form H=N, XXXX. All additional setting commands during that two minute interval must be of the form H=N, XXXX followed by command 150, and will be executed immediately by the spacecraft.

Data Crossing Settings:
Data Crossing 1 - Command H=18, 0XXX.

Format	Frame	Word	Bits
1,2	24	25	9-11
3	6	26	9-11
4	6,14,22,30	7	9-11

Telemetry is inverted.

Data Crossing 2 - Command H=19, 0XXX

Format	Frame	Word	Bits
1,2	28	25	9-11
3	7	26	9-11
4	7,15,23,31	7	9-11

Telemetry is inverted.

This experiment has four detectors and four FPA's. The data sample from any one of the detectors can be commanded onto any of the FPA's by changing the data crossing settings. The detectors are labeled W,X,Y and Z and are indentified as follows:

W	Shallow Neon
X	Deep Neon
Y	Shallow Krypton
Z	Deep Krypton

The FPA's are numbered 1 through 4. A truth table to identify which detector's data apppears on which FPA follows. The bit states are the telemetered states, not the commanded states.

Data Crossing 1		Data Crossing 2		FPA			
Bit 10	Bit 11	Bit 10	Bit 11	1	2	3	4
1	1	1	1	W	X	Y	Z
1	1	1	0	W	X	Z	Y
1	1	0	1	W	X	W	X
1	1	0	0	W	X	W	X
1	0	1	1	X	W	Y	Z
1	0	1	0	X	W	Z	Y
1	0	0	1	X	W	X	W
1	0	0	0	X	W	X	W
0	1	1	1	Y	Z	Y	Z
0	1	1	0	Z	Y	Z	Y
0	1	0	1	Y	Z	W	X
0	1	0	0	Z	Y	W	X
0	0	1	1	Y	Z	Y	Z
0	0	1	0	Z	Y	Z	Y
0	0	0	1	Y	Z	X	W
0	0	0	0	Z	Y	X	W

If the experiment is in normal sampling mode, all four FPA values will be telemetered carrying information as indicated in the truth table unless bit 9 of either data crossing is a 0. The information contained in FPA's 1 and 2 for optional sampling mode 1, or FPA 1 for optional sampling mode 2 is as given in the truth table unless bit 9 of either data crossing is a 0. If the telemetered value of bit 9 of data crossing 1 is 0, data from detector X is suppressed and data from a second channel of detector W is carried in its place. When the calibration source is moved into place in front of detector W, the high voltage settings can then be adjusted to make the counting rate from the normally telemetered channel of detector W twice that of the detector W channel replacing detector X. If the telemetered value of bit 9 of data crossing 2 is 0, data from detector Z is suppressed and data from a second channel of detector Y is carried in its place. Telemetering values from two channels of detector Y permits adjusting high voltage settings when the calibration source is moved in front of detector Y.

The data crossing settings are considered HVPS settings for command purposes. Only the last HVPS setting can be stored in the spacecraft for execution at the beginning of the next frame 0. Any additional HVPS commands sent during the two minute interval between successive frames 0 must be followed by command 150 and will be executed immediately by the spacecraft.

Experiment 3: In formats 1 and 2 data samples acquired during frames 0 through 15 are telemetered in word 17, frame 17 (continuum) word 17, frame 19 (Mg XI) and word 17, frame 21 (Mg XII). Data samples acquired during frames 16 through 31 are telemetered in word 17, frame 1 (continuum), and word 17, frame 3 (Mg XI), and word 17, frame 5 (Mg XII). Twelve bit linear registers are used and the MSB is transmitted first. The sampling time is calculated by multiplying the sampling time per spin by the number of spins completed during the one minute intervals between the beginning of frames 0 and 16 and the beginning of frames 16 and 0. The sampling time for samples telemetered in frames 17, 19 and 21 is calculated as follows: The spin period based on the star sensor is given in word 18, frames 2 and 10 in format 1 or word 24, frames 4, 8, and 12 in format 2. The spin period based on the Earth sensor is given in word 20, frames 3 and 11 in format 1. If these sensors are locked onto their respective targets all of the above words should agree and give a spin period between 3.7 and 4.3 seconds when the value contained in each words' 12 bit linear register is multiplied by 2.4414 milliseconds. Multiplying the value contained in the six MSB (bits 1-6), of one of the above spin period words by 2.4414 milliseconds will give the sampling time per spin. The total sampling time is obtained by adding the values contained in word 19, bits 9 through 12 (bit 9 is MSB) of frames 11 and 19 in format 1 or word 24 bits 9 through 12 of frames 10 and 18 in format 2, and then multiplying the sum by the sampling time per spin. Bits 9 through 12, word 19, frames 11 and 19 are 4 bit registers which give the number of star pulses observed in each 30 second period defined by frames 0 through 7 and frames 8 through 15. The sampling time for samples telemetered in frames 1, 3, and 5 is based on spin period data from the star sensor contained in word 18, frames 18 and 26 in format 1 or word 24, frames 16, 20, 24 and 28 in format 2, and spin period data from the Earth sensor contained in word 20, frames 19 and 27 in format 1. The number of star pulses in the 30 seconds defined by frames 16 through 23 is given in word 19, bits 9 through 12 of frame 27 in format 1 or word 24, bits 9 through 12 of frame 26 in format 2. The number of star pulses in the 30 seconds defined by frames 24 through 31 is given in word 19, bits 9 through 12 of frame 3 in format 1 or word 24, bits 9 through 12 of frame 2 in format 2.

Status Indicators:

Electronics On-Off RPI:

Electronics On - Command 80 - One State

Electronics Off - Command 142* - Zero State

Format	Frame	Word	Bit
1,2	4,20	31	9
3	20	25	9
4	4,12,20,28	5	9

*Command 142 also turns off Exp. 11 electronics but not Exp. 11 HV.

HV On-Off RPI:
HV On - Command 111 - One State
HV OFF - Command 142* - Zero State

Format	Frame	Word	Bit
1,2	4,20	31	10
3	20	25	10
4	4,12,20,28	5	10

*Command 142 also turns off Exp. 11 electronics but not Exp. 11 HV.

HV Select RPI:
HV1 Select - Command 81 - One State
HV2 Select - Command 112 - Zero State
Experiment HV must be on for this RPI to function

Format	Frame	Word	Bit
1,2	4,20	31	11
3	20	25	11
4	4,12,20,28	5	11

Analog Monitor:
High Voltage: 0.00 - 5.10 volts, 20 Millivolts per bit.
Monitor values correspond to selected HV.

Format	Frame	Word	Bits
1,2	1	25	1-8
3	8	26	1-8
4	0,8,16,24	8	1-8

HVPS Settings:
HV1 - Command H=7, XXXX (MSB on left)
Lowest voltage setting command: H=7, 0000
Highest voltage setting command: H=7, 1111

Format	Frame	Word	Bits
1,2	1	25	9-12
3	8	26	9-12
4	0,8,16,24	8	9-12

Bit 12 is MSB of telemetered 4 bit group. Telemetry is also inverted.

HV2 - Command H=8, XXXX (MSB on left)
Lowest voltage setting command: H=8, 0000
Highest voltage setting command: H=8, 1111

Format	Frame	Word	Bits
1,2	5	25	9-12
3	9	26	9-12
4	1,9,17,25	8	9-12

Bit 12 is MSB of telemetered 4 bit group. Telemetry is also inverted.

One HVPS setting can be stored in the spacecraft for execution at the beginning of the next frame 0. If more than one HVPS setting is required during the two minute interval between successive frames 0, whether from only one or more than one experiment, only the last setting command can be of the form H=N, XXXX. All additional setting commands during that two minute interval must be of the form H=N, XXXX followed by command 150, and will be executed immediately by the spacecraft.

Experiment 4: Each data sample is an instantaneous reading of an analog voltage. The voltage range is 0.00 to 5.10 volts. Each bit is equivalent to 20 millivolts.

Format	Frame	Word	Bits
1	2,6,10,14,18,22,26,30	7	1-8
1,2	0,4,8,12,16,20,24,28	12	1-8
1,2	14	25	1-8
3	Even	29	1-8
3	19	26	1-8
4	3,11,19,27	9,28	1-8
4	Even	31	1-8

Status Indicators:

In each of the above words, bits 9 through 12 convey the following information:

Bits 9,10 Range Identification
Bit 11 Range Change Mode
Bit 12 A-B Select RPI

Range Identification

Bit 9	Bit 10	Range
0	0	One
0	1	Two
1	0	Three
1	1	Four

Range Change Mode: Bit 11
Automatic - Command 9 - One state
Manual - Commands 102,164,40(4A) - Zero state
102,164,164,40(4B)

A-B Select RPI: Bit 12
A Select - Commands 102,164,133 - One State
B Select - Commands 102,164,164,133 - Zero State

On-Off RPI:
On - Command 201 - One State
Off- Command 232 - Zero State

Format	Frame	Word	Bit
1,2	4	31	12
3	20	25	12
4	4,12,20,28	5	12

Calibrate On-Off RPI:
Calibrate On - Command 263 - One State
Calibrate Off - Command 294 - Zero State

Format	Frame	Word	Bit
1	0,4,8,12,16,20,24,28	7	12
1,2	2,10,18,26	13	12
3	Odd	30	12
3	26	26	12
4	Odd	30	12
4	2,10,18,26	10,29	12

Once the proper command is received, calibration will begin and this relay will change position at the beginning of the next frame 0. Calibration will then automatically terminate at the beginning of the subsequent frame 0 and this relay will also revert to the off position at that time. Calibration can be terminated prior to automatic termination by use of command 294.

Experiment 5: Each data sample is an instantaneous reading of an analog voltage. The voltage range is 0.00 to 5.10 volts. Each bit is equivalent to 20 millivolts.

Format	Frame	Word	Bits
1	3,7,11,15,19,23,27,31	7	1-8
1,2	0,8,16,24	13	1-8
1,2	18	25	1-8
3	Odd	29	1-8
3	20	26	1-8
4	4,12,20,28	9,28	1-8
4	Odd	31	1-8

Status Indicators:
In each of the above words bits 9 through 12 convey the following information:

Bits 9,10	Range Identification
Bit 11	Range Change Mode
Bit 12	A-B Select RPI

Range Identification:

Bit 9	Bit 10	Range
0	0	One
0	1	Two
1	0	Three
1	1	Four

Range Change Mode: Bit 11
Automatic - Command 9 - One State
Manual - Commands 102,164,164,164,40(5A) - Zero State
102,164,164,164,164,40(5B)

A-B Select RPI: Bit 12
A Select - Commands 102,164,164,164,133 - One State
B Select - Commands 102,164,164,164,164,133 - Zero State

On-Off RPI: See Experiment 4.

Calibrate On-Off RPI: See Experiment 4.

Experiment 6: Each data sample is an instantaneous reading of an analog voltage. The voltage range is 0.00 to 5.10 volts. Each bit is equivalent to 20 millivolts.

Format	Frame	Word	Bits
1,2	1,9,17,25	13	1-8
1,2	22	25	1-8
3	21	26	1-8
4	5,13,21,29	9,28	1-8

Status Indicators:
In each of the above words, bits 9 through 12 convey the following information:

Bits 9,10	Range Identification
Bit 11	Range Change Mode
Bit 12	Shutter Position Indicator

Range Identification:

Bit 9	Bit 10	Range
0	0	One
0	1	Two
1	0	Three
1	1	Four

Range Change Mode: Bit 11
Automatic - Command 9 - One State
Manual - Commands 102,164,164,164,164,164,40 - Zero State

Shutter Position Indicator: Bit 12
Open - One State
Source - Zero State
Commands to move shutter: 102,164,164,164,164,164,264

On-Off RPI: See Experiment 4.

Calibrate On-Off RPI: See Experiment 4.

Experiment 7: Each data sample is an instantaneous reading of an analog voltage. Twelve bit linear registers are used. The voltage range is 0.000 to 4.914 volts. Each bit is equivalent to 1.200 millivolts. Experiment 7A data is telemetered in word 14, bits 1 through 12 of even frames in formats 1 and 2. Experiment 7B data is telemetered in word 14, bits 1 through 12 of odd frames in formats 1 and 2. Experiment 7C data appears in word 16, bits 1 through 12 of odd frames in formats 1 and 2 and word 27, bits 1 through 12 of odd frames in format 4.
Status Indicators:
Range Information - word 16, bits 4 through 12, even frames, formats 1 and 2; word 27, bits 4 through 12, even frames, format 4.
Exp. 7A Range Identification - bits 11,12 (bit 12 is MSB)
Exp. 7B Range Identification - bits 8,9 (bit 9 is MSB)
Exp. 7C Range Identification - bits 5,6 (bit 6 is MSB)

MSB	LSB	Range
0	0	One
0	1	Two
1	0	Three
1	1	Four

Range Change Mode:
Exp. 7A - bit 10
Exp. 7B - bit 7
Exp. 7C - bit 4
Automatic - Command 9 - One State
Manual - Commands 102,164,164,164,164,164,164,40 (7A) - Zero State
102,164,164,164,164,164,164,164,40 (7B)
102,164,164,164,164,164,164,164,164,40 (7C)

On-Off RPI: See Experiment 4.

Calibrate On-Off RPI: See Experiment 4.

Experiment 8: Each data sample is an instantaneous reading of an analog voltage. A twelve bit linear register is used. The voltage range is 0.000 to 4.914 volts. Each bit is equivalent to 1.200 millivolts. Experiment data is telemetered in word 12, bits 1 through 12, frames 1,5,9,13,17,21,25,29 in formats 1 and 2.

Status Indicators:
Range Identification: Even frames, word 16, bits 2 and 3 in formats 1 and 2; even frames, word 27, bits 2 and 3 in format 4.

Bit 3	Bit 2	Range
0	0	One
0	1	Two
1	0	Three
1	1	Four

A-B Select RPI: Even frames, word 16, bit 1 in formats 1 and 2.
A Select - Command 102,164,164,164,164,164,164,164,164,164,164,133 - One State
B Select - Command 102,164,164,164,164,164,164,164,164,164,164,164, 133 - Zero State

On-Off RPI: See Experiment 4.

Calibrate On-Off RPI: See Experiment 4.

Range Change Mode:
Automatic - Command 9 - One State
Manual - Commands 102,164,164,164,164,164,164,164,164,164,164,40 - Zero State

Format	Frame	Word	Bit
1,2	10	30	11
3	27	26	11
4	3,11,19,27	10,29	11

Shutter Position Indicators:

Bit A

Format	Frame	Word	Bit
1	1,5,9,13,17,21,25,29	7	12
1,2	3,7,11,15,19,23,27,31	12	12
3	Even	30	12
3	25	26	12
4	Even	30	12
4	1,9,17,25	10,29	12

Bit B

Format	Frame	Word	Bit
1,2	2	25	12
3	16	26	12
4	0,8,16,24	9,28	12

Bit A	Bit B	
0	0	Dark - no information
0	1	Detectors 8A exposed
1	0	Detectors 8A covered

Commands to move shutter: 102,164,164,164,164,164,164,164,164,164,264

Experiment 9: Data appears in word 9, bits 1 through 12 of every frame in formats 1 and 2. The spectrometer scans are constrained to begin during frame 0. Scan start is indicated by having the five MSB (bits 1-5) of word 9, frame 0 in the one state. This is the control word. If bit 12 of the control word is a 1 (fast scan), the next 30 frames will contain FPA data in word 9, and frame 31, word 9 will contain the contents of a 12 bit linear register giving the stepping motor count. If the last bit of the control word is 0 (slow scan), the next 222 frames will contain FPA data in word 9, and the 223rd frame will contain the contents of the stepping motor register. FPA data accumulation time is one frame, 3.750 seconds. FPA data accumulation starts at the beginning of word 9, frame i-1 and continues until the end of word 8, frame i. That data is then telemetered in word 9, frame i. The bits of the control word contain the following information:

Bits	Information
1-5	Control word identification - always one state
6	Stepping motor torque. One state = high torque, zero state = normal torque.
7-9	High voltage setting (bit 9 is MSB).
10-11	Always zero state
12	Scan mode. One state is fast scan; zero state is slow scan.

FPA data is pre-scaled by a factor of eight.

Information contained in word 9, frame 1 immediately following a control word in frame 0 is not correct.

Status Indicators:
Experiment On-Off RPI:
Experiment On - Command 82 - One State
Experiment Off - Command 113 - Zero State

Format	Frame	Word	Bit
1,2	5	31	9
3	21	25	9
4	5,13,21,29	5	9

Scan Rate RPI:
Fast Scan - Command 144 - One State
Slow Scan - Command 143 - Zero State
This relay will change position as soon as the proper command is received. However, the instrument's scan mode will not change until the beginning of the next scan.

Format	Frame	Word	Bit
1,2	5	31	10
3	21	25	10
4	5,13,21,29	5	10

Analog Monitors:
Low Voltage: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bit
1,2	5	25	1-8
3	9	26	1-8
4	1,9,17,25	8	1-8

High Voltage: 0.00 = 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bit
1,2	9	25	1-8
3	10	26	1-8
4	2,10,18,26	8	1-8

High Voltage Power Supply and Motor Torque Settings:
Command H=9, TVVV
Normal torque, lowest voltage setting command: H=9,0000
High torque, highest voltage setting command: H=9,1111

Format	Frame	Word	Bit
1,2	9	25	9-12
3	10	26	9-12
4	2,10,18,26	8	9-12

Bit 12 indicates motor torque setting. Bit 11 is MSB of 3 bit group indicating voltage setting. Telemetry is inverted.

One HVPS setting can be stored in the spacecraft for execution at the beginning of the next frame 0. If more than one HVPS setting is required during the two minute interval between successive frames 0, whether from only one or more than one experiment, only the last setting command can be of the form H=N, XXXX. All additional setting commands during that two minute interval must be of the form H=N, XXXX, followed by command 150, and will be executed immediately by the spacecraft.

