2

CR 128636

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Apollo Lunar Surface Experiments Package

Apollo 17 ALSEP (ARRAY E)
Familiarization Course Handout

For Training Purposes Only

BSR 3270

1 September 1972

Contract NAS 9-5829

(NASA-CR-128636) APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE. APOLLO 17 ALSEP (ARRAY E) FAMILIARIZATION COURSE HANDOUT (Bendix Corp.) 1 Sep. 1972 262 p CSCL 14B

N73-12459

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MANNED SPACECRAFT CENTER

HOUSTON, TEXAS

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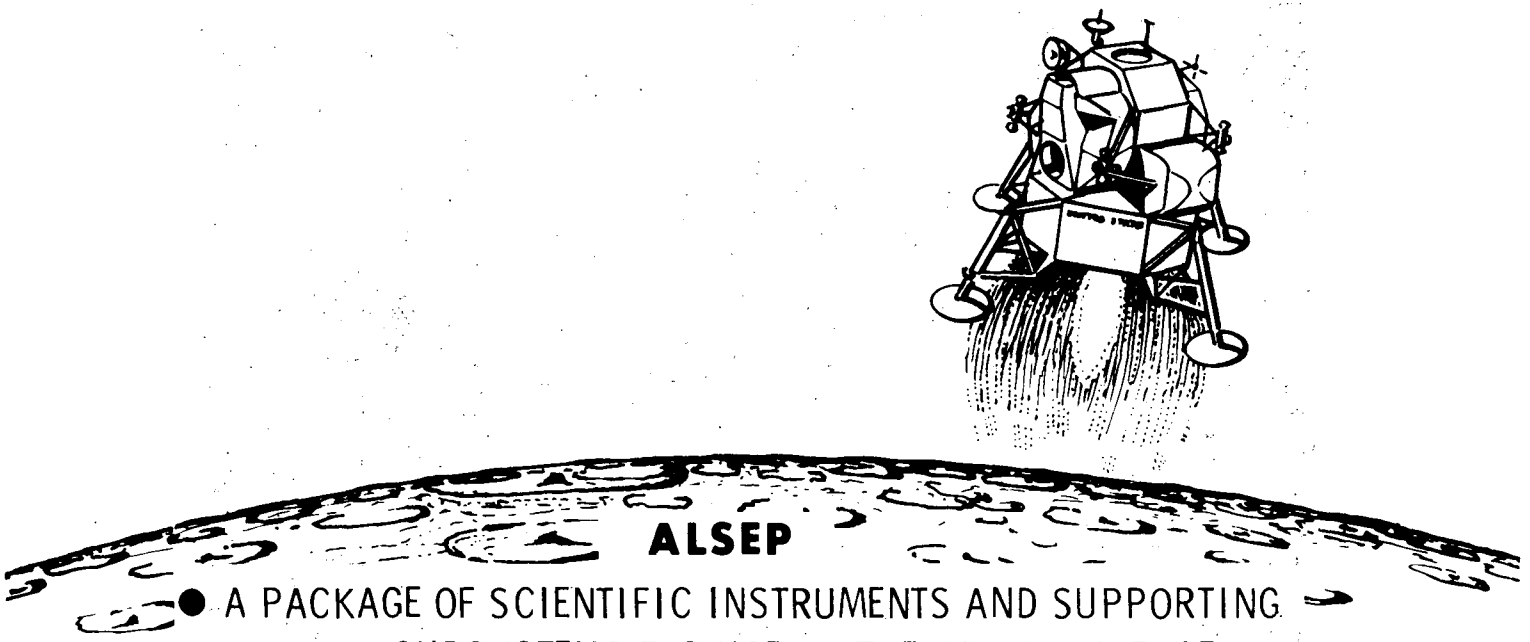
TABLE OF CONTENTS

APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

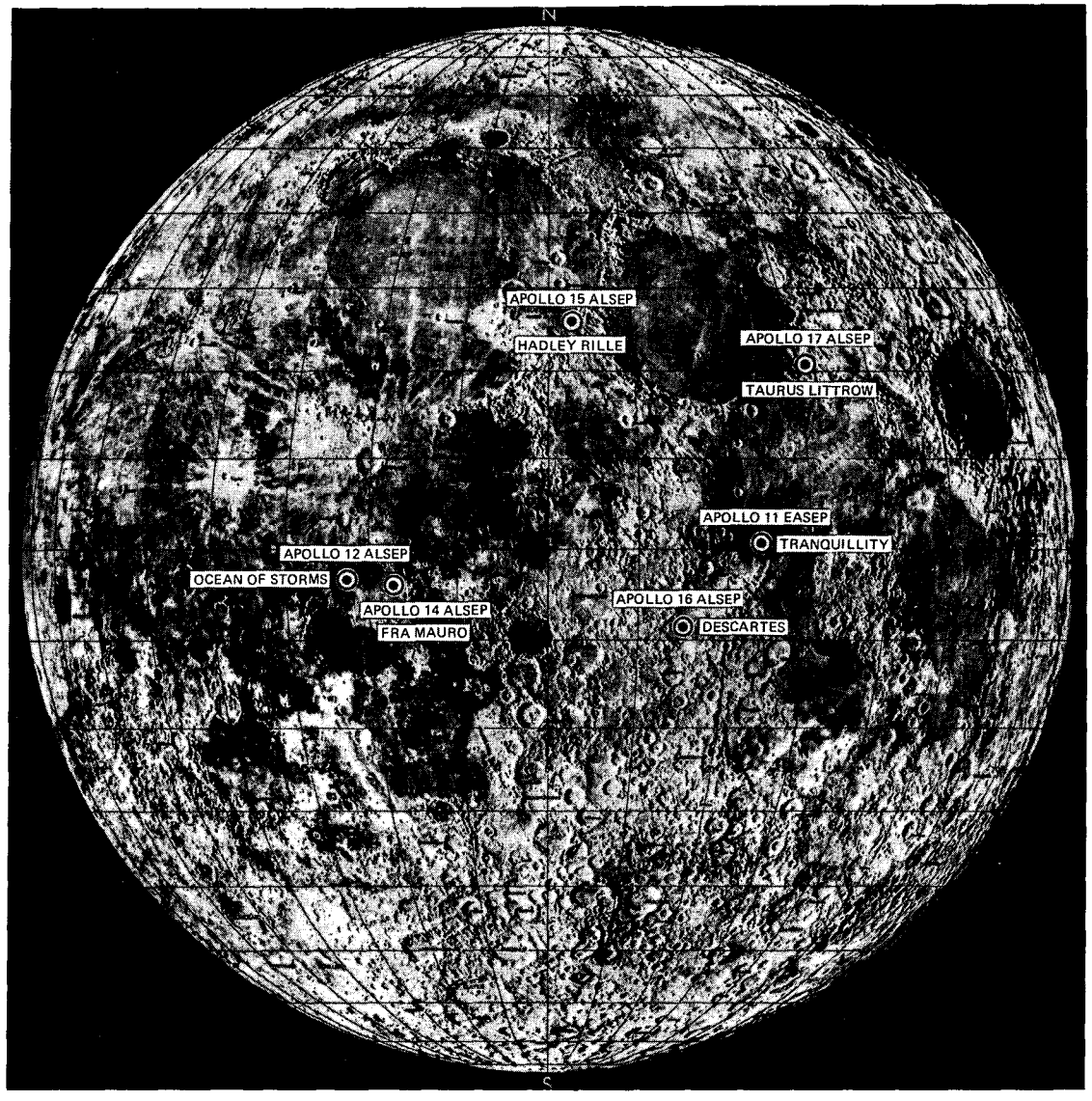


ALSEP

- A PACKAGE OF SCIENTIFIC INSTRUMENTS AND SUPPORTING SUBSYSTEMS FOR USE ON THE LUNAR SURFACE
- CARRIED ON APOLLO, DEPLOYED BY ASTRONAUT
- TWO-YEAR CONTINUOUS OPERATION (5-YEAR GOAL) FOR APOLLO 17. PREVIOUS ALSEP'S HAD ONE-YEAR DESIGN LIFE.