Experiment 10: This experiment has two detectors (A and B) and each detector has two energy channels (1 and 2). The roll plane is divided into 8 sectors for data acquisition but data from the first and fifth sectors share the same FPA. Data from the second and sixth sectors, third and seventh sectors, and fourth and eighth sectors also share FPA's. FPA data is transmitted in formats 1 and 2 according to the following table:

Detector	Channel	Sectors	Frames	Word
A	1	1,5	0,8,16,24	22
		2,6	1,9,17,25	22
		3,7	2,10,18,26	22
		4,8	3,11,19,27	22
A	2	1,5	0,8,16,24	23
		2,6	1,9,17,25	23
		3,7	2,10,18,26	23
		4,8	3,11,19,27	23
B	1	1,5	4,12,20,28	22
		2,6	5,13,21,29	22
		3,7	6,14,22,30	22
		4,8	7,15,23,31	22
B	2	1,5	4,12,20,28	23
		2,6	5,13,21,29	23
		3,7	6,14,22,30	23
		4,8	7,15,23,31	23

All 12 bits of each word are used. Timing of data acquisition is controlled at the beginning of frames 0,8,16 and 24. All channels and detectors acquire data simultaneously, controlled by the sectoring electronics. Data acquired during one 30 second control period is telemetered during the next 30 seconds. The data acquisition control at the beginning of frames 0,8,16 and 24 shifts FPA data into storage registers for telemetering during the next 30 seconds and sets the FPA's to zero. The first star pulse after the beginning of frames 0,8,16 and 24 starts data acquisition and the seventh star pulse stops data acquisition. Data acquisition can only occur for 6 complete spins in each 30 seconds. Sampling

time for one spin is obtained as follows: The spin period based on the star pulse is given in word 18, frames 2,10,18 and 26 in format 1; or word 24, frames 4,8,12,16,20,24,28 in format 2. The spin period based on the Earth pulse is given in word 20, frames 3,11,19 and 27 in format 1. If star and Earth pulses are being generated, all of the above words should agree and give a spin period between 3.7 and 4.3 seconds when the value contained in each word's 12 bit linear register is multiplied by 2.4414 milliseconds. Multiplying the value contained in the 6 MSB (bits 1-6) of one of the above spin period words by 19.531 (8x2.4414) milliseconds gives the sampling time per spin per sector based on an 8 sector roll plane. Since two sectors are accumulated on the same FPA and data is accumulated for six complete spins in 30 seconds, the total sampling time for each of the sectored FPA's will be 234.37 (8 x 2.4414 ms x 2 sectors x 6 spins) milliseconds times the value in the 6 MSB of the spin period words. Spin period words corresponding to the 30 second period when the data is acquired should be selected. Therefore FPA data telemetered in a 30 second period should be coupled with spin period words from the previous 30 second period.

Background and coincidence data from the two detectors is telemetered in frames 4,12,20, and 28, word 13 in formats 1 and 2. Data is cycled on the FPA so that the following information appears in the telemetry frames:

Frame 4	Coincidence - B Detector
Frame 12	Background - A Detector
Frame 20	Coincidence - A Detector
Frame 28	Background - B Detector

Data acquisition control at the beginning of frames 0,8,16, and 24 shift acquired data to a storage register for readout during the next 30 seconds, zero the FPA, shift the data input to the FPA, and start data acquisition. Sampling time is a full 30 seconds. It is not affected by star pulses or sectoring controls.

Status Indicators:
Electronics On-Off RPI:
Electronics On - Command 83 - One State
Electronics and HV Off - Command 84 - Zero State

Format	Frame	Word	Bit
1,2	6,22	31	9
3	22	25	9
4	6,14,22,30	5,26	9

HV A On-Off RPI:
HV A On - Command 114 - One State
HV and Electronics Off - Command 84 - Zero State

Format	Frame	Word	Bit
1,2	6,22	31	10
3	22	25	10
4	6,14,22,30	5,26	10

HV B On-Off RPI:
HV B On - Command 145 - One State
HV and Electronics Off - Command 84 - Zero State

Format	Frame	Word	Bit
1,2	6,22	31	11
3	22	25	11
4	6,14,22,30	5,26	11

Calibration On-Off RPI:
Calibration On - Command 115 - One State
Calibration Off - Command 47 - Zero State
Once the proper command is received calibration will begin and this relay will change position at the beginning of the next frame 0. Calibration will then terminate automatically at the beginning of the subsequent frame 0 and this relay will also revert to the off position at that time. Calibration can be terminated prior to automatic termination by use of command 47.

Format	Frame	Word	Bit
1,2	6,22	31	12
3	22	25	12
4	6,14,22,30	5,26	12

Analog Monitors:
High Voltage A: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	13	25	1-8
3	11	26	1-8
4	3,11,19,27	8	1-8

High Voltage B: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	17	25	1-8
3	12	26	1-8
4	4,12,20,28	8	1-8

High Voltage Power Supply (HVPS) Settings:
HV A - Command H=10, XXXX (MSB on left)
Lowest voltage setting command: H=10, 0000
Highest voltage setting command: H=10, 1111

Format	Frame	Word	Bits
1,2	13	25	9-12
3	11	26	9-12
4	3,11,19,27	8	9-12

Bit 12 is MSB of telemetered 4 bit group. Telemetry is also inverted.

HV B - Command H=11, xxxx (MSB on left)
Lowest voltage setting command: H=11, 0000
Highest voltage setting command: H=11, 1111

Format	Frame	Word	Bits
1,2	17	25	9-12
3	12	26	9-12
4	4,12,20,28	8	9-12

Bit 12 is MSB of telemetered 4 bit group. Telemetry is also inverted.

One HVPS setting can be stored in the spacecraft for execution at the beginning of the next frame 0. If more than one HVPS setting is required during the two minute interval between successive frames 0, whether from only one or more than one experiment, only the last setting command can be of the form H=N, XXXX. All additional setting commands during that two minute interval must be of the form H=N,XXXX followed by command 150, and will be executed immediately by the spacecraft.

Experiment 11: FPA data is acquired in two minute blocks with 8-sector roll plane control. The FSP (format start pulse at the beginning of frame 0) transfers data from the 8 FPA's into storage registers for telemetering during the next two minutes and resets the FPA's to zero. The first star pulse after the FSP starts data acquisition in the 8 FPA's. FPA data acquisition is controlled by the sectoring electronics and continues for 27 spins. It is halted by the 28th star pulse after the FSP. Data is telemetered in word 25, frames 3,7,11,15,19,23,27,31 in formats 1 and 2. First sector data appears in frame 3 and the data readout cycles through the sectors in sequence so that data from the eighth sector appears in frame 31. Sampling time is calculated as follows: The spin period based on the star pulse is given in word 18, frames 2,10,18 and 26 in format 1; or word 24, frames 4,8,12,16,20,24,28 in format 2. The spin period based on the Earth pulse is given in word 20, frames 3,11,19, and 27 in format 1. If star and Earth pulses are being generated, all of the above words should agree and give a spin period between 3.7 and 4.3 seconds when the value contained in each word's 12 bit linear register is multiplied by 2.4414 milliseconds. Multiplying the value contained in the 6 MSB (bits 1-6) of one of the above spin period words by 19.531 (8 x 2.4414) milliseconds gives the sampling time per spin per sector based on an 8 sector roll plane. Since FPA data is accumulated for 27 spins during a two minute period, the total sampling time for each FPA will be 527.34 (8 x 2.4414 ms x 27 spins) milliseconds times the value in the 6 MSB of the spin period words. Spin period words selected should correspond to the two minute data acquisition time, not the 2 minutes during which the data is telemetered.

Status Indicators:
Electronics On-Off RPI:
Electronics On - Command 80 - One State
Electronics Off - Command 142 - Zero State

Format	Frame	Word	Bit
1,2	4,20	31	9
3	30	25	9
4	4,12,20,28	5	9

HV On-Off FPI:
HV On - Command 116 - One State
HV Off - Command 147 - Zero State

Format	Frame	Word	Bit
1,2	5,21	31	12
3	21	25	12
4	5,13,21,29	5	12

Analog Monitor:
High Voltage: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	21	25	1-8
3	13	26	1-8
4	5,13,21,29	8	1-8

HVPS Settings:
Command H=12, XXXX (MSB on left)
Lowest voltage setting command: H=12, 0000
Highest voltage setting command: H=12, 1111

Format	Frame	Word	Bits
1,2	21	25	9-12
3	13	26	9-12
4	5,13,21,29	8	9-12

Bit 12 is MSB of telemetered 4 bit group. Telemetry is also inverted.

One HVPS setting can be stored in the spacecraft for execution at the beginning of the next frame 0. If more than one HVPS setting is required during the two minute interval between successive frames 0, whether from only one or more than one experiment, only the last setting command can be of the form H=N, XXXX. All additional setting commands during that two minute interval must be of the form H=N,XXXX followed by command 150, and will be executed immediately by the spacecraft.

Experiment 12: Each data sample is an instantaneous reading of an analog voltage. The voltage range is 0.00 to 5.10 volts. Each bit is equivalent to 20 millivolts.

Format	Frame	Word	Bits
1	1,5,9,13,17,21,25,29	7	1-8
1,2	3,7,11,15,19,23,27,31	12	1-8
3	Even	30	1-8
3	25	26	1-8
4	Even	30	1-8
4	1,9,17,25	10,29	1-8

Status Indicators: In each of the above words, bits 9 through 11 convey the following information:

Bits 9,10	Range Identification
Bit 11	Range Change Mode

Range Identification

Bit 9	Bit 10	Range
0	0	One
0	1	Two
1	0	Three
1	1	Four

Range Change Mode: Bit 11
Automatic - Command 9 - One State
Manual-Commands 102,164,164,164,164,164,164,164,164,164,164,164,40
- Zero State

On-Off RPI: See Experiment 4.

Calibrate On-Off RPI: See Experiment 4.

Experiment 13: Each data sample is an instantaneous reading of an analog voltage. The voltage range is 0.00 to 5.10 volts. Each bit is equivalent to 20 millivolts.

Format	Frame	Word	Bits
1	0,4,8,12,16,20,24,28	7	1-8
1,2	2,10,18,26	13	1-8
3	Odd	30	1-8
3	26	26	1-8
4	Odd	30	1-8
4	2,10,18,26	10,29	1-8

Status Indicators: In each of the above words, bits 9 through 11 convey the following information:

Bits 9,10 Range Identification
Bit 11 Range Change Mode

Range Identification

Bit 9	Bit 10	Range
0	0	One
0	1	Two
1	0	Three
1	1	Four

Range Change Mode: Bit 11
Automatic - Command 9 - One State
Manual-Commands 102,164,164,164,164,164,164,164,164,164,164,164,164,40
- Zero State

On-Off RPI: See Experiment 4.

Calibrate On-Off RPI: See Experiment 4.

Experiment 14: Data from two proton channels (P6 and P7) two alpha particle channels (A6 and A7), and a heavy nuclei channel is acquired during a two minute sampling period bounded by consecutive FSP's (Format start pulse at the beginning of each frame 0). Data acquired during one two minute period is telemetered during the next two minute period. FPA data from the proton and alpha channels appears as follows:

Channel	Format	Frame	Word	Bits
P6	1,2	0	28	1-12
P7	1,2	1	28	1-12
A6	1,2	2	28	1-12
A7	1,2	3	28	1-12

Heavy nuclei data is telemetered as a 4 bit linear register appearing in frame 8, word 28, bits 9-12, of formats 1 and 2. Bit 9 is MSB.

Status Indicators:
Experiment On-Off RPI:
Experiment On - Command 89 - One State
Experiment Off - Command 213 - Zero State

Format	Frame	Word	Bit
1,2	7,23	31	9
3	23	25	9
4	7,15,23,31	5,26	9

Experiment 15: This experiment produces 32 data words plus an identification word on every sampling cycle. Linear 8 bit registers are used. Three 8 bit experiment words are telemetered as two 12 bit words. Each sampling cycle is made up of 33 discrete samples, but the results of the last discrete sample are never telemetered. The sampling time for each of the discrete samples depends upon the type of sample. The 24 proton differential samples in normal sampling mode each have a sampling time of 160 milliseconds. All other types of samples have a 40 millisecond sampling time. In either case the time interval between start of each of the discrete samples is 205.08 milliseconds. One complete sampling cycle requires about 6.8 seconds. The time

interval between the start of each sampling cycle is 2 minutes (slow read rate) or 11.75 seconds (fast read rate). When the experiment is operating in fast read rate, telemetry format 3 must be used. When the experiment is operating in slow read rate, telemetry format 3 must not be used. Violation of these constraints will result in useless data. In slow read rate, each FSP (format start pulse at the beginning of each frame 0) starts a sampling cycle. The sampling cycle is complete before the end of frame 1. Experiment data is then telemetered in word 28, formats 1 and 2 as follows:

Experiment Words	Telemetry Frames (Word 28)
1,2,3	10,11
4,5,6	12,13
7,8,9	14,15
10,11,12	16,17
13,14,15	18,19
16,17,18	20,21
19,20,21	22,23
22,23,24	24,25
25,26,27	26,27
28,29,30	28,29
31,32,33	30,31

The 24 bits from 3 experiment words correspond to the 24 bits from 2 telemetry words as in this example from the first line of the previous table:

Experiment Word	Bit	Telemetry Frame	Word	Bit
1	1(MSB)	10	28	1
1	8(LSB)	10	28	8
2	1(MSB)	10	28	9
2	8(LSB)	11	28	4
3	1(MSB)	11	28	5
3	8(LSB)	11	28	12

In fast read rate, a pulse at the beginning of frames 0,3,6,9,12,15 18,21,24,27 and 30 starts a sampling cycle. Data acquired during these cycles is read out in frames 2,5,8,11,14,17,20,23,26, and 29 of format 3. Note that the data sample acquired during frames 30 and 31 is never telemetered because a new cycle is started at the beginning of frame 0. In each of the frames carrying experiment 15 data in format 3, the correspondence between experiment words and telemetry words is as follows:

Experiment Words	Telemetry Words
1,2,3	2,3
4,5,6	4,5
7,8,9	6,7
10,11,12	8,9
13,14,15	10,11
16,17,18	12,13
19,20,21	14,15
22,23,24	16,17
25,26,27	18,19
28,29,30	20,21
31,32,33	22,23

The bit correspondence between experiment words and telemetry words is shown in this example from the first line of the previous table:

Experiment Word	Bit	Telemetry Word	Bit
1	1(MSB)	2	1
1	8(LSB)	2	8
2	1(MSB)	2	9
2	8(LSB)	3	4
3	1(MSB)	3	5
3	8(LSB)	3	12

Status Indicators:
Electronics On-Off RPI:
Electronics On - Command 86 - One State
Electronics Off - Command 148 - Zero State

Format	Frame	Word	Bit
1,2	8,24	31	9
3	24	25	9
4	0,8,16,24	6	9

HV On-Off RPI:
HV On - Command 117* - One State
HV Off - Command 148 - Zero State
*Must be preceded by ordnance enabling commands for SOLRAD 11B.

Format	Frame	Word	Bit
1,2	8,24	31	10
3	24	25	10
4	0,8,16,24	6	10

Fast-Slow Read Rate RPI:
Fast Read Rate - Command 179 - One State
Slow Read Rate - Command 210 - Zero State

Format	Frame	Word	Bit
1,2	8,24	31	11
3	24	25	11
4	0,8,16,24	6	11

Normal-Flux Sampling Mode Indicator:
Normal Mode Select - Command 241
Flux Mode Select - Command 272
This information is only available from the first experiment word from each sample. If the two MSB of the first experiment word (bits 1-2) are both in the one state, the experiment is operating in flux sampling mode. If the two MSB are not both in the one state, the experiment is operating in normal sampling mode.

Experiment 16: This experiment uses 12-bit linear accumulators to acquire data under control of the sectoring electronics. The roll plane is divided into 64 sectors. Eight linear accumulators each accept data from one of the 64 sectors during a two minute period bounded by FSP's (format start pulse at beginning of each frame 0). The data acquisition for these accumulators is controlled by star pulses. One linear accumulator accepts data from 2 of the 64 sectors during a two minute period bounded by FSP's. Data acquisition for this accumulator is controlled by Earth pulses. The 64 roll plane sectors are grouped into 8 groups of 8 adjacent sectors. Each of the 8 groups is specifically associated with one of the linear accumulators controlled by star pulses. During any two minute sampling period, data will be acquired from only one of the eight sectors contained within each group. Therefore, it will take 16 minutes to collect data from all 64 sectors. If the sector immediately following the star pulse is sector 1 and the last complete sector before the next star pulse is 64, the data contained in each linear accumulator can be associated with its appropriate sector by means of a three-bit sector identifier. The sector identifier is changed by the FSP. The correspondence between the data telemetered from each linear accumulator and the value telemetered from the sector identifier during a two minute interval bounded by FSP's is as follows:

Linear Accumulator No.	Sector No.*
1	Sector ID
2	Sector ID + 8
3	Sector ID + 16
4	Sector ID + 24
5	Sector ID + 32
6	Sector ID + 40
7	Sector ID + 48
8	Sector ID + 56

*Sector ID, as telemetered, is inverted and transposed. When the three sector ID bits are all zero state (telemetered as all in one state) use the value 8, not 0. Values corrected for inversion and transposition should be used in the table above.

Each FSP shifts the data in the linear accumulators into storage registers for telemetering during the next two minutes and resets the linear accumulators to zero. The first star pulse after the FSP lets data acquisition begin under the control of the sectoring electronics. Data acquisition continues during 27 complete spins and is halted by the 28th star pulse after the FSP. Data is telemetered in word 30, frames 0 through 7, in formats 1 and 2. Data from linear accumulator 1 appears in frame 0 and the data readout cycles through the linear accumulators in sequence so that data from linear accumulator 8 appears in frame 7. Sampling time is calculated as follows: The spin period based on the star pulse is given in word 18, frames 2, 10, 18, and 26 in format 1; or word 24, frames 4, 8, 12, 16, 20, 24, 28 in format 2. If star pulses are being generated, a spin period between 3.7 and 4.3 seconds should be obtained when the value contained in each spin period word's linear register is multiplied by 2.4414 milliseconds. Multiplying the value contained in the 6 MSB (bits 1-6) of one of the above spin period words by 2.4414 milliseconds gives the sampling time per spin for each of the linear accumulators. Since data is accumulated for 27 spins during a two minute period, the total sampling time for each linear accumulator will be 65.918 (2.4414 ms x 27 spins) milliseconds times the value in the 6 MSB of the spin period words. Spin period words selected should correspond to the two minute acquisition time, not the 2 minutes during which the data is telemetered. Data from the linear accumulator controlled by Earth pulses appears in frame 8, word 30 of formats 1 and 2. Each FSP shifts data in this accumulator into a storage register for telemetering during the next two minutes and resets the linear accumulator to zero. The first Earth pulse after the FSP permits data acquisition into this linear accumulator during a time period starting 8 sector periods after the Earth pulse and continuing for 2 sector periods. The next 26 Earth pulses also permit data acquisition with the same time phasing. The 28th Earth pulse after the FSP halts data acquisition. The sector period is calculated as follows: The spin period based on the Earth pulse is given in word 20, frames 3, 11, 19, and 27 in format 1. If Earth pulses are being generated, the spin period obtained by multiplying the value in each spin period word's linear register by 2.4414 milliseconds will be between 3.7 and 4.3 seconds. Multiplying the value contained in the 6 MSB (bits 1-6) of one of the above spin period words by 2.4414 milliseconds gives the sector period. Since the sampling time per spin is 2 sector periods and data acquisition occurs over 27 spins, the total sampling time for this linear accumulator during each two minute period will be 131.84 (2 sector periods x 2.4414 ms x 27 spins) milliseconds times the value contained in the 6 MSB of the spin period words. Spin period words selected should correspond to the two minute data acquisition time, not the two minutes during which the data is telemetered.