FEB 72 3270.1.1

ALSEP LOCATIONS ON MOON



FEB 72 3270.1.2

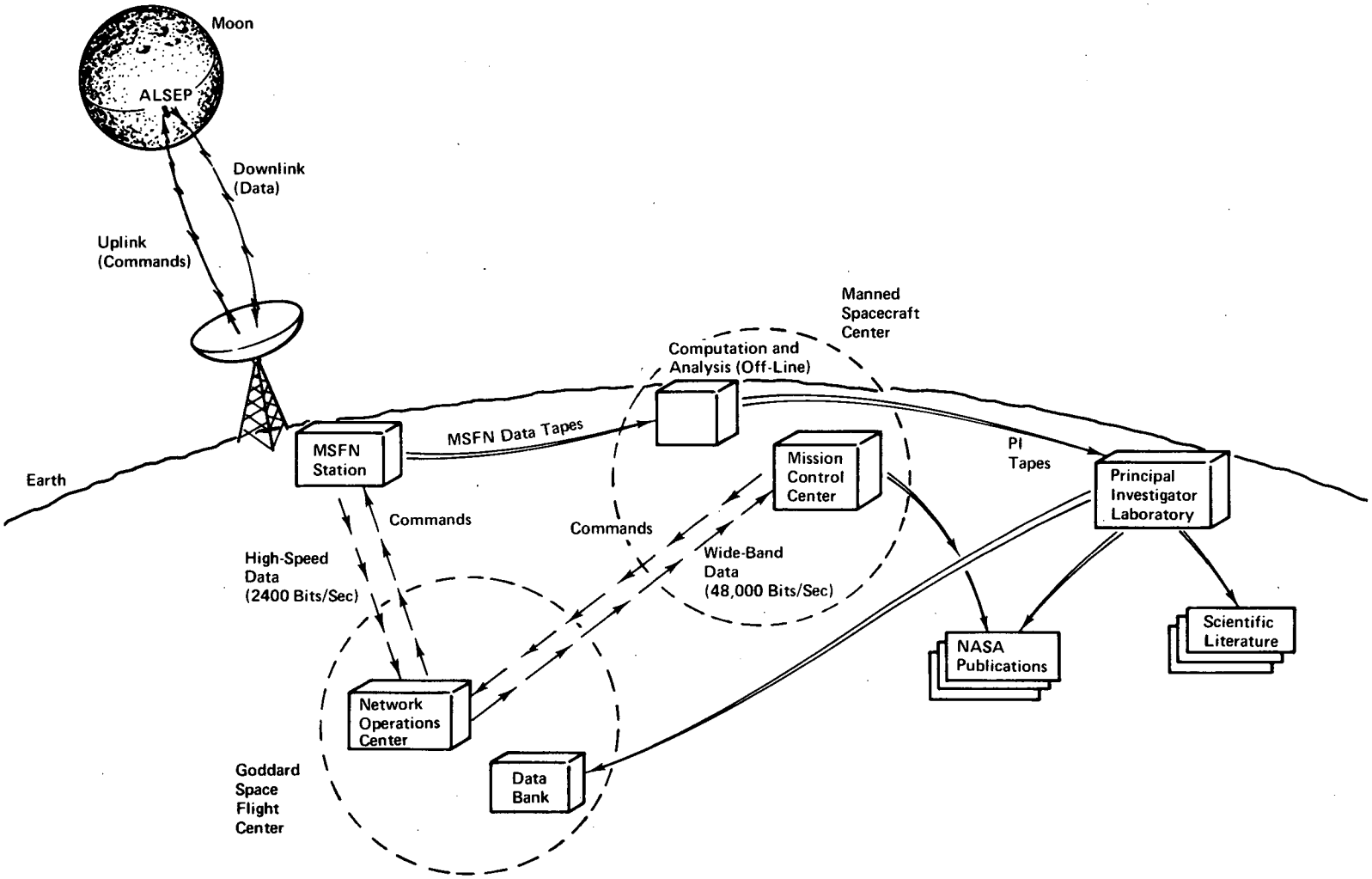
MISSION ASSIGNMENTS

ALSEP EXPERIMENT / APOLLO	11	12	13	14	15	16
LOCATION	23.4°E 0.7°N	23.5°W 3.0°S		17.5°W 3.7°S	3.7°E 26.1°N	15.5°E 8.9°S
PASSIVE SEISMIC EXPERIMENT	●	●	●	●	●	●
ACTIVE SEISMIC EXPERIMENT				●		●
SUPRATHERMAL ION DETECTOR		●		●	●	
COLD-CATHODE ION GAGE		●	●	●	●	
SOLAR WIND SPECTROMETER		●			●	
CHARGED-PARTICLE EXPERIMENT			●	●		
LUNAR SURFACE MAGNETOMETER		●			●	●
HEAT FLOW EXPERIMENT			●		●	●
LASER-RANGING RETRO-REFLECTOR	●			●	●	