Background and coincidence data from the detector is telemetered in frames 5,13,21,29, word 13, formats 1 and 2. An FPA is used. Each FSP shifts the FPA data into a storage register for telemetering during the next two minutes, resets the FPA to zero, shifts the data input, and starts data acquisition. The sampling time is 2 minutes. It is not affected by star or Earth pulses or sectoring controls. The same data is transmitted four times during the two minute period.

Status Indicators:
Electronics On-Off RPI:
Electronics On - Command 197 - One State
Electronics Off - Command 259 - Zero State

Format	Frame	Word	Bit
1,2	12,28	31	9
3	28	25	9
4	4,12,20,28	6	9

HV On-Off RPI:
HV On - Command 228 - One State
HV Off - Command 290 - Zero State

Format	Frame	Word	Bit
1,2	12,28	31	10
3	28	25	10
4	4,12,20,28	6	10

HV A-B Select RPI:
HV A Select - Command 198 - One State
HV B Select - Command 229 - Zero State

Format	Frame	Word	Bit
1,2	12,28	31	11
3	28	25	11
4	4,12,20,28	6	11

Background-Coincidence Indicator:
Coincidence data telemetered - One State
Background data telemetered - Zero State

Format	Frame	Word	Bit
1,2	9	30	9
3	24	26	9
4	0,8,16,24	10,29	9

Sector Identification:

Format	Frame	Word	Bits
1,2	10	30	9,10,12
3	27	26	9,10,12
4	3,11,19,27	10,29	9,10,12

Bit 12 is MSB. Bit 9 is LSB. Telemetry is also inverted.

Experiment 17: The data channels for Experiment 17 are divided into three groups: 17A, 17C, and 17D. A total of 23 different channels are telemetered from this experiment. Nineteen of the channels have a two minute sampling time bounded by FSP's (format start pulse at beginning of frame 0). Each FSP shifts accumulated data into 19 storage registers for telemetering during the next two minutes, resets the FPA's to zero, and restarts data accumulation. Four channels acquire data in two minute blocks but with 4-sector roll plane control. Each FSP shifts accumulated data into 16 storage registers for telemetering during the next two minutes and resets the FPA's to zero. The first star pulse after the FSP starts data acquisition in the 16 FPA's under the control of the sectoring electronics. Data acquisition continues for 27 spins. It is halted by the 28th star pulse after the FSP. Sampling time is calculated as follows: The spin period based on the star pulse is given in word 18, frames 2,10,18, and 26 in format 1; or word 24, frames 4,8,12,16,20,24,28 in format 2. If star pulses are being generated, each of the spin period words should give a spin period between 3.7 and 4.3 seconds when the value contained in each word's 12 bit linear register is multiplied by 2.4414 milliseconds. Multiplying the value contained in the 6 MSB (bits 1-6) of one of the above spin period words by 39.062 (16 x 2.4414) milliseconds gives the sampling time per spin per sector based on a 4 sector roll plane. Since each sector-controlled FPA accumulates data for 27 spins during a two minute period, the total sampling time for each FPA will be 1054.7 (16 x 2.4414 ms x 27 spins) milliseconds times the value in the 6 MSB of the spin period words. Spin period words selected should correspond to the 2 minute data acquisition time, not the 2 minutes during which the data is telemetered.

There are ten data channels in the 17A group. A proton (P) and and alpha (A) channel is telemetered from each of 5 sensors (17A1-17A5). All ten 17A channels have a 2 minute sampling time. None are sectored. Data from the 10 FPA's associated with the 17A channels appears in word 29 of formats 1 and 2 as follows:

Channel	Frame
17A1-P1	0
17A1-A1	1
17A2-P2	2
17A2-A2	3
17A3-P3	4
17A3-A3	5
17A4-P4	6
17A4-A4	7
17A5-P5	8
17A5-A5	9

There are five data channels in the 17C group: P14, A12, H6, H7, and H8. Channels P14, H7, and H8 are not sectored and have a 2 minute sampling period. Channels A12 and H6 are sectored and have a sampling time based on 4 sector roll plane control. Data from the 11 FPA's associated with the 17C channels appears in word 29 of formats 1 and 2 as follows:

Channel	Sector	Frame
P14	-	10
H7	-	11
H8	-	12
A12	1	19
	2	20
	3	21
	4	22
H6	1	23
	2	24
	3	25
	4	26

There are eight data channels in the 17D group: P10, P11, P12, L1, L2, L3, L4, and L5. Channels P11 and L2 are sectored and have a sampling time based on 4 sector roll plane control. The other six channels are not sectored and have a 2 minute sampling time. Data from the 14 FPA's associated with the 17D channels appears in formats 1 and 2 as follows:

Channel	Sector	Frame	Word
P10	-	13	29
P12	-	14	29
L1	-	15	29
L3	-	16	29
L4	-	17	29
L5	-	18	29
P11	1	27	29
	2	28	29
	3	29	29
	4	30	29
L2	1	31	29
	2	0	15
	3	1	15
	4	2	15

Status Indicators:
17A On-Off RPI:
17A On - Command 120 - One State
17A Off - Command 244 - Zero State

Format	Frame	Word	Bit
1,2	7,23	31	10
3	23	25	10
4	7,15,23,31	5,26	10

17C On-Off RPI:
17C On - Command 151 - One State
17C Off - Command 213 - Zero State

Format	Frame	Word	Bit
1,2	7,23	31	11
3	23	25	11
4	7,15,23,31	5,26	11

17D On-Off RPI:
17D On - Command 182 - One State
17D Off - Command 244 - Zero State

Format	Frame	Word	Bit
1,2	7,23	31	12
3	23	25	12
4	7,15,23,31	5,26	12

Analog Monitors:
17C High Voltage: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	4	25	1-8
3	1	26	1-8
4	1,9,17,25	7	1-8

17C Low Voltage: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	12	30	1-8
3	2	27	1-8
4	2,10,18,26	11	1-8

Experiments 18 and 19: These experiments are controlled and operate as a unit so they will be described together. Each of the two experiments has 8 FPA's which acquire data under control of sectoring electronics. The roll plane is divided into 64 sectors. Pulses at the beginning of frames 0,4,8,12,16,20,24, and 28 shift data from the 16 FPA's into storage registers for telemetering during the next 15 second period and reset the FPA's to zero. The first star pulse after this shifting and resetting allows data acquisition under control of sectoring electronics. The next star pulse halts data acquisition. Each FPA accepts data from one of the 64 sectors of the roll plane. Since FPA's from the two experiments are paired (one from each experiment) for sector control, eight of the 64 sectors are scanned during each 15 seconds and the entire roll plane is scanned every two minutes. If the 64 roll plane sectors are labeled so that sector 1 occurs right after the star pulse and sector 64 is the last complete sector before the next star pulse the correspondence between FPA number, the sector from which data is being acquired (not telemetered), and the frame numbers is as follows:

FPA No.		1	2	3	4	5	6	7	8
Frame	0-3	1	9	17	25	33	41	49	57
	4-7	2	10	18	26	34	42	50	58
	8-11	3	11	19	27	35	43	51	59
	12-15	4	12	20	28	36	44	52	60
	16-19	5	13	21	29	37	45	53	61
	20-23	6	14	22	30	38	46	54	62
	24-27	7	15	23	31	39	47	55	63
	28-31	8	16	24	32	40	48	56	64

Telemetry of data occurs during the four frames following acquisition. FPA data from these experiments appears in format 2 only.

Experiment	FPA	Frames	Word
18	1	0,4,8,12,16,20,24,28	18
	2	1,5,9,13,17,21,25,29	18
	3	2,6,10,14,18,22,26,30	18
	4	3,7,11,15,19,23,27,31	18
	5	0,4,8,12,16,20,24,28	19
	6	1,5,9,13,17,21,25,29	19
	7	2,6,10,14,18,22,26,30	19
	8	3,7,11,15,19,23,27,31	19
19	1	0,4,8,12,16,20,24,28	20
	2	1,5,9,13,17,21,25,29	20
	3	2,6,10,14,18,22,26,30	20
	4	3,7,11,15,19,23,27,31	20
	5	0,4,8,12,16,20,24,28	21
	6	1,5,9,13,17,21,25,29	21
	7	2,6,10,14,18,22,26,30	21
	8	3,7,11,15,19,23,27,31	21

Sampling time for each FPA is obtained as follows: The spin period based on the star pulse is given in word 18, frames 2,10,18 and 26 in format 1; or word 24, frames 4,8,12,16,20, 24, and 28 in format 2. If star pulses are being generated, a spin period between 3.7 and 4.3 seconds should be obtained when the value contained in each spin period word's linear register is multiplied by 2.4414 milliseconds. Multiplying the value contained in the 6 MSB (bits 1-6) of one of the above spin period words by 2.4414 milliseconds gives the sampling time for each of the FPA's. Spin period words selected should correspond to the acquisition time not the telemetry time. This is only a factor in the case of data telemetered during frames 0-3. A spin period word from the previous 2 minutes should be used with that data. Since the spin period is only measured once during each 2 minute period bounded by FSP's (format start pulse at beginning of frame 0) if star pulses are being generated, the same spin period measurement is telemetered several times.

Status Indicators:
Experiments 18,19 Electronics On-Off RPI:
Electronics On - Command 87 - One State
Electronics Off - Command 211 - Zero State

Format	Frame	Word	Bits
1,2	9,25	31	9
3	25	25	9
4	1,9,17,25	6	9

Experiments 18,19 HV On-Off RPI:
HV On - Command 118 - One State
HV Off - Command 211 - Zero State

Format	Frame	Word	Bits
1,2	9,25	31	10
3	25	25	10
4	1,9,17,25	6	10

Experiments 18,19 HV 1-2 Select RPI:
HV 1 Select - Command 149 - One State
HV 2 Select - Command 180 - Zero State

Format	Frame	Word	Bits
1,2	9,25	31	11
3	25	25	11
4	1,9,17,25	6	11

Experiment 18,19 Door Release Indicator:
Door Shut - One State
Door Open - Zero State

Format	Frame	Word	Bit
1,2	12,28	8	12
3	12	25	12
4	4,12,20,28	4,25	12

Analog Monitors:
HV Monitor: 0.00 - 5.10 volts. 20 millivolts per bit. Monitor value corresponds to selected HV.

Format	Frame	Word	Bits
1,2	25	25	1-8
3	14	26	1-8
4	6,14,22,30	8	1-8

Wheel Position Monitor: 0.00 - 5.10 volts.
20 millivolts per bit.
Wheel Rotation Command: 242

Format	Frame	Word	Bits
1,2	29	25	1-8
3	15	26	1-8
4	7,15,23,31	8	1-8

High Voltage Power Supply (HVPS) Settings:
HV 1 - Command H=13, XXXX (MSB on left)
Lowest voltage setting command: H=13, 0000
Highest voltage setting command: H=13, 1111

Format	Frame	Word	Bits
1,2	25	25	9-12
3	14	26	9-12
4	6,14,22,30	8	9-12

Bit 12 is MSB of telemetered 4 bit group. Telemetry is also inverted.

HV2 - Command H=14, XXXX (MSB on left)
Lowest voltage setting command: H=14, 0000
Highest voltage setting command: H=14, 1111

Format	Frame	Word	Bits
1,2	29	25	9-12
3	15	26	9-12
4	7,15,23,31	8	9-12

Bit 12 is MSB of telemetered 4 bit group. Telemetry is also inverted.

One HVPS setting can be stored in the spacecraft for execution at the beginning of the next frame 0. If more than one HVPS setting is required during the two minute interval between successive frames 0, whether from only one or more than one experiment, only the last setting command can be of the form H=N, XXXX. All additional setting commands during that two minute interval must be of the form H=N, XXXX followed by command 150, and will be executed immediately by the spacecraft.

Experiment 20: Three FPA's are used to acquire data in eight different modes during one minute. The sampling period for each FPA is 7.50 seconds for each mode. A pulse at the beginning of every even frame shifts the data from the three FPA's into storage registers for transmission during the next 7.5 second interval, resets the FPA's to 0, shifts the experiment into the next sampling mode, and starts data acquisition in the FPA's. FPA data is telemetered in formats 1 and 2 only. The word locations for both formats are as follows:

FPA	Frame	Word
Coincidence	Even	4
200 Micron	Odd	4
750 Micron	Odd	5

Status Indicators:
Experiment On-Off RPI:
Experiment On - Command 90 - One State
Experiment Off - Command 152 - Zero State

Format	Frame	Word	Bit
1,2	13,29	31	9
3	29	25	9
4	5,13,21,29	6	9

Sampling Mode Indicator:
This indicator tells the mode of the data being acquired, not telemetered.

Format	Frame	Word	Bits
1,2	Even	5	10-12
4	Every	2	10-12
5	Every	2	10-12

Bit 10 is MSB.

Analog Monitors:
200LL: Measures the lower discriminator level for the 200 micron detector. Monitor value telemetered corresponds to FPA data being acquired, not telemetered. 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	Even	2	1-8
3	28	26	1-8
4	4,12,20,28	10,29	1-8
5	4,12,20,28	4,10,16,22,28	1-8

200UL: Measures the upper discriminator level for the 200 micron detector. Monitor value telemetered corresponds to FPA data being acquired, not telemetered. 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	Odd	2	1-8
3	29	26	1-8
4	5,13,21,29	10,29	1-8
5	4,12,20,28	5,11,17,23,29	1-8

750LL: Meausres the lower discriminator level for the 750 micron detector. Monitor value telemetered corresponds to FPA data being acquired, not telemetered. 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	Even	3	1-8
3	30	26	1-8
4	6,14,22,30	10,29	1-8
5	4,12,20,28	6,12,18,24,30	1-8

750 UL: Measures the upper discriminator level for the 750 micron detector. Monitor value telemetered corresponds to FPA data being acquired, not telemetered. 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	Odd	3	1-8
3	31	26	1-8
4	7,15,23,31	10,29	1-8
5	4,12,20,28	7,13,19,25,31	1-8

5 Volt Reference Monitor: 0.00 - 5.10 volt
20 millivolts per bit.

Format	Frame	Word	Bits
1,2	27	30	1-8
3	25	28	1-8
4	1,9,17,25	18	1-8

2.5 Volt Reference Monitor: 0.00 - 5.10 volt.
20 millivolts per bit.

Format	Frame	Word	Bits
1,2	18	30	1-8
3	16	28	1-8
4	0,8,16,24	17	1-8

0 Volt Reference Monitor: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	19	30	1-8
3	17	28	1-8
4	1,9,17,25	17	1-8

28 Volt Reference Monitor: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	20	30	1-8
3	18	28	1-8
4	2,10,18,26	17	1-8

+15 Volt Reference Monitor: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	21	30	1-8
3	19	28	1-8
4	3,11,19,27	17	1-8

+10 Volt Reference Monitor: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	22	30	1-8
3	20	28	1-8
4	4,12,20,28	17	1-8

-5 Volt Reference Monitor: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	23	30	1-8
3	21	28	1-8
4	5,13,21,29	17	1-8

Bias Monitor: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	24	30	1-8
3	22	28	1-8
4	6,14,22,30	17	1-8

Electronics Temperature: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	25	30	1-8
3	23	28	1-8
4	7,15,23,31	17	1-8

Detector Temperature: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	26	30	1-8
3	24	28	1-8
4	0,8,16,24	18	1-8

Experiment 21: Twelve FPA's are used to acquire data from twelve channels every two minutes. The two minute sampling period is bounded by successive FSP's (format start pulse at beginning of frame 0). Each FSP shifts acquired data into storage registers for transmission during the next two minutes, resets the FPA's to zero, and starts data acquisition. FPA data appears in word 15, frames 20 through 31 in formats 1 and 2. Channel 1 data appears in frame 20 and the channels are read out in sequence, one channel per frame.

Status Indicators:
Experiment On-Off RPI:
Experiment On - Command 121 - One State
Experiment Off - Command 152 - Zero State

Format	Frame	Word	Bit
1,2	13,29	31	10
3	29	25	10
4	5,13,21,29	6	10

Analog Monitor: Experiment 21 has seven different analog monitors. The value from only one of the monitors is telemetered during a two minute period bounded by FSP's. The 8 MSB (bits 1-8) of the telemetry word are an 8 bit linear counter giving the monitor values (Range: 0.00 - 5.10 volts. 20 millivolts per bit). Bits 9-11 of the telemetry word are a 3 bit counter which identifies which of the analog monitors is being sampled.

Format	Frame	Word
1,2	30	25
3	23	26
4	7,15,23,31	9,28

The three bit counter which identifies the analog monitor is interpreted as follows:

Telemetered Values

Bit 9	Bit 10	Bit 11	Monitor Identification
1	1	1	Calibration Warning
0	1	1	+10 volt monitor
1	0	1	Electronics Temperature
0	0	1	+2.5 volt monitor
1	1	0	Calibration warning
0	1	0	Detector temperature
1	0	0	-2.5 volt monitor
0	0	0	-200 volt monitor

Telemetered values must be reversed (let bit 11 be MSB) and inverted to make counter cycle in normal sequence.

Experiment 22: Nineteen FPA's are used to acquire data from 13 channels. Nine of the channels have a two minute sampling time bounded by FSP's (format start pulse at beginning of frame 0). Each FSP shifts accumulated data into storage registers for telemetering during the next two minutes, resets the FPA's to zero, and restarts data accumulation. Two channels (3 and 8) have a 15 second sampling time. A pulse at the beginning of frames 0, 4, 8, 12, 16, 20, 24, and 28 shifts accumulated data into storage registers for telemetering during the next 15 seconds, resets the two FPA's to zero, and restarts data acquisition. Two channels (1 and 7) acquire data in two minute blocks but with 4-sector roll plane control. Each FSP shifts accumulated data into storage registers for telemetering during the next two minutes, and resets the eight FPA's to zero. The first star pulse after the FSP starts data acquisition in the 8 FPA's under control of the sectoring electronics. Data acquisition continues for 27 spins. It is halted by the 28th star pulse after the FSP. Sampling time is calculated as follows: The spin period based on the star pulse is given in word 18, frames 2, 10, 18, and 26 in formal 1; or word 24, frames 4, 8, 12, 16, 20, 24, and 28 in format 2. If star pulses are being generated, each of the spin period words should give a spin period between 3.7 and 4.3 seconds when the value contained in each word's 12 bit linear register is multiplied by 2.4414 milliseconds. Multiplying the value contained in the 6 MSB (bits 1-6) of one of the above spin period words by 39.062 (16 x 2.4414) milliseconds gives the sampling time per spin

per sector based on a 4 sector roll plane. Since each sector-controlled FPA accumulates data for 27 spins during a two minute period, the total sampling time for each FPA will be 1054.7 (16 x 2.4414 ms x 27 spins) milliseconds times the value in the 6 MSB of the spin period words. Spin period words selected should correspond to the 2 minute data acquisition time, not the 2 minutes during which the data is telemetered. Data from the nineteen FPA's is located in telemetry formats 1 and 2 as follows:

Channel	Sector	Frame	Word
1	1	12	15
	2	13	15
	3	14	15
	4	15	15
2	-	3	15
3	-	2,6,10,14,18,22,26,30	12
4	-	4	15
5	-	5	15
6	-	6	15
7	1	16	15
	2	17	15
	3	18	15
	4	19	15
8	-	3,7,11,15,19,23,27,31	13
9	-	7	15
10	-	8	15
11	-	9	15
12	-	10	15
13	-	11	15

Status Indicators:
Experiment On-Off RPI:
Experiment On - Command 91 - One State
Experiment Off - Command 122- Zero State

Format	Frame	Word	Bit
1,2	9,25	31	12
3	25	25	12
4	1,9,17,25	6	12

Analog Monitors:
Low Voltage Monitor: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	6	25	1-8
3	17	26	1-8
4	1,9,17,25	9,28	1-8

High Voltage Monitor: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	9	28	1-8
3	1	27	1-8
4	1,9,17,25	11	1-8

Experiment 23: Data from two proton channels (P8 and P9), two alpha particle channels (A8 and A9), and a heavy nuclei channel is acquired during a two minute sampling period bounded by consecutive FSP's (format start pulse at the beginning of each frame 0). Data acquired during one two minute period is telemetered during the next two minute period. FPA data from the proton and alpha channels appears as follows:

Channel	Format	Frame	Word	Bits
P8	1,2	4	28	1-12
P9	1,2	5	28	1-12
A8	1,2	6	28	1-12
A9	1,2	7	28	1-12

Heavy nuclei data is telemetered as a 4 bit linear register appearing in frame 8, word 28, bits 5-8, of formats 1 and 2. Bit 5 is MSB.

Status Indicators:
Experiment On-Off RPI:
Experiment On - Command 89 - One State
Experiment Off - Command 213 - Zero State

Format	Frame	Word	Bit
1,2	7,23	31	9
3	23	25	9
4	7,15,23,31	5,26	9

Experiment 24: This experiment has two sets of 256 8-bit linear registers. The sampling time is 16 minutes. The FSP (format start pulse at the beginning of frame 0) which occurs when the eight LSB of the 10-bit frame counter are all in zero state halts data acquisition and enables telemetry readout of the 256 linear registers that just completed their 16 minute data acquisition period, and starts data acquisition in the 256 linear registers that were just telemetered. Each linear register is reset to zero after its value is telemetered. Each linear register contains data from one of the experiment's 256 energy channels. The energy channels and linear registers are numbered from 0 to 255. The values contained in the linear registers are telemetered at the rate of one register per frame in word 6, bits 5-12 (bit 5 is MSB) of every frame in formats 1 and 2. Identification of the linear register and energy channel is obtained from the

8 LSB of the frame counter contained in word 1, bits 3-12 (bit 3 is MSB), of every frame in formats 1 and 2.

Status Indicators:
Electronics On-Off RPI:
Electronics On - Command 92 - One State
Electronics Off - Command 154 - Zero State

Format	Frame	Word	Bit
1,2	10,26	31	9
3	26	25	9
4	2,10,18,26	6	9

HV On-Off RPI:
HV On - Command 123 - One State
HV Off - Command 154 - Zero State

Format	Frame	Word	Bit
1,2	10,26	31	10
3	26	25	10
4	2,10,18,26	6	10

Calibration On-Off RPI: This is not an indication that calibration is occurring. It means that the electronics controlling rotation of the wheel in front of the detector are on or off.
Wheel Electronics On - Command 93 - One State
Wheel Electronics Off - Command 124 - Zero State

Format	Frame	Word	Bit
1,2	10,26	31	11
3	26	25	11
4	2,10,18,26	6	11

Calibration Timer On-Off RPI: When the timer is running rotation power is being applied to the wheel in front of the detector. Rotation power is shut off when the timer stops or when command 124 is received.
Timer On - Command 93 - One State
Timer Off - Command 124 - Zero State

Format	Frame	Word	Bit
1,2	10,26	31	12
3	26	25	12
4	2,10,18,26	6	12

Memory Identification RPI: This bit identifies the set of linear registers which is being telemetered.

Format	Frame	Word	Bit
1,2	2	25	11
3	16	26	11
4	0,8,16,24	9,28	11

Wheel Position Indicator:

Format	Frame	Word	Bits
1,2	2	25	9,10
3	16	26	9,10
4	0,8,16,24	9,28	9,10

Bit 9	Bit 10	Wheel Position
0	0	20° Collimation (Open)
1	0	Source
1	1	3° Collimation
0	1	Background

On SOLRAD 11A, when 8 bit power A is selected bit 9 of the Wheel Position Indicator is stuck in the one state.
8 Bit Power A-B Select RPI:
A Select - Command 226 - One State
B Select - Command 257 - Zero State

Format	Frame	Word	Bit
1,2	26	25	9
3	22	26	9
4	6,14,22,30	9,28	9

Analog Monitors:
Ratemeter: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	28	30	1-8
3	26	28	1-8
4	2,10,18,26	18	1-8

High Voltage Monitor: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	2	25	1-8
3	16	26	1-8
4	0,8,16,24	9,28	1-8

Experiment 25: This experiment has a memory containing 1024 twelve bit words. Each of the 12 bit memory words is made up of two six-bit words. The memory words are telemetered at the rate of one word per frame in word 7 in format 2. The memory words are numbered 0 through 1023 and the memory word telemetered in each frame is identified by the 10 bit frame counter contained in word 1, bits 3-12 (bit 3 is MSB) of every frame in format 2. The memory is divided into 16 sections containing 128 six-bit words. When a gamma ray burst is detected, one or more of the

memory sections will be filled with data. Data written in a memory section is preserved until written over by a later event or a calibration sequence. Therefore it is important to shift to format 2 as soon as possible after an event is detected to read out the pertinent memory sections. The memory section which will receive the next set of data is identified by a four-bit event counter. By monitoring changes in the event counter it is possible to know which memory sections contain data which has not been telemetered. The telemetered event counter value is found as follows:

Format	Frame	Word	Bits
1,2	Even	5	4-7
4,5	Every	2	4-7

Bit 4 is MSB.

The correspondence between memory section and the spacecraft's 10 bit frame counter is as follows:

Memory Section	Frame Counter Range
0	0-63
1	64-127
2	128-191
3	192-255
4	256-319
5	320-383
6	384-447
7	448-511
8	512-575
9	576-639
10	640-703
11	704-767
12	768-831
13	832-895
14	896-959
15	960-1023

Sampling time varies with the counting rate and must be extracted directly from each data sample.

Status Indicators:
Detectors On-Off RPI:
Detectors On - Command 200 - One State
Detectors Off - Command 231 - Zero State

Format	Frame	Word	Bit
1,2	11,27	31	9
3	27	25	9
4	3,11,19,27	6	9

Logic On-Off RPI:
Logic On - Command 200 - One State
Logic Off - Command 262* - Zero State
*Must be preceded by ordnance enabling commands

Format	Frame	Word	Bit
1,2	11,27	31	10
3	27	25	10
4	3,11,19,27	6	10

State-of-Health (SOH) Detector Identification: This bit identifies the detector whose state-of-health value is being telemetered. Read out of the two detectors alternates automatically.

Detector A - One State
Detector B - Zero State

Format	Frame	Word	Bit
1,2	11,27	31	11
3	27	25	11
4	3,11,19,27	6	11

State-of-Health (SOH) Data: Counts from one of the two detectors are accumulated on an FPA with a two minute sampling time bounded by FSP's(format start pulse at the beginning of frame 0). Each FSP stops data accumulation on the FPA, shifts data into a storage register for telemetering during the next two minutes, zeros the FPA, and restarts data accumulation from the other detector. The SOH detector identification bit telemetered during the two minute interval bounded by FSP's identifies the detector which was the source of the data telemetered during the same two minute interval. The SOH FPA data appears in word 17, frames 15 and 31, of formats 1 and 2.

High Voltage Power Supply (HVPS) Settings:
HVA - Command H = 15, XXXX (MSB on left)
Lowest voltage setting command: H=15, 1111
Highest voltage setting command: H=15, 0000

Format	Frame	Word	Bits
1,2	6	25	9-12
3	17	26	9-12
4	1,9,17,25	9,28	9-12

Bit 12 is MSB of telemetered 4 bit group. Telemetry is also inverted.

HVB - Command H=16, XXXX (MSB on left)
Lowest voltage setting command: H=16, 1111
Highest voltage setting command: H=16, 0000

Format	Frame	Word	Bits
1,2	10	25	9-12
3	18	26	9-12
4	2,10,18,26	9,28	9-12

Bit 12 is MSB of telemetered 4 bit groups. Telemetry is also inverted.

Threshold Control - Command H=17, BASM
Bit B: When commanded into one state (telemetered as zero state), the B detector high voltage is on; when commanded into zero state (telemetered as one state), the B detector high voltage is off.
Bit A: When commanded into one state (telemetered as zero state), the A detector high voltage is on; when commanded into zero state (telemetered as one state), the A detector high voltage is off.
Bit S: When commanded into one state (telemetered as zero state), data from energy channels 1,2,3, and 4 are counted for SOH data, when commanded into zero state (telemetered as one state), data from channels 2 and 3 are counted for SOH data.
Bit M: When commanded into one state (telemetered as zero state), data from energy channels 1,2,3, and 4 control the memory trigger; when commanded into zero state (telemetered as one state) data from energy channels 2 and 3 control the memory trigger.

Format	Frame	Word	Bits
1,2	15,31	31	9-12
3	31	25	9-12
4	7,15,23,31	6	9-12

Bit 9 is bit M; bit 10 is bit S; bit 11 is bit A; and bit 12 is bit B.

The threshold control setting is considered an HVPS setting for command purposes. Only one HVPS setting can be stored in the spacecraft for execution at the beginning of the next frame 0. If more than one HVPS command is to be sent during the two minute interval between successive frames 0, each HVPS setting command except the last must be followed by a command 150. Command 150 will cause the preceding HVPS setting to be executed without holding until the next frame 0.

Experiment Temperature Monitors: Many of the experiments have thermistors attached to monitor component temperatures. The voltage output of the thermistor is transmitted as a linear 8 bit register with a voltage range of 0.00 to 5.10 volts (20 millivolt steps). Ten tables to convert from voltage to temperature are provided. Most of the experiments use Table 1. Location of temperature words in the telemetry follows:

Experiment 4A Temperature Monitor - Table 1:

Format	Frame	Word	Bits
1	0	24	1-8
3	16	27	1-8
4	0,8,16,24	13	1-8

Experiment 4B Temperature Monitor - Table 1:

Format	Frame	Word	Bits
1	1	24	1-8
3	17	27	1-8
4	1,9,17,25	13	1-8

Experiment 5A Temperature Monitor - Table 1:

Format	Frame	Word	Bits
1	2	24	1-8
3	18	27	1-8
4	2,10,18,26	13	1-8

Experiment 5B Temperature Monitor - Table 1:

Format	Frame	Word	Bits
1	3	24	1-8
3	19	27	1-8
4	3,11,19,27	13	1-8

Experiment 6 Temperature Monitor - Table 1:

Format	Frame	Word	Bits
1	4	24	1-8
3	20	27	1-8
4	4,12,20,28	13	1-8

Experiment 7A Temperature Monitor - Table 1:

Format	Frame	Word	Bits
1	5	24	1-8
3	21	27	1-8
4	5,13,21,29	13	1-8

Experiment 7B Temperature Monitor - Table 1:

Format	Frame	Word	Bits
1	6	24	1-8
3	22	27	1-8
4	6,14,22,30	13	1-8

Experiment 7C Temperature Monitor - Table 1:

Format	Frame	Word	Bits
1	7	24	1-8
3	23	27	1-8
4	7,15,23,31	13	1-8

Experiment 8 Temperature Monitor - Table 1:

Format	Frame	Word	Bits
1,2	10	30	1-8
3	27	26	1-8
4	3,11,19,27	10,29	1-8

Experiment 9 Temperature Monitor - Table 4:

Format	Frame	Word	Bits
1	9	24	1-8
3	25	27	1-8
4	1,9,17,25	14	1-8

Experiment 12 Temperature Monitor - Table 1:

Format	Frame	Word	Bits
1	10	24	1-8
3	26	27	1-8
4	2,10,18,26	14	1-8

Experiment 13 Temperature Monitor - Table 1:

Format	Frame	Word	Bits
1	11	24	1-8
3	27	27	1-8
4	3,11,19,27	14	1-8

Experiment 15 Temperature Monitor 1 (Electron Cup) - Table 1:

Format	Frame	Word	Bits
1	12	24	1-8
3	28	27	1-8
4	4,12,20,28	14	1-8

Experiment 15 Temperature Monitor 2 (Modulator) - Table 1:

Format	Frame	Word	Bits
1	13	24	1-8
3	29	27	1-8
4	5,13,21,29	14	1-8

Experiment 15 Temperature Monitor 3 (Logic Package) - Table 1:

Format	Frame	Word	Bits
1	14	24	1-8
3	30	27	1-8
4	6,14,22,30	14	1-8

Experiment 15 Temperature Monitor 4 (Proton Cup) - Table 1:

Format	Frame	Word	Bits
1	15	24	1-8
3	31	27	1-8
4	7,15,23,31	14	1-8

Experiment 16 Temperature Monitor 1 - Table 1:

Format	Frame	Word	Bits
1	16	24	1-8
3	0	28	1-8
4	0,8,16,24	15	1-8

Experiment 16 Temperature Monitor 2 - Table 1:

Format	Frame	Word	Bits
1	17	24	1-8
3	1	28	1-8
4	1,9,17,25	15	1-8

Experiment 17C Temperature Monitor - Table 2:

Format	Frame	Word	Bits
1	18	24	1-8
3	2	28	1-8
4	2,10,18,26	15	1-8

Experiment 18, 19 Temperature Monitor 1 - Table 1:

Format	Frame	Word	Bits
1	22	24	1-8
3	6	28	1-8
4	6,14,22,30	15	1-8

Experiment 18, 19 Temperature Monitor 2 - Table 1:

Format	Frame	Word	Bits
1	23	24	1-8
3	7	28	1-8
4	7,15,23,31	15	1-8

Experiment 20 Electronics Temperature Monitor - SOLRAD 11A - Table 5A; SOLRAD 11B - Table 5B:

Format	Frame	Word	Bits
1,2	25	30	1-8
3	23	28	1-8
4	7,15,23,31	17	1-8

Experiment 20 Detector Temperature Monitor - SOLRAD 11A - Table 6A; SOLRAD 11B - Table 6B:

Format	Frame	Word	Bits
1,2	26	30	1-8
3	24	28	1-8
4	0,8,16,24	18	1-8

Experiment 21 Temperature Monitors: This experiment's temperature monitors are two of seven monitors which are cycled on the telemetry with a 16 minute period. The value from only one monitor is telemetered during a two minute period bounded by FSP's (format start pulse at beginning of frame 0). The 8 MSB (bits 1-8) of the telemetry word are an 8 bit linear counter giving the monitor value. Bits 9-11 of the telemetry word are a 3 bit counter which identifies the analog monitor being telemetered. The telemetered values for the bits of the 3 bit counter corresponding to the temperature monitors follow:

Bit 9	Bit 10	Bit 11	Monitor	Table
1	0	1	Electronics Temperature	7A
0	1	0	Detector Temperature	7B

Format	Frame	Word
1,2	30	25
3	23	26
4	7,15,23,31	9,28

Experiment 22 Temperature Monitor - Table 2:

Format	Frame	Word	Bits
1	19	24	1-8
3	3	28	1-8
4	3,11,19,27	15	1-8

Experiment 24 Detector Temperature Monitor - Table 3:

Format	Frame	Word	Bits
1	20	24	1-8
3	4	28	1-8
4	4,12,20,28	15	1-8

Experiment 24 Electronics Temperature Monitor - Table 1:

Format	Frame	Word	Bits
1	21	24	1-8
3	5	28	1-8
4	5,13,21,29	15	1-8

Experiment Temperature Tables

Volts	Table 1(C°)	Table 2(C°)	Table 4(C°)	Table 5A(C°)	Table 5B(C°)
0.00	-	-	-	-	-
0.10	153.5	-50	-	-	-
0.20	119.3	-44	-	-	-
0.30	101.4	-37	-	-	-
0.40	89.5	-31	-	-	-
0.50	80.5	-26	-	-	-
0.60	73.4	-22	-	-	-
0.70	67.4	-19	-	-	-
0.80	62.4	-16	-	-	-
0.90	57.9	-14	-	0.0	-
1.00	53.9	-11	-	1.5	0.2
1.10	50.3	-9	-19.0	3.0	1.2
1.20	47.0	-7	-17.0	4.2	2.2
1.30	44.0	-4	-15.0	5.5	3.2
1.40	41.1	-2	-13.0	6.8	4.2
1.50	38.5	0	-11.5	8.0	5.2
1.60	36.0	1	-9.5	9.5	6.2
1.70	33.6	3	-7.5	10.5	7.2
1.80	31.3	5	-5.5	12.0	8.2
1.90	29.1	7	-3.5	13.5	9.2
2.00	27.0	9	-2.0	14.8	10.2
2.10	24.9	10	0.0	16.2	11.2
2.20	23.0	12	2.0	17.8	12.2
2.30	21.0	14	3.5	19.0	13.2
2.40	19.1	15	5.5	20.2	14.2
2.50	17.3	17	7.5	21.5	15.1
2.60	15.5	18	9.0	23.0	16.1
2.70	13.7	20	11.0	24.5	17.1
2.80	11.9	22	13.0	25.7	18.1
2.90	10.1	23	15.0	26.5	19.1
3.00	8.4	25	16.5	27.5	20.1
3.10	6.6	27	18.5	28.2	21.1
3.20	4.9	28	20.5	29.2	22.1
3.30	3.1	30	22.5	30.2	23.1
3.40	1.4	32	24.5	31.0	24.1
3.50	-0.4	34	27.0	32.0	25.1
3.60	-2.2	36	29.0	33.0	26.6
3.70	-4.1	37	31.5	33.8	27.8
3.80	-6.0	39	34.0	34.8	28.9
3.90	-7.9	41	37.0	35.6	30.0
4.00	-9.9	43	41.0	36.6	31.2
4.10	-12.0	45	45.0	37.6	32.4
4.20	-14.2	47	49.5	38.6	33.6
4.30	-16.5	50	-	39.5	34.8
4.40	-18.9	52	-	40.5	36.0
4.50	-21.5	55	-	41.4	37.2

Experiment Temperature Tables (cont)

Volts	Table 1(C°)	Table 2(C°)	Table 4(C°)	Table 5A(C°)	Table 5B(C°)
4.60	-24.3	57	-	42.2	38.4
4.70	-27.5	60	-	43.2	39.5
4.80	-31.0	63	-	44.0	40.6
4.90	-35.2	66	-	45.0	41.8
5.00	-	70	-	45.9	43.0
5.10	-	-	-	46.9	44.2

Experiment Temperature Tables

Volts	Table 6A(C°)	Table 6B(C°)	Table 7A(C°)	Table 7B(C°)
0.00	-	-	-	-
0.10	-	-	-	-
0.20	-	-	-	-
0.30	-	-	51.5	-
0.40	-	-	47.5	-
0.50	-	-	43.5	51.0
0.60	1.1	0.6	39.5	47.0
0.70	2.5	1.8	36.0	43.5
0.80	3.9	2.9	32.5	40.2
0.90	5.3	4.0	29.0	36.8
1.00	6.8	5.2	25.8	33.5
1.10	8.3	6.3	22.8	30.2
1.20	9.8	7.5	19.8	27.2
1.30	11.2	8.7	17.0	24.2
1.40	12.5	9.8	14.2	21.4
1.50	14.0	10.9	11.8	18.8
1.60	15.4	12.0	9.5	16.2
1.70	16.8	13.2	7.2	13.8
1.80	18.2	14.4	5.0	11.4
1.90	19.7	15.6	3.0	9.2
2.00	21.0	16.8	1.2	7.0
2.10	22.5	18.0	-0.8	5.0
2.20	23.8	19.2	-2.2	3.2
2.30	25.4	20.4	-3.8	1.4
2.40	26.4	21.6	-5.4	-0.4
2.50	27.3	22.8	-6.8	-2.0
2.60	28.3	24.0	-8.0	-3.5
2.70	29.3	25.0	-9.3	-5.0
2.80	30.3	26.0	-10.5	-6.3
2.90	31.3	27.0	-11.6	-7.6
3.00	32.3	28.0	-12.7	-8.8
3.10	33.3	29.0	-13.6	-10.0
3.20	34.3	30.0	-14.5	-11.2
3.30	35.4	31.1	-15.3	-12.2
3.40	36.4	32.1	-16.1	-13.2
3.50	37.5	33.1	-16.8	-14.0
3.60	38.5	34.1	-17.5	-14.8
3.70	39.5	35.1	-18.1	-15.6
3.80	40.5	36.2	-18.7	-16.4
3.90	41.5	37.2	-19.2	-17.0
4.00	42.5	38.3	-19.6	-17.6
4.10	43.5	39.4	-20.0	-18.2
4.20	44.5	40.4	-20.3	-18.7
4.30	45.6	41.5	-20.6	-19.2
4.40	46.6	42.5	-20.9	-19.6
4.50	47.7	43.5	-21.1	-20.0
4.60	48.7	44.5	-	-

Experiment Temperature Tables (cont)

Volts	Table 6A(C°)	Table 6B(C°)	Table 7A(C°)	Table 7B(C°)
4.70	49.7	45.5	-	-
4.80	50.7	46.6	-	-
4.90	51.7	47.6	-	-
5.00	52.7	48.6	-	-
5.10	53.7	49.6	-	-

Experiment Temperature Tables

Volts	Table 3(C^{o})
1.10	-160
1.20	-142
1.30	-124
1.40	-106
1.50	-88
1.60	-70
1.70	-52
1.80	-34
1.90	-16
2.00	2
2.10	20
2.20	38
2.30	56
2.40	74

Miscellaneous Information: This section covers important telemetry words which were neglected in the experiment sections of this document. The following information is covered here:

Sync Pattern
Telemetry Format Identification
Frame Identification
Spacecraft Identification
Experiment Calibration Arm Indicator
Vernier and Absolute Time Registers
Experiment 4 to 8, 12, and 13 Range Change Register

Sync Pattern: The first word of every frame of every format contains the 12 bit sync pattern 110101110101. The sync pattern is the same for both spacecraft and occurs at 3.75 second intervals.

Telemetry Format Identification: The telemetry format in use is identified by three bits. Two bits are needed to distinguish formats 1, 2, and 3. They are bits 1 and 2, word 1, every frame, in all five formats. These same two bits will also indicate formats 4 or 5, but will not differentiate the formats. The bit which distinguishes formats 4 and 5 is bit 1, word 2 every frame, in formats 4 and 5. The following table shows how to distinguish the five telemetry formats:

Format Number	Word 1 Bit 1	Word 1 Bit 2	
1	0	1	
2	1	0	
3	1	1	
4	0	0	Word 2, Bit 1 = 0
5	0	0	Word 2, Bit 1 = 1

Frame Identification: A 10 bit frame counter which increments once each frame is telemetered in word 1, bits 3-12 (bit 3 is MSB) of every frame in every format. A complete cycle of the 5 LSB (bits 8-12) takes 2 minutes. The term "frame 0" is frequently used in this document and refers to the condition when bits 8-12 are all in zero state. The value of the 5 MSB (bits 3-7) is sometimes called the page number. The complete 10 bit counter is sometimes referred to as the subframe identification.

Spacecraft Identification:

SOLRAD 11A - Zero State
SOLRAD 11B - One State

Format	Frame	Word	Bit
1,2	11	30	9
3	0	27	9
4	0,8,16,24	11	9
5	7,15,23,31	4,10,16,22,28	9

Experiment Calibration Arm Indicator: Before experiments 1, 2, 4, 5, 6, 7, 8, 10, 12, or 13 can be calibrated and before the wheel for experiments 18 and 19 can be rotated, the experiment calibration system must be armed.

Experiment Calibration System Armed - One State
Experiment Calibration System Safe - Zero State

Format	Frame	Word	Bit
1,2	9	28	9
3	1	27	9
4	1,9,17,25	11	9

Time Registers: Spacecraft time is given by a 24 bit linear register that increments at 2.5 second intervals. The 12 MSB are called the absolute time register and the 12 LSB are called the vernier time register.

Absolute Time Register

Format	Frame	Word	Bits
1	6,14,22,30	19	1-12
4	6,14,22,30	20	1-12

Vernier Time Register

Format	Frame	Word	Bits
1	6,14,22,30	18	1-12
4	6,14,22,30	19	1-12

Experiment 4 to 8, 12, and 13 Range Change Register: In order to command any of experiments 4 to 8, 12, or 13 into manual range change mode or to manually change the range that experiment must first be addressed on the range change register. The command to select A or B detectors for experiments 4, 5, and 8

must be preceded by putting the correct address in the range change register. Also, shutter rotation for experiments 6 and 8A require the correct address in the range change register. Command 102 resets the range change register and command 164 is used to step through the register.

Format	Frame	Word	Bits
1,2	3,19	31	9-12
3	19	25	9-12
4	3,11,19,27	5,26	9-12

Bit 9	Bit 10	Bit 11	Bit 12	Address
0	0	0	0	Reset
1	0	0	0	4A
0	1	0	0	4B
1	1	0	0	5A
0	0	1	0	5B
1	0	1	0	6
0	1	1	0	7A
1	1	1	0	7B
0	0	0	1	7C
1	0	0	1	8A
0	1	0	1	8B
1	1	0	1	12
0	0	1	1	13
1	0	1	1	Unused
0	1	1	1	Unused
1	1	1	1	Unused

FPA (Floating Point Accumulator): The first four bits transmitted give the value E. The last eight bits of the telemetry word give the value T. The number of counts, C, in the accumulator is given by:

$$C = (T + 255) \cdot 2^{E} - 255.$$

If $T = 0$ and $E \neq 0$ use

$$C = 511 \cdot 2^{E-1} - 255.$$

Both E. and T are transmitted MSB first.

Roll Reference System: The SOLRAD 11 roll reference system generates a star pulse and an Earth pulse as reference points for electronic sectoring in the roll plane for experiment data acquisition. The roll reference system has the following controllable components (see Figure 1 and 2):

Visible Earth Sensor Array
Infrared Earth Sensor Array
Stellar Sensor
Electronic Gates
Programmable Time Delays (PTD)

The visible Earth sensor array and the infrared Earth sensor array make up a subsystem which can fire a one-shot whenever the Earth is sensed. The visible Earth sensor array is made up of six sensors, each with a 20° field of view in a plane containing the satellite's spin axis. The infrared Earth sensor array is make up of three sensors, each with a 40° field of view. Figure 3 shows the identification of the sensors. All nine of the Earth sensors can be on simultaneously or only one of the nine can be on. During each roll of the satellite the peak signal generated by each of the Earth sensor arrays is stored. If the appropriate electronic gate is open (1 or 2), a one-shot (T2-1) will fire when the generated signal next reaches approximately 40% of the stored signal. The response of each of the nine Earth sensors to an appropriately sized artificial Earth was calibrated to show the amount by which the firing of the Earth sensor one-shot will lead the center of the Earth. The calibration corrects for mechanical alignment of the sensor as well as for triggering on the Earth's leading edge. The following table gives the results of this calibration for the final (65000 nm) orbit:

Sensor	Type	Earth Aspect Angle(Degrees)	Lead Angle(Degrees) 11A	11B
1	Visible	130-150	4.2-5.5	3.7-6.8
2	Visible	110-130	3.8-4.2	3.6-4.0
3	Visible	90-110	3.2-3.8	3.6-4.9
4	Visible	70-90	3.1-3.2	2.8-3.0
5	Visible	50-70	3.0-3.3	2.9-3.6
6	Visible	30-50	3.3-5.7+	3.0-5.4
7	IR	70-110	2.6-3.3	0.4-1.5
8	IR	30-70	4.1-5.0	(-0.6)-(-0.2)
9	IR	110-150	2.5-3.3	0.7-1.5

The pulse generated by the Earth sensor one-shot (T2-1) can cause the simultaneous firing of the Earth pulse one-shot (T4) if gate 4 is open. The firing of the Earth pulse one-shot(T4) can be delayed with respect to the Earth sensor one-shot (T2-1) by means of programmable time delay 1 (PTD 1) and gate 3. The Earth pulse can cause the star pulse one-shot (T2-2) to fire by means of PTD 4 and gate 7.

The stellar sensor is designed to use Canopus as a reference point. Initial acquisition of Canopus requires the Earth pulse as a reference point. The expected time delay between the Earth pulse and centering of Canopus in the field of view of the stellar sensor is calculated and put into PTD 4. This results in the opening of a 44 millisecond gate at the programmed time after the Earth pulse. If a response occurs during this 44 millisecond gate, a counter starts and the peak intensity is recorded. The delayed Earth pulse opens the 44 ms gate again and if a signal at least 75% of that observed during the previous gate opening is observed, control of the electronic gate will shift to the stellar aspect electronics and the delayed Earth pulse input will be inhibited. The stellar aspect system is then considered "locked" and, if gate 8 is open, will fire the star pulse one-shot (T2-2) whenever Canopus is detected. Canopus detection can also cause the Earth pulse one-shot (T4) to fire by means of PTD 3 and gate 6.

A solar pulse generated by the solar aspect system can cause one-shot T8-2 to fire. This can cause the Earth pulse one-shot (T4) to fire by means of PTD 2 and gate 5. It can also fire the star pulse one-shot (T2-2) be means of PTD 5 and gate 9. Details of the solar pulse generation are covered in Solar Aspect System.

A summary of the telemetered roll reference system data follows:

Relay Position Indicators:
Earth IR and Visible Aspect System On-Off RPI:
System On - Command 156 or 155 - One State
System Off- Command 157 - Zero State

Format	Frame	Word	Bit
1,2	7,23	8	12
3	7	25	12
4	7,15,23,31	3	12

Stellar Aspect System On-Off RPI:
System On - Command 32 or 247 - One State
System Off - Command 33 - Zero State

Format	Frame	Word	Bit
1,2	7,23	8	11
3	7	25	11
4	7,15,23,31	3	11

Stellar Aspect State Indicator
Locked - One State
Unlocked - Zero State

Format	Frame	Word	Bit
1,2	8	8	9
3	8	25	9
4	0,8,16,24	4	9

Programmable Time Delays (PTD): The time delay imposed between roll reference system events is given by binary controlled decimal decoding of a 16 bit register. The register range is 0 to 9999 and the time delay unit is 0.61035 millisecond. Therefore time delays from 0 to 6.1029 seconds are possible. The decoding of the 16 bit register to obtain the decimal value 7438 is as shown below.

Register Bit No.	16 15 14 13	12 11 10 9	8 7 6 5	4 3 2 1
Register Contents	0 1 1 1	0 1 0 0	0 0 1 1	1 0 0 0
Decimal Value	7	4	3	8

PTD 1:
Register bits 16-13

Format	Frame	Word	Bits
1	1,9,17,25	20	5-8
4	1,9,17,25	21	5-8
5	7,15,23,31	7,13,19,25,31	5-8

Telemetry bit 5 is register bit 16.

Register bits 12-1

Format	Frame	Word	Bits
1	0,8,16,24	18	1-12
4	0,8,16,24	19	1-12
5	7,15,23,31	6,12,18,24,30	1-12

Telemetry bit 1 is register bit 12.

PTD 2:
Register bits 16-13

Format	Frame	Word	Bits
1	1,9,17,25	20	1-4
4	1,9,17,25	21	1-4
5	7,15,23,31	7,13,19,25,31	1-4

Telemetry bit 1 is register bit 16.

Register bits 12-1

Format	Frame	Word	Bits
1	0,8,16,24	19	1-12
4	0,8,16,24	20	1-12

Telemetry bit 1 is register bit 12.

PTD 3:
Register bits 16-13

Format	Frame	Word	Bits
1	1,9,17,25	20	9-12
4	1,9,17,25	21	9-12
5	7,15,23,31	7,13,19,25,31	9-12

Telemetry bit 9 is register bit 16.

Register bits 12-1

Format	Frame	Word	Bits
1	0,8,16,24	20	1-12
4	0,8,16,24	21	1-12

Telemetry bit 1 is register bit 12.

PTD 4:
Register bits 16-13

Format	Frame	Word	Bits
1	1,9,17,25	21	5-8
4	1,9,17,25	22	5-8
5	5,13,21,29	9,15,21,27	5-8

Telemetry bit 5 is register bit 16.

Register bits 12-1

Format	Frame	Word	Bits
1	0,8,16,24	21	1-12
4	0,8,16,24	22	1-12

Telemetry bit 1 is register bit 12.

PTD 5:
Register bits 16-13

Format	Frame	Word	Bits
1	1,9,17,25	21	1-4
4	1,9,17,25	22	1-4
5	5,13,21,29	9,15,21,27	1-4

Telemetry bit 1 is register bit 16.

Register bits 12-1

Format	Frame	Word	Bits
1	1,9,17,25	18	1-12
4	1,9,17,25	19	1-12

Telemetry bit 1 is register bit 12.

Gate Status: The electronic gates in the roll reference system can be separated into three groups such that not more than one gate of a group should normally be open. Gates 1 and 2 would be one such group; gates 3 through 6 another; and gates 7, 8 and 9 would be the third group. A one state in the telemetry indicates an open gate.

Gates 1-4

Format	Frame	Word	Bits
1	1,9,17,25	21	9-12
4	1,9,17,25	22	9-12
5	5,13,21,29	9,15,21,27	9-12

Gate	Telemetry Bit
1	9
2	10
3	11
4	12

Gates 5-9

Format	Frame	Word	Bits
1	1,9,17,25	19	1-5
4	1,9,17,25	20	1-5
5	5,13,21,29	8,14,20,26	1-5

Gate	Telemetry Bit
5	1
6	2
7	3
8	4
9	5

Visible and Infrared Earth Sensor Select Indicators: The six visible Earth sensors are numbered 1 through 6 and the three infrared Earth sensors are numbered 7 through 9 (Figure 3). The decimal number equivalent to the contents of a four bit register

indicates which of the Earth sensors are on. A value of zero means that all nine sensors are on. A decimal value of 10 through 15 is invalid. The only choices are nine sensors on or one sensor on.

Format	Frame	Word	Bits
1	1,9,17,25	19	9-12
4	1,9,17,25	20	9-12
5	5,13,21,29	8,14,20,26	9-12

Bit 9 is MSB.

Analog Monitors:
Infrared Earth Aspect Level: 0.00 - 5.10 volts
20 millivolts per bit

Format	Frame	Word	Bits
1,2	14,30	17	1-8
3	10	27	1-8
4	2,10,18,26	12	1-8
5	6,14,22,30	6,12,18,24,30	1-8

Visible Earth Aspect Level: 0.00 - 5.10 volts
20 millivolts per bit

Format	Frame	Word	Bits
1,2	13	30	1-8
3	11	27	1-8
4	3,11,19,27	12	1-8
5	6,14,22,30	7,13,19,25,31	1-8

Bit 1 is MSB.

Stellar Aspect Level: 0.00 - 5.10 volts. 20 millivolts per bit.

Format	Frame	Word	Bits
1,2	17	30	1-8
3	15	27	1-8
4	7,15,23,31	12	1-8

Bit 1 is MSB.

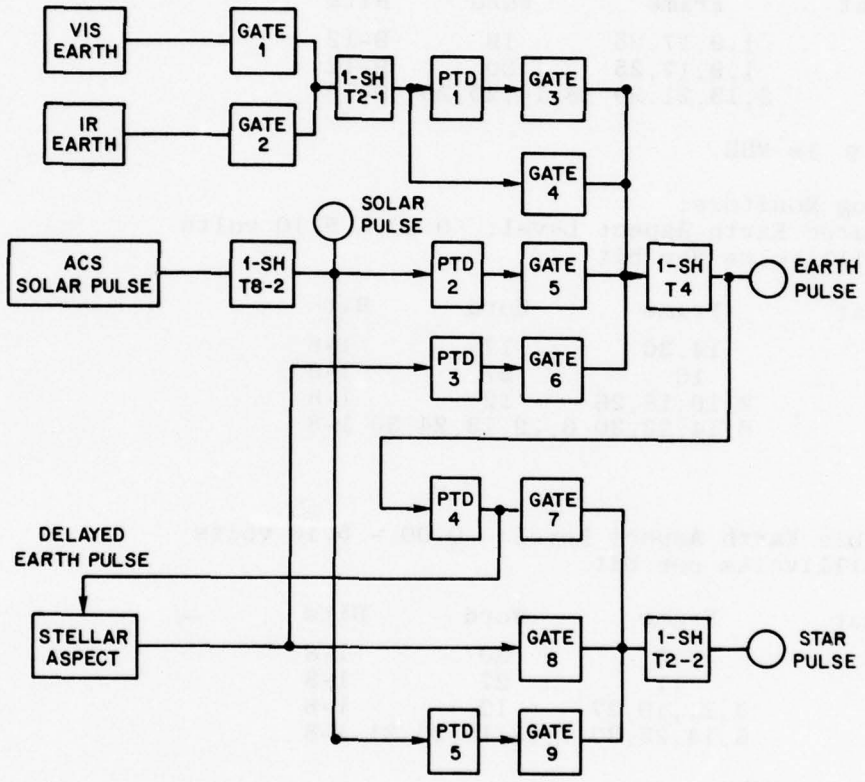
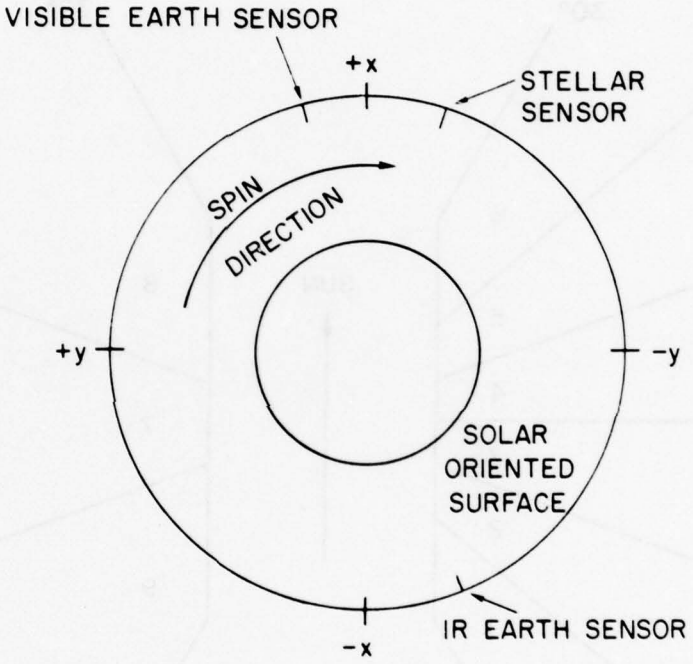


Fig. 1 - Roll reference system



	IIA (DEGREES)	IIB (DEGREES)
+x AXIS	0	0
+y AXIS	90.00	90.00
IR EARTH SENSOR	203.52	202.85
STELLAR SENSOR	342.06	341.87
VISIBLE EARTH SENSOR	13.60	14.12

Fig. 2 - Roll reference sensors

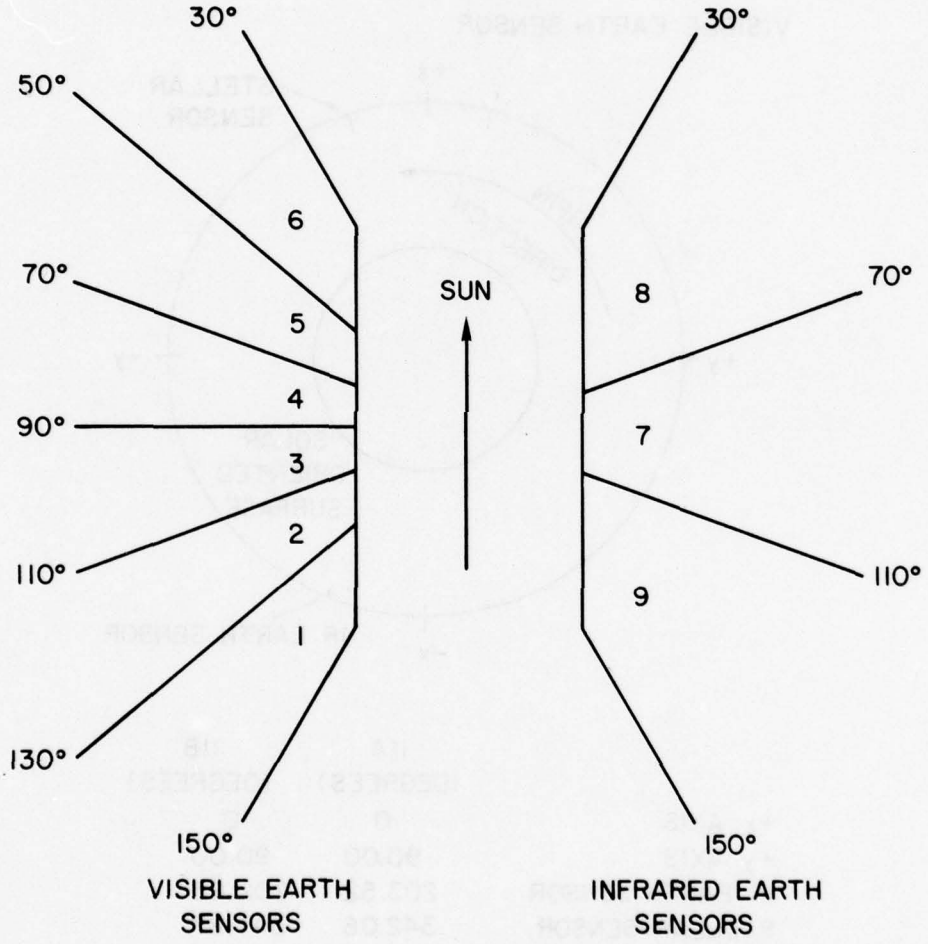


Fig. 3 Earth sensors

Roll Plane Sectoring Control and Identification. The SOLRAD 11 roll reference system produces star pulses and Earth pulses which control the division of the roll plane into 64 sectors and gating of data into accumulators associated with these sectors. Measurement of elapsed time between various pulses enables calculation of spin period; verification that the stellar aspect system has locked up on its proper target, Canopus; orientation of the roll plane sectors on the celestial sphere; and determination of the direction of the spin vector. The "time between" registers (TBR) are 12 bit linear registers. The time unit is 2.4414 milliseconds.

TBR 1: This register measures the time between successive star pulses and thus measures the spin period. The FSP (format start pulse at the beginning of frame 0) sets this register to zero. The first subsequent star pulse starts the register and the next star pulse stops the register. The number stored in the register is then telemetered several times until it is reset to zero by the next FSP. FSP's occur at two minute intervals. The number contained in the 6 MSB of this register gives the time duration of each of the 64 roll plane sectors. The number contained in the 6 LSB gives the dead time during each spin corresponding to a 65th partial sector. Data acquisition during this 65th sector is inhibited. Maximum dead time per spin is 0.154 seconds. Sectoring based on dividing the roll plane into four or eight sectors is based on an appropriate multiple of the time duration of a 64th sector.

Format	Frame	Word	Bits
1	2,10,18,26	18	1-12
2	4,8,12,16,20,24,28	24	1-12
3	4,8,12,16,20,24,28	31	1-12
4	2,10,18,26	19	1-12
5	7,15,23,31	8,14,20,26	1-12

Bit 1 is MSB.

TBR 2: This register measures the time between the FSP and the first star pulse. The first of the 64 roll plane sectors begins with the star pulse and this register is needed to orient the roll sectors on the celestial sphere. After accounting for roll reference system gate status and programmable time delays this register enables a determination of the time, referenced to the FSP, at which the source sensor (Earth, solar, stellar) detected its target. The absolute time of the FSP is determinable on the ground. The number in the register is telemetered several times until it is reset by the next FSP.

Format	Frame	Word	Bits
1	2,10,18,26	19	1-12
2	1,5,9,13,17,21,25,29	24	1-12
3	1,5,9,13,17,21,25,29	31	1-12
4	2,10,18,26	20	1-12
5	7,15,23,31	9,15,21,27	1-12

Bit 1 is MSB.

TBR 3: This register measures the time between the FSP and the first Earth pulse. The Earth pulse controls the location of the auroral window for Experiment 16. After accounting for roll reference system gate status and programmable time delays this register enables a determination of the time, referenced to the FSP, at which the source sensor (Earth, solar, stellar) detected its target. The absolute time of the FSP is determinable on the ground. The number in this register is telemetered several times until it is reset by the next FSP.

Format	Frame	Word	Bits
1	2,10,18,26	20	1-12
2	3,7,11,15,19,23,27,31	24	1-12
3	3,7,11,15,19,23,27,31	31	1-12
4	2,10,18,26	21	1-12

Bit 1 is MSB.

TBR 4: This register measures the time between the Earth pulse generated by the roll reference system and the solar pulse generated by the solar aspect system. The FSP sets this register to zero. The first subsequent Earth pulse starts the register and the first solar pulse after the first Earth pulse stops the register. The number stored in the register is then telemetered several times until it is reset to zero by the next FSP. If the source of the Earth pulse is not the solar pulse, data contained in this register corrected for roll reference system gate status and programmable time delays enables determination of the roll angle between the source of the Earth pulse and the sun. This information plus the solar aspect angle permits a complete determination of the spin axis orientation. The information contained in this register can also be obtained by means of TBR 3 and TBR 5.

Format	Frame	Word	Bits
1	2,10,18,26	21	1-12
4	2,10,18,26	22	1-12

Bit 1 is MSB.

TBR 5: This register measures the time between the FSP and the first solar pulse generated by the solar aspect system after the FSP. This information plus that contained in TBR 2 or TBR 3 will enable determination of the location of the sun in the roll plane provided the solar pulse is not the source of the TBR 2 and TBR 3 data. The number in TBR 5 is telemetered several times until it is reset by the next FSP.

Format	Frame	Word	Bits
1	3,11,19,27	18	1-12
4	3,11,19,27	19	1-12

Bit 1 is MSB.

TBR 6A: This is a four bit register that counts the number of star pulses in a 30 second period. A control pulse at the beginning of frames 0, 8, 16, and 24 shifts the data in this register into a storage register for telemetering during the next 30 second period.

Format	Frame	Word	Bits
1	3,11,19,27	19	9-12
2	2,6,10,14,18,22,26,30	24	9-12
3	2,6,10,14,18,22,26,30	31	9-12
4	3,11,19,27	20	9-12

Bit 9 is MSB.

TBR 6B: This is an 8 bit register that counts the number of Earth pulses during the two minute period between FSP's. The number is telemetered several times until new data is shifted in at the next FSP.

Format	Frame	Word	Bits
1	3,11,19,27	19	1-8
2	2,6,10,14,18,22,26,30	24	1-8
3	2,6,10,14,18,22,26,30	31	1-8
4	3,11,19,27	20	1-8

Bit 1 is MSB.

TBR 7: This 12 bit register measures the time between successive Earth pulses and thus measures the spin period. The FSP sets the register to zero. The first subsequent Earth pulse starts the register and the next Earth pulse stops the register. The number stored in the register is then telemetered several times until it

is reset to zero by the next FSP. The number contained in the 6 MSB of this register gives the time duration of each of the 64 roll plane sectors. The number contained in the 6 LSB gives the dead time during each spin corresponding to a 65th partial sector. Data acquisition during this 65th sector is inhibited.

Format	Frame	Word	Bits
1	3,11,19,27	20	1-12
4	3,11,19,27	21	1-12

Bit 1 is MSB.

TBR 8: This is a 6 bit register that counts the number of star pulses during the two minute period between FSP's. The number is telemetered several times until new data is shifted in at the next FSP.

Format	Frame	Word	Bits
1	5,13,21,29	21	7-12
4	5,13,21,29	22	7-12

Bit 7 is MSB.

Solar Aspect System: The SOLRAD 11 solar aspect system provides a measurement of the angle between the satellite's spin axis and the satellite sun line (the solar aspect angle) and generates a solar pulse which permits calculation of the location of the sun in a plane perpendicular to the spin axis. There are two types of solar aspect sensors on each spacecraft-wide angle (Adcole) and fine angle. Two of each type are carried for redundancy. One of the two wide angle sensors is selected by ground command whenever the aspect angle exceeds 5°. One of the two fine angle sensors is used when the aspect angle is less than 5°. Figure 1 shows the location and orientation of the solar aspect sensors.

Relay Position Indicators:
On-Off RPI:
On - Commands 13 or 173 - One State
Off - Command 14 - Zero State

Format	Frame	Word	Bit
1,2	4,20	8	10
3	4	25	10
4	4,12,20,28	3,23	10

Sensor 1-2 Select RPI:
Sensor 1 Select - Command 15 - One State
Sensor 2 Select - Command 16 - Zero State

Format	Frame	Word	Bit
1,2	4,20	8	11
3	4	25	11
4	4,12,20,28	3,23	11

Wide-Fine Sensor Select RPI:
Wide Angle Sensor Select - Command 17 - One State
Fine Angle Sensor Select - Command 18 - Zero State

Format	Frame	Word	Bit
1,2	4,20	8	12
3	4	25	12
4	4,12,20,28	3,23	12

Wide Angle Sensors: The wide angle (Adcole) sensors are located on the side of the spacecraft. If the solar aspect angle is greater than 5°, the sun will trigger the wide angle sensor once each spin. This will provide a measurement of the solar aspect angle and cause a solar pulse to be generated which will interface with the roll reference system and trigger "time between" registers. Data from the wide angle sensors is telemetered in an eight bit gray code plus a sign bit. The gray code must be translated into binary notation as follows.

Binary Value of

Bit Number

8	= Gray Code Value of bit 8 (GCV8)
7	= BV8 + GCV7
6	= BV7 + GCV6
5	= BV6 + GCV5
4	= BV5 + GCV4
3	= BV4 + GCV3
2	= BV3 + GCV2
1	= BV2 + GCV1

Bits 4-1

Format	Frame	Word	Bits
1,2	Even	2	9-12
3	28	26	9-12
4	4,12,20,28	10,29	9-12
5	4,12,20,28	4,10,16,22, 28	9-12

Telemetry bit 17 is Adccle bit 4.

Wide Angle (Adccle) Sensor 2:

Bit 0 (Sign Bit)

Format	Frame	Word	Bit
1,2	Even	2	8
3	Every	26	8
4	Every	29	8

Each of the sensor halves is recessed behind an aperture. If the optical axis of the sensor half and its aperture is parallel to the satellite's spin axis, the two components of the sensor half will be equally illuminated by the sun at zero aspect angle. The two components of each sensor half are connected to a differential amplifier which produces an output voltage proportional to the difference in illumination of the two components. If the aspect angle is not zero, the two components of the sensor half will not be equally illuminated, and the differential amplifier will produce a voltage output. As the satellite rotates about its spin axis, the aperture shadow will move around the two components of the sensor half, and the differential amplifier will produce a sinusoidal voltage output. The values of the positive and negative peak voltages for the x axis and y axis biased by 2.50 volts are transmitted. If the optical axis of a sensor half and its aperture is not parallel to the spin axis of the satellite, there will be a dc offset voltage. The values of these offset voltages for the x and y axis are also included in the telemetry. A telemetered value of 125 (2.50 volts) indicates zero offset.

where SAA is the solar aspect angle, B is the conversion factor from telemetered decimal value to degrees, P is the peak and V is the valley value telemetered, and i is x or y. The following tables give values of B for fine angle sensors 1 and 2 for each spacecraft.

	SOLRAD 11A	SOLRAD 11B
x1	0.02211	0.02278
x2	0.02345	0.02230
y1	0.02235	0.02275
y2	0.02322	0.02493

X Peak:

Format	Frame	Word	Bits
1,2	0,16	17	1-8
3	3	27	1-8
4	3,11,19,27	11	1-8
5	5,13,21,29	4,10,16,22,28	1-8

Bit 1 is MSB.

X Valley

Format	Frame	Word	Bits
1,2	0,16	17	1-8
3	3	27	1-8
4	4,12,20,28	11	1-8
5	5,13,21,29	5,11,17,23,29	1-8

Bit 1 is MSB.

Y Peak

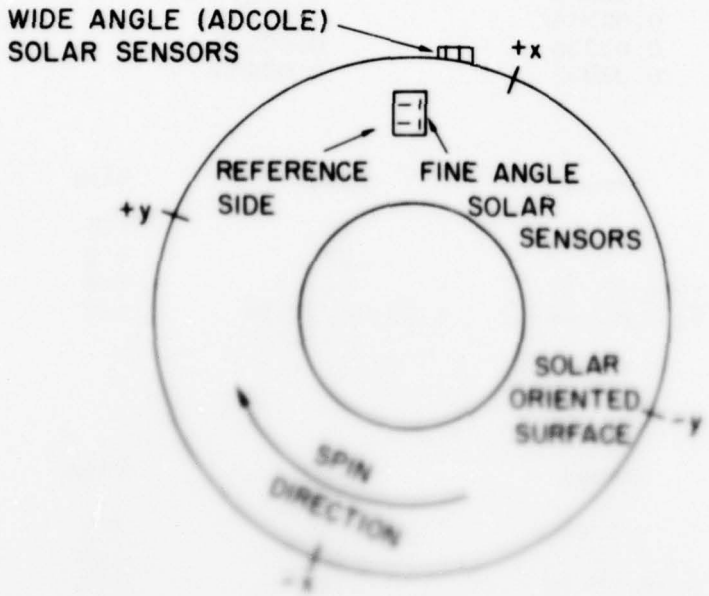
Format	Frame	Word	Bits
1,2	0,16	17	1-8
3	3	27	1-8
4	4,12,20,28	11	1-8
5	5,13,21,29	4,10,16,22,28	1-8

Bit 1 is MSB.

Y Valley

Format	Frame	Word	Bits
1,2	0,16	17	1-8
3	3	27	1-8
4	4,12,20,28	11	1-8
5	5,13,21,29	5,11,17,23,29	1-8

Bit 1 is MSB.


WIDE ANGLE (ADCOLE)
SOLAR SENSORS
+x
REFERENCE
SIDE
FINE ANGLE
SOLAR
SENSORS
+y
SOLAR
ORIENTED
SURFACE
-y
SPIN
DIRECTION
-x

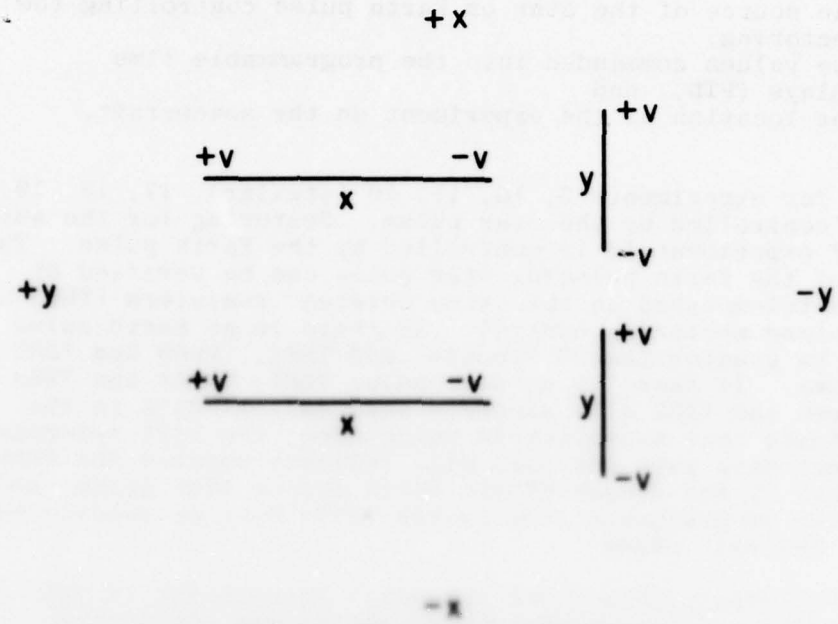


Fig. 7 - Solar aspect system
Fine angle sensor voltage output

Roll Plane Orientation for Sectored Experiments: The roll plane is divided into 64 sectors by the roll plane sectoring control, the roll reference system and the solar aspect system. The orientation of the 64 sectors on the celestial sphere for a given experiment is a function of

1. the roll reference system electronic gate settings,
2. the source of the star or Earth pulse controlling the sectoring,
3. the values commanded into the programmable time delays (PTD), and
4. the location of the experiment on the spacecraft.

Sectoring for experiments 3, 10, 11, 16 (stellar), 17, 18, 19, and 22 is controlled by the star pulse. Sectoring for the auroral portion of experiment 16 is controlled by the Earth pulse. The presence of the Earth pulse or star pulse can be verified by the values telemetered in the "time between" registers (TBR) of the roll plane sectoring control. If there is no Earth pulse TBR3 will be greater than 5 seconds, and TBR4, TBR6B and TBR7 will be zero. If there is no star pulse TBR1, TBR6A and TBR8 will be zero and TBR2 will exceed 5 seconds. If data in the TBR's indicate that sectoring is being done, the roll reference system electronic gate settings will indicate whether the Earth, sun, or star is the source of the Earth and/or star pulse, and which of the programmable time delays (PTD) must be considered to orient the roll plane.

The following table gives the angle between the +x axis in the spacecraft coordinate system and the normal (projected onto the plane perpendicular to the spin axis where necessary) to the reference surface for components which are important to the roll plane orientation. Note that the angles given do not necessarily correspond to the physical location of a component because some are mounted so their normal is not along a local radius.

	SOLRAD 11A (Degrees)	SOLRAD 11B (Degrees)
Fine Angle Solar Pulse	17.9	17.8
Adcole 1 Solar Pulse	17.9	17.8
Adcole 2 Solar Pulse	18.0	17.8

The visible Earth sensor is actually an array of 6 sensors and the infrared Earth sensor is an array of 3 sensors. The response of each of the nine sensors to an appropriately sized artificial Earth was calibrated to show the amount by which the firing of the Earth sensor one-shot will lead the center of the Earth. The calibration corrects for mechanical misalignment of the sensor with respect to the nominal array value, as well as for triggering on the Earth's leading edge. Figure 1 gives the lead angle δ, as a function of Earth aspect angle, which must be algebraically subtracted from the nominal angles given in the above table for the visible and infrared Earth sensor arrays. Which Earth sensor is being used can be determined from the roll reference system's visible and infrared Earth sensor select indicators. The precise Earth aspect angle must be obtained by considering ground based orbit information and telemetered spacecraft orientation information.

The roll reference system's electronic gate settings and programmable time delays (PTD) enable the generation of the star or Earth pulse to be delayed, rather than simultaneous with the sensing of the target by the selected Earth, star, or solar sensor. The time of generation of the star or Earth pulse is the starting time for the first of the 64 sectors. The direction in which a given experiment sensor is looking when the star or Earth pulse is generated marks the origin of the 64 sectors for that particular sensor. The starting time of the first sector can be obtained from TBR2 for sectoring controlled by the star pulse, and from TBR3 for sectoring controlled by the Earth pulse. The following table identifies and locates the source of the star or Earth pulse at the starting time of the first sector by giving the angle between the spacecraft's +x axis and the location of the pulse source when the star or Earth pulse is generated. This location is a function of the roll reference system's electronic gate settings and programmable time delays. The angle associated with a given PTD (PTD$_{ANG}$) is obtained by dividing the PTD delay time by the spin period given by TBR1 or TBR2 and multiplying by 360°. In the following table the +x axis is at 0° and the +y axis is at 90°.

Open Gates	Earth Pulse Source	Pulse Source Location SOLRAD 11A	SOLRAD 11B
1,3	Earth	$13.6-\delta_j$ + <PTD1	$14.1-\delta_j$ + <PTD1
1,4	Earth	$13.6-\delta_j$	$14.1-\delta_j$
2,3	Earth	$203.5-\delta_i$ + <PTD1	$202.9-\delta_i$ + <PTD1
2,4	Earth	$203.5-\delta_i$	$202.9-\delta_i$
5	Sun	17.9+ <PTD2	17.8+ <PTD2
6	Star	342.1+ <PTD3	341.9+ <PTD3

Open Gates	Star Pulse Source	Pulse Source Location SOLRAD 11A	SOLRAD 11B
1,3,7	Earth	$13.6-\delta_j$ +<PTD1+<PTD4	$14.1-\delta_j$ +<PTD1+<PTD4
1,4,7	Earth	$13.6-\delta_j$ +<PTD4	$14.1-\delta_j$ +<PTD4
2,3,7	Earth	$203.5-\delta_i$ +<PTD1+<PTD4	$202.9-\delta_i$ +<PTD1+<PTD4
2,4,7	Earth	$203.5-\delta_i$ +<PTD4	$202.9-\delta_i$ +<PTD4
5,7	Sun	17.9+<PTD2+<PTD4	17.8+<PTD2+<PTD4
9	Sun	17.9+<PTD5	17.8+<PTD5
6,7	Star	342.1+<PTD3+<PTD4	341.9+<PTD3+<PTD4
8	Star	342.1	341.9

The lead angles for the six visible Earth sensors, δ_j, and the three infrared Earth sensors δ_i, are given in Figure 1. Once the direction in which a given experiment sensor is looking at the beginning of the first sector is determined, the orientation of all sectors pertinent to that experiment's sampling sequence can be obtained by considering that both spacecraft are spinning such that the +y axis is rotating toward the +x axis (spin vector in -z direction where +z is toward sun). If the solar pulse is present, the time at which the projected solar image is located at 17.9° (SOLRAD 11A) or 17.8° (SOLRAD 11B) can be determined from data telemetered from TBR4 or TBR5. If the sun is not the source of both the Earth and the star pulse, then the orientation of the solar aspect angle (the angle between the satellite's spin axis and the satellite-sun line) can be determined by the location of the non-solar source of the star or Earth pulse and the time between the star or Earth pulse and the solar pulse. (The magnitude of the solar aspect angle can be calculated from the solar aspect system's solar sensors.) If a solar pulse is present, the value in TBR5 will not exceed the spin period.

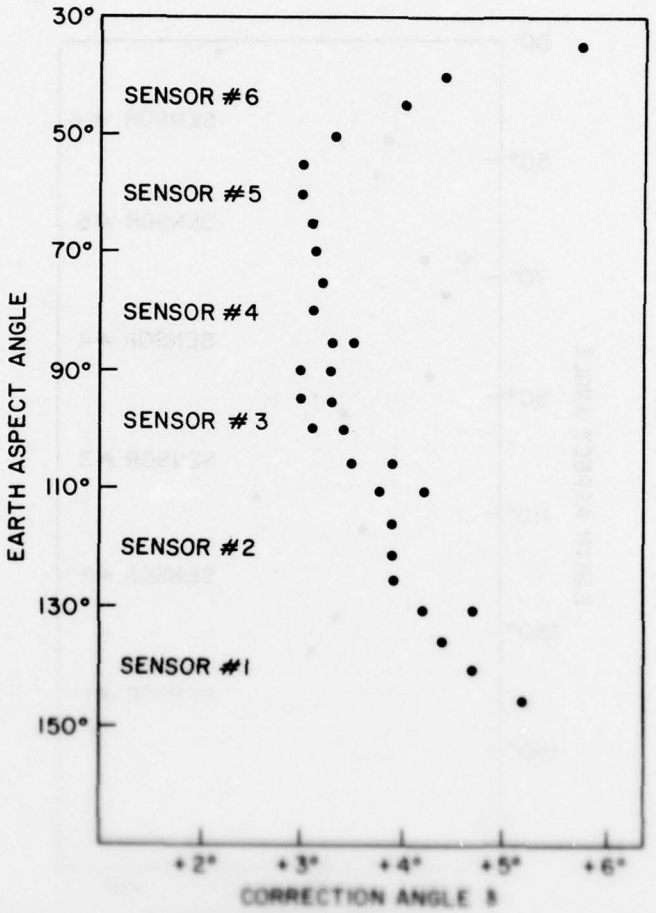


Fig. 1A - Roll plane orientation for sectored experiments
SOLRAD 11A visible earth sensors

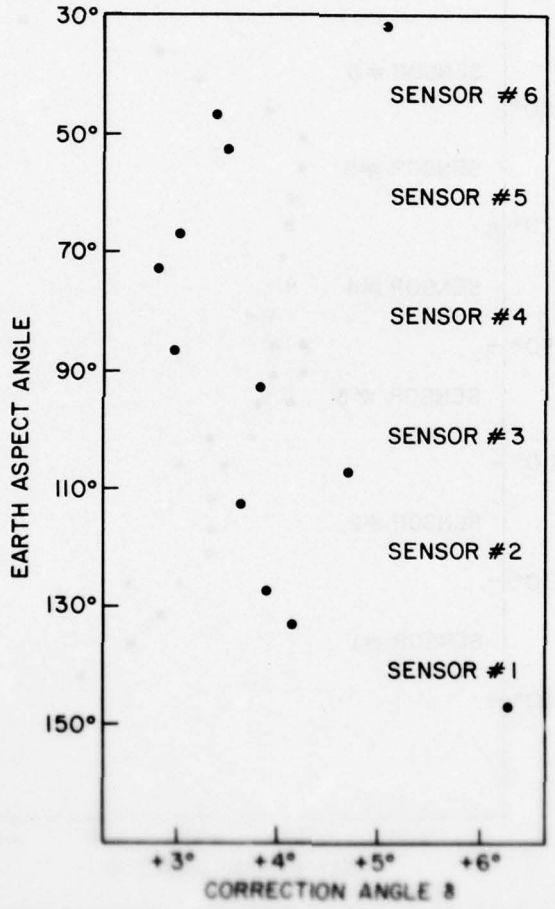


Fig. 18 - Roll plane orientation for sectored experiments SOLRAD 11B visible earth sensors

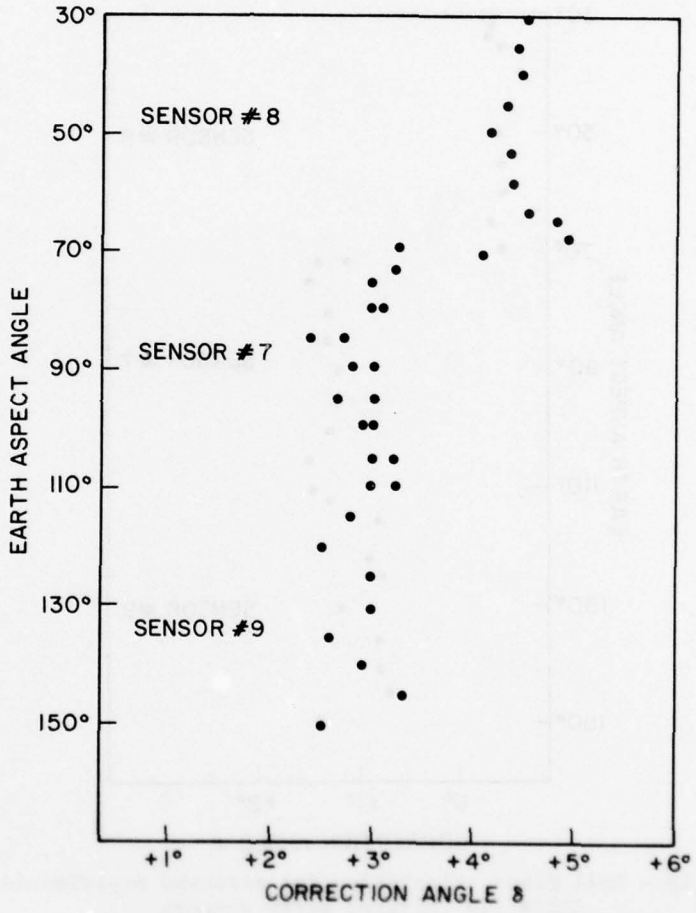


Fig. 1C - Roll plane orientation for sectored experiments
SOLRAD 11A infrared earth sensors

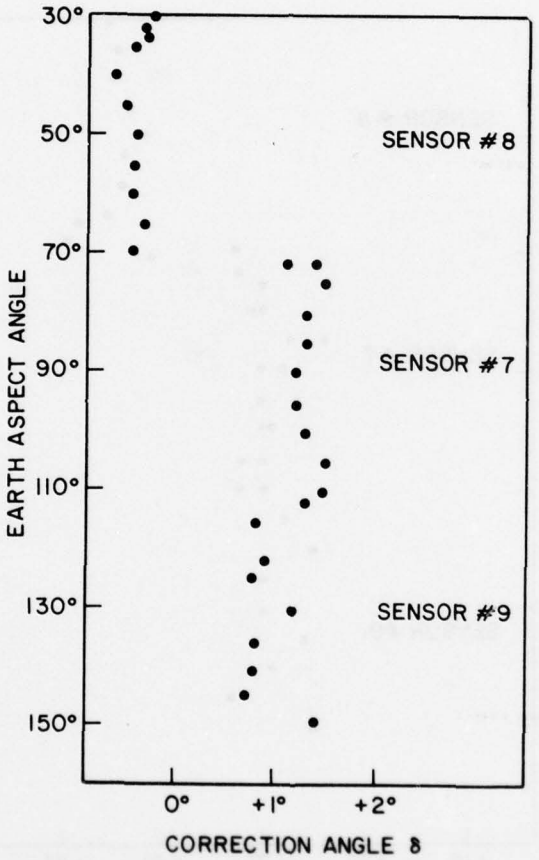
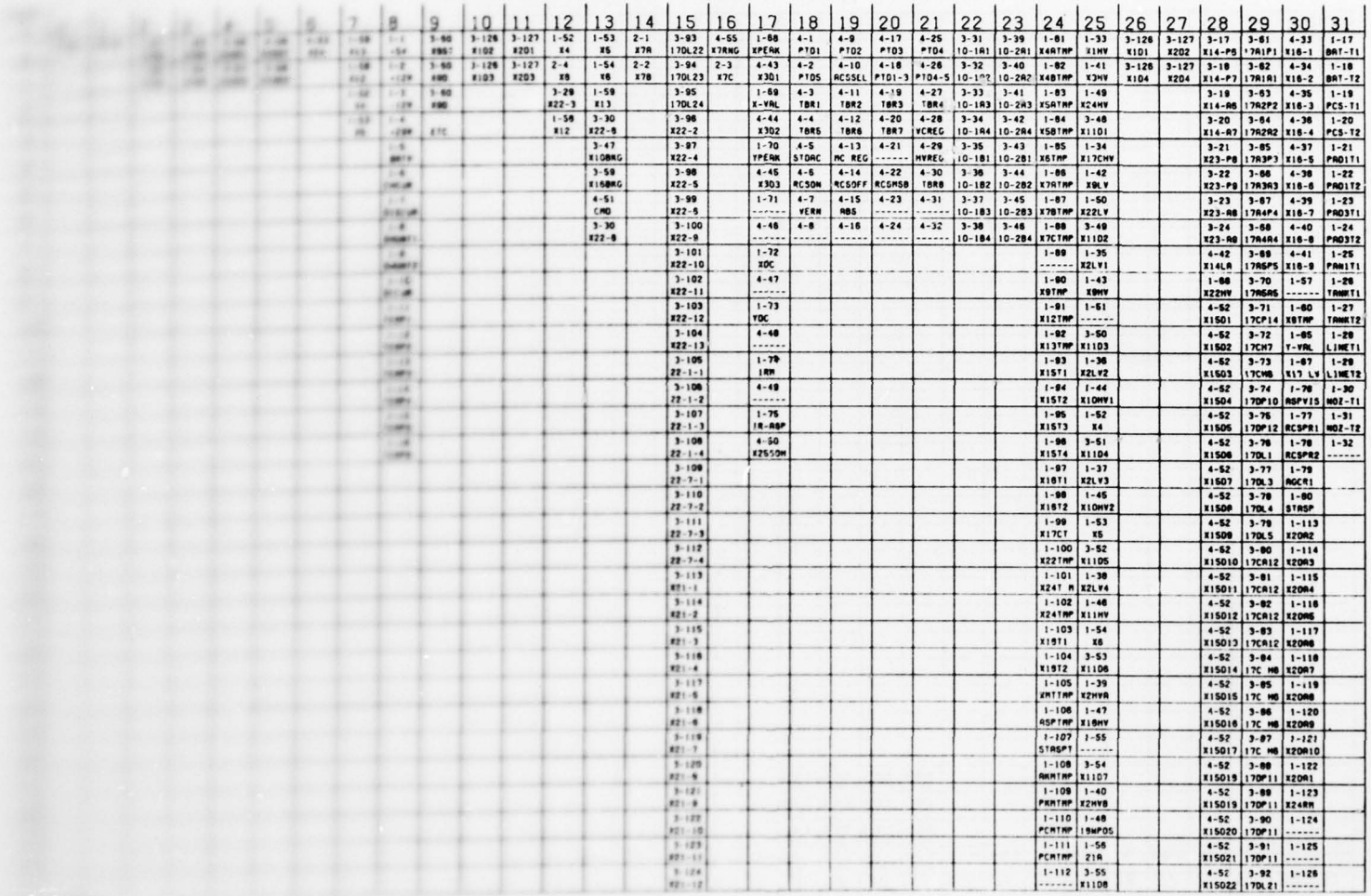


Fig. 1D - Roll plane orientation for sectored experiments
SOLAR 11B infrared earth sensors



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SOLRAD 11. EXPERIMENT TIMING, TELEMETRY AND COMMAND SUMMARY.(U)
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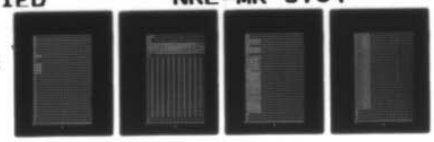

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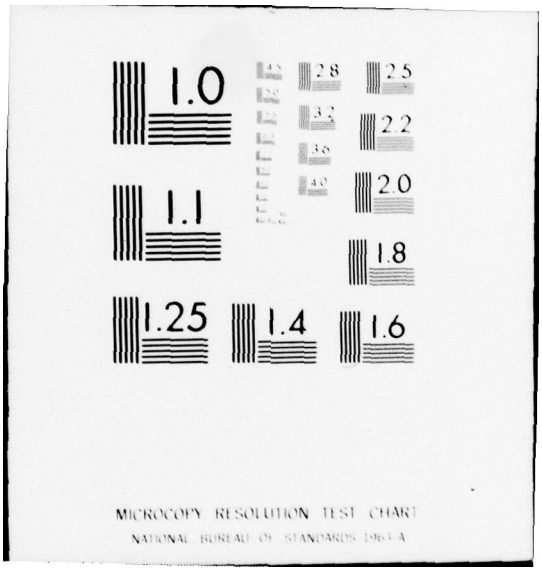
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

FMT 2	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	SYNC	SF10	=SAME	AS	FORMAT	ONE=	======	4-54 X-25	======	======	======	=SAME	AS	FORMAT	ONE=	======	======	======	3-1 X19-1	3-5 X19-5	3-9 X19-1	3-13 X19-5	======	======	4-3 TOR1	=SAME	AS	FORMAT	ONE=	======	======	======
1																			3-2 X19-2	3-6 X19-6	3-10 X19-2	3-14 X19-6			4-11 TOR2							
2																			3-3 X19-3	3-7 X19-7	3-11 X19-3	3-15 X19-7			4-12 TOR3							
3																			3-4 X19-4	3-8 X19-8	3-12 X19-4	3-16 X19-8			4-13 TOR3							
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FMT 3	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	SYNC	SFID																							4-51 CMD	1-1 +5V	1-33 X1HV	1-65 Y-VAL	1-97 X16T1	1-52 X4	1-59 X12	4-3 TBR1
1																										1-2 +12V	1-34 X17CHV	1-66 X22NV	1-98 X16T2	1-53 X5	1-59 X13	4-11 TBR2
2			4-52 X1S-1	4-52 X1S-2	4-52 X1S-3	4-52 X1S-4	4-52 X1S-5	4-52 X1S-6	4-52 X1S-7	4-52 X1S-8	4-52 X1S-9	4-52 X1S-10	4-52 X1S-11	4-52 X1S-12	4-52 X1S-13	4-52 X1S-14	4-52 X1S-15	4-52 X1S-16	4-52 X1S-17	4-52 X1S-19	4-52 X1S-19	4-52 X1S-20	4-52 X1S-21	4-52 X1S-22		1-3 -12V	1-35 X2LV1	1-67 X17 LV	1-99 X17CT			4-12 TBR6
3																										1-4 +29V	1-36 X2LV2	1-68 XPEAK	1-100 X22TMP			4-19 TBR3
4																										1-5 BATV	1-37 X2LV3	1-69 XVAL	1-101 X247 M			
5			4-52 X1S-1	4-52 X1S-2	4-52 X1S-3	4-52 X1S-4	4-52 X1S-5	4-52 X1S-6	4-52 X1S-7	4-52 X1S-8	4-52 X1S-9	4-52 X1S-10	4-52 X1S-11	4-52 X1S-12	4-52 X1S-13	4-52 X1S-14	4-52 X1S-15	4-52 X1S-16	4-52 X1S-17	4-52 X1S-19	4-52 X1S-19	4-52 X1S-20	4-52 X1S-21	4-52 X1S-22		1-6 CMCUR	1-38 X2LV4	1-70 YPEAK	1-102 X24TMP			
6																										1-7 DISCUR	1-39 X2HVA	1-71 ------	1-103 X18T1			
7																										1-8 SHUNT1	1-40 X2HVB	1-72 XDC	1-104 X18T2			
8			4-52 X1S-1	4-52 X1S-2	4-52 X1S-3	4-52 X1S-4	4-52 X1S-5	4-52 X1S-6	4-52 X1S-7	4-52 X1S-8	4-52 X1S-9	4-52 X1S-10	4-52 X1S-11	4-52 X1S-12	4-52 X1S-13	4-52 X1S-14	4-52 X1S-15	4-52 X1S-16	4-52 X1S-17	4-52 X1S-19	4-52 X1S-19	4-52 X1S-20	4-52 X1S-21	4-52 X1S-22		1-9 SHUNT2	1-41 X3HV	1-73 YDC	1-105 XRTTMP			
9																										1-10 SCCUR	1-42 X8LV	1-74 IRH	1-106 RSPTMP			
10																										1-11 TEMP1	1-43 X9HV	1-75 RSP IR	1-107 STRSPT			
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12																										1-13 TEMP3	1-45 X10HV2	1-77 RCSPR1	1-109 PXRTMP			
13																										1-14 TEMP4	1-46 X11HV	1-78 RCSPR2	1-110 PCRTMP			
14			4-52 X1S-1	4-52 X1S-2	4-52 X1S-3	4-52 X1S-4	4-52 X1S-5	4-52 X1S-5	4-52 X1S-7	4-52 X1S-9	4-52 X1S-9	4-52 X1S-10	4-52 X1S-11	4-52 X1S-12	4-52 X1S-13	4-52 X1S-14	4-52 X1S-15	4-52 X1S-16	4-52 X1S-17	4-52 X1S-19	4-52 X1S-19	4-52 X1S-20	4-52 X1S-21	4-52 X1S-22		1-15 TEMP5	1-47 X18HV	1-79 AGC R1	1-111 PCRTMP			
15																										1-16 TEMP6	1-48 19MPOS	1-80 RSP ST	1-112 ------			
16																										1-17 BAT T1	1-48 X24HV	1-81 X49TMP	1-113 X20R2			
17			4-52 X1S-1	4-52 X1S-2	4-52 X1S-3	4-52 X1S-4	4-52 X1S-5	4-52 X1S-6	4-52 X1S-7	4-52 X1S-8	4-52 X1S-9	4-52 X1S-10	4-52 X1S-11	4-52 X1S-12	4-52 X1S-13	4-52 X1S-14	4-52 X1S-15	4-52 X1S-16	4-52 X1S-17	4-52 X1S-19	4-52 X1S-19	4-52 X1S-20	4-52 X1S-21	4-52 X1S-22		1-18 BAT T2	1-50 X25LV	1-82 X48TMP	1-114 X20R3			
18																										1-19 PCS T1	1-51 ------	1-83 X5ATMP	1-115 X20R4			
19																										1-20 PCS T2	1-52 X4	1-84 X50TMP	1-116 X20R5			
20			4-52 X1S-1	4-52 X1S-2	4-52 X1S-3	4-52 X1S-4	4-52 X1S-5	4-52 X1S-5	4-52 X1S-7	4-52 X1S-8	4-52 X1S-9	4-52 X1S-10	4-52 X1S-11	4-52 X1S-12	4-52 X1S-13	4-52 X1S-14	4-52 X1S-15	4-52 X1S-16	4-52 X1S-17	4-52 X1S-19	4-52 X1S-19	4-52 X1S-20	4-52 X1S-21	4-52 X1S-22		1-21 PRD1T1	1-53 X5	1-85 X6 TMP	1-117 X20R6			
21																										1-22 PRD1T2	1-54 X6	1-86 X7ATMP	1-118 X20R7			
22																										1-23 PRD3T1	1-55 ------	1-87 X7BTMP	1-119 X20R8			
23			4-52 X1S-1	4-52 X1S-2	4-52 X1S-3	4-52 X1S-4	4-52 X1S-5	4-52 X1S-6	4-52 X1S-7	4-52 X1S-8	4-52 X1S-9	4-52 X1S-10	4-52 X1S-11	4-52 X1S-12	4-52 X1S-13	4-52 X1S-14	4-52 X1S-15	4-52 X1S-16	4-52 X1S-17	4-52 X1S-19	4-52 X1S-19	4-52 X1S-20	4-52 X1S-21	4-52 X1S-22		1-24 PRD3T2	1-56 X21A	1-88 X7CTMP	1-120 X20R9			
24																										1-25 PAN1T1	1-57 ------	1-89 ------	1-121 X20R10			
25																										1-26 TANK1	1-58 X12	1-90 X9TMP	1-122 X20R1			
26			4-52 X1S-1	4-52 X1S-2	4-52 X1S-3	4-52 X1S-4	4-52 X1S-5	4-52 X1S-6	4-52 X1S-7	4-52 X1S-9	4-52 X1S-9	4-52 X1S-10	4-52 X1S-11	4-52 X1S-12	4-52 X1S-13	4-52 X1S-14	4-52 X1S-15	4-52 X1S-15	4-52 X1S-17	4-52 X1S-19	4-52 X1S-13	4-52 X1S-20	4-52 X1S-21	4-52 X1S-22		1-27 TANK2	1-59 X13	1-91 X12TMP	1-123 X24TM			
27																										1-28 LINE1	1-60 X9TMP	1-92 X13TMP	1-124 ------			
28																										1-29 LINE2	1-61 X20A	1-93 X15T1	1-125 ------			
29			4-52 X1S-1	4-52 X1S-2	4-52 X1S-3	4-52 X1S-4	4-52 X1S-5	4-52 X1S-6	4-52 X1S-7	4-52 X1S-9	4-52 X1S-9	4-52 X1S-10	4-52 X1S-11	4-52 X1S-12	4-52 X1S-13	4-52 X1S-14	4-52 X1S-15	4-52 X1S-16	4-52 X1S-17	4-52 X1S-19	4-52 X1S-13	4-52 X1S-20	4-52 X1S-21	4-52 X1S-22		1-30 NOZ T1	1-62 X20A	1-94 X15T2	1-126 ------			
30																										1-31 NOZ T2	1-63 X20A	1-95 X15T3	1-127 ------			
31																										1-32 ------	1-64 X20A	1-96 X15T4	1-128 ------			

FMT 4	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	SYNC	SF10	4-56 FMT-10	1-1 +5V	1-9 SMUNT2	1-17 BAT T1	1-25 PMALT1	1-33 X1	1-41 X3	1-49 X24 HV	1-57 ------	1-65 ASP YV	1-73 ASPYDC	1-81 X4ATMP	1-89 ------	1-97 X16T1	1-105 XMTTMP	1-113 X20A2	1-121 X20A10	4-1 PTD1	4-9 PTD2	4-17 PTD3	4-25 PTD4	1-1 +5V	4-51 CMD	1-9 SMUNT2	1-17 BAT T1	4-55 X7RNG	1-49 X24 HV	1-57 ------	1-58 X12	1-62 X4
1				1-2 +12V	1-10 SCCUR	1-18 BAT T2	1-26 TANKT1	1-34 X17CHV	1-42 X9	1-50 X22 LV	1-58 X12	1-66 X22 HV	1-74 IRH	1-82 X4BTMP	1-90 X9 TMP	1-98 X16T2	1-106 ASPTMP	1-114 X20A3	1-122 X20A1	4-2 PTD5	4-10 ACSSEL	4-18 PTD1-3	4-26 PTD4-5	1-2 +12V		1-10 SCCUR	1-18 BAT T2	2-3 X7C	1-50 X24 LV	1-58 X12	1-59 X13	1-63 X5
2				1-3 -12V	1-11 TEMP1	1-19 PCS T1	1-27 TANKT2	1-35 X2	1-43 X9	1-51 ------	1-59 X13	1-67 X17 LV	1-75 ASP IR	1-83 R5ATMP	1-91 X12TMP	1-99 X17C1	1-107 STASPT	1-115 X20A4	1-123 X24RH	4-3 TBR1	4-11 TBR2	4-19 TBR3	4-27 TBR4	1-3 -12V		1-11 TEMP1	1-19 PCS T1		1-67 ------	1-69 X13		
3				1-4 +28V	1-12 TEMP2	1-20 PCS T2	1-28 LINET1	1-36 X2	1-44 X10HV1	1-52 X4	1-60 X8 TMP	1-68 ASP XP	1-76 ASP E	1-84 X5BTMP	1-92 X13TMP	1-100 X22TMP	1-108 AMRTMP	1-116 X20A5	1-124 ------	4-4 TBR5	4-12 TBR6	4-20 TBR7	4-28 VCREG	1-4 +28V		1-12 TEMP2	1-20 PCS T2		1-52 X4	1-60 X8 TMP		
4				1-5 BATV	1-13 TEMP3	1-21 PRD1T1	1-29 LINET2	1-37 X2	1-45 X10HV2	1-53 X5	1-61 X20A	1-69 ASP XV	1-77 RCSPR1	1-85 X6 TMP	1-93 X15T1	1-101 X24T A	1-109 PRATMP	1-117 X20A6	1-125 ------	4-5 STDAC	4-13 MC REG	4-21 ------	4-29 HVREG	1-5 BATV		1-13 TEMP3	1-21 PRD1T1		1-53 X5	1-61 X20A		
5				1-6 CMCUR	1-14 TEMP4	1-22 PRD1T2	1-30 HOZ T1	1-38 X2	1-46 X11 HV	1-54 X6	1-62 X20A	1-70 ASP YP	1-78 RCSPR2	1-86 X7ATMP	1-94 X15T2	1-102 X24TMP	1-110 PCATMP	1-118 X20A7	1-126 ------	4-6 RCSON	4-14 RCSOFF	4-22 RCSMSB	4-30 TBRB	1-6 CMCUR		1-14 TEMP4	1-22 PRD1T2		1-54 X6	1-62 X20A		
6				1-7 DISCUR	1-15 TEMP5	1-23 PRD3T1	1-31 HOZ T2	1-39 X2	1-47 X10 HV	1-55 ------	1-63 X20A	1-71 ------	1-79 AGC R1	1-87 X7BTMP	1-95 X15T3	1-103 X16T1	1-111 PCATMP	1-119 X20A8	1-127 ------	4-7 VERN	4-15 ABS	4-23 ------	4-31 ------	1-7 DISCUR		1-15 TEMP5	1-23 PRD3T1		1-55 ------	1-63 X20A		
7				1-8 SMUNT1	1-16 TEMP6	1-24 PRD3T2	1-32 ------	1-40 X2	1-48 IRMP05	1-56 21A	1-64 X20A	1-72 ASPXDC	1-80 ASP ST	1-88 X7CTMP	1-96 X15T4	1-104 X16T2	1-112 ------	1-120 X20A9	1-128 ------	4-8 ------	4-16 ------	4-24 ------	4-32 ------	1-8 SMUNT1		1-16 TEMP6	1-24 PRD3T2		1-56 21A	1-64 X20A		
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0	SYNC	SF10	4-58 FMT10	4-58 FMT10	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1
1					2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1	2-5 X-1	2-6 Y-1
2					2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2
3					2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2	2-7 X-2	2-8 Y-2
4					1-61 1AC1-4	1-62 1AC5-8	1-63 2AC1-4	1-64 2AC5-8	1-4 +28V	1-10 SC CUR	1-61 1AC1-4	1-62 1AC5-8	1-63 2AC1-4	1-64 2AC5-8	1-4 +28V	1-10 SC CUR	1-61 1AC1-4	1-62 1AC5-8	1-63 2AC1-4	1-64 2AC5-8	1-4 +28V	1-10 SC CUR	1-61 1AC1-4	1-62 1AC5-8	1-63 2AC1-4	1-64 2AC5-8	1-4 +28V	1-10 SC CUR	1-61 1AC1-4	1-62 1AC5-8	1-63 2AC1-4	1-64 2AC5-8
5					1-69 XPEAK	1-69 XVAL	1-70 YPEAK	1-71 ------	4-10 ACSSEL	4-26 PTD4-5	1-68 XPEAK	1-69 XVAL	1-70 YPEAK	1-71 ------	4-10 ACSSEL	4-26 PTD4-5	1-68 XPEAK	1-69 XVAL	1-70 YPEAK	1-71 ------	4-10 ACSSEL	4-26 PTD4-5	1-69 XPEAK	1-69 XVAL	1-70 YPEAK	1-71 ------	4-10 ACSSEL	4-26 PTD4-5	1-68 XPEAK	1-69 XVAL	1-70 YPEAK	1-71 ------
6					1-72 YDC	1-73 XDC	1-75 ASP-1R	1-76 ASP-VE	1-77 RCSPR1	1-11 TEMP1	1-72 YDC	1-73 XDC	1-75 ASP-1R	1-76 ASP-VE	1-77 RCSPR1	1-11 TEMP1	1-72 YDC	1-73 XDC	1-75 ASP-1R	1-76 ASP-VE	1-77 RCSPR1	1-11 TEMP1	1-72 YDC	1-73 XDC	1-75 ASP-1R	1-76 ASP-VE	1-77 RCSPR1	1-11 TEMP1	1-72 YDC	1-73 XDC	1-75 ASP-1R	1-76 ASP-VE
7					1-65 Y VAL	4-28 VCREG	4-1 PTD1	4-18 PTD1-3	4-3 TBR1	4-11 TBR2	1-65 Y VAL	4-28 VCREG	4-1 PTD1	4-18 PTD1-3	4-3 TBR1	4-11 TBR2	1-65 Y VAL	4-28 VCREG	4-1 PTD1	4-19 PTD1-3	4-3 TBR1	4-11 TBR2	1-65 Y VAL	4-28 VCREG	4-1 PTD1	4-19 PTD1-3	4-3 TBR1	4-11 TBR2	1-65 Y VAL	4-28 VCREG	4-1 PTD1	4-18 PTD1-3
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