APOLLO 17 (ARRAY E) MISSION ASSIGNMENTS

- SECOND GENERATION OF LUNAR SCIENTIFIC MEASUREMENTS:
  - LUNAR SURFACE GRAVIMETER FOR INVESTIGATION OF GRAVITY FIELDS (PI: JOSEPH WEBER, UNIVERSITY OF MARYLAND)
  - LUNAR MASS SPECTROMETER FOR ATMOSPHERIC SPECTRUM ANALYSIS (PI: JOHN H. HOFFMAN, UNIVERSITY OF TEXAS)
  - LUNAR SEISMIC PROFILING EXPERIMENT FOR DETERMINATION OF SUBSURFACE PROPERTIES TO SUBSTANTIAL DEPTHS (PI: ROBERT KOVACH, STANDFORD UNIVERSITY)
  - LUNAR EJECTA AND METEORITES EXPERIMENT TO DETERMINE LONG-TERM COSMIC INFLUX EFFECTS (PI: OTTO BERG, GODDARD SPACE FLIGHT CENTER)
  - HEAT FLOW EXPERIMENT TO COMPLEMENT AND SUPPLEMENT PREVIOUS ONES (PI: MARK LANGSETH, LAMONT DOHERTY GEOLOGICAL OBSERVATORY)

EARTH-MOON COMMUNICATIONS



FEB 72 3270.1.5

ANTENNA POINTING CONSTRAINTS

LUNAR LIBRATION: AN APPARENT WOBBLING MOTION AS VIEWED FROM THE EARTH; CAUSES EQUIVALENT EARTH MOTION IN LUNAR COORDINATES

PRINCIPAL EFFECTS:

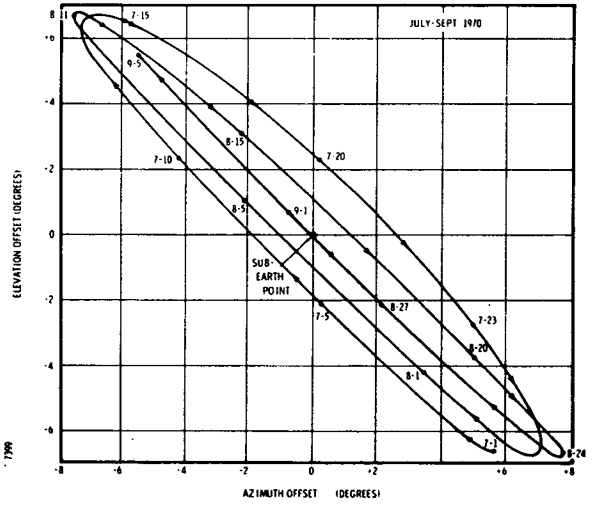
± 7.5° LUNAR LONGITUDE DUE TO:
- CONSTANT ANGULAR RATE OF MOON ABOUT ITS AXIS
- VARIABLE ANGULAR RATE IN ELLIPTICAL ORBIT AROUND EARTH

± 6.5° LUNAR LATITUDE DUE TO:
- INCLINATION OF MOON'S ROTATION AXIS TO ITS ORBITAL PLANE

SECONDARY EFFECTS:
- NON-SPHERICAL EARTH & MOON
- SOLAR PERTURBATIONS
- GYROSCOPE & PENDULUM COUPLING

COMBINED EFFECTS: PATTERN CHANGES
- MONTHLY & YEARLY

ALSEP ANTENNA: 22° BEAM WIDTH DOWN
- 4.2 db AIMED AT MEAN CENTER OF PATTERN



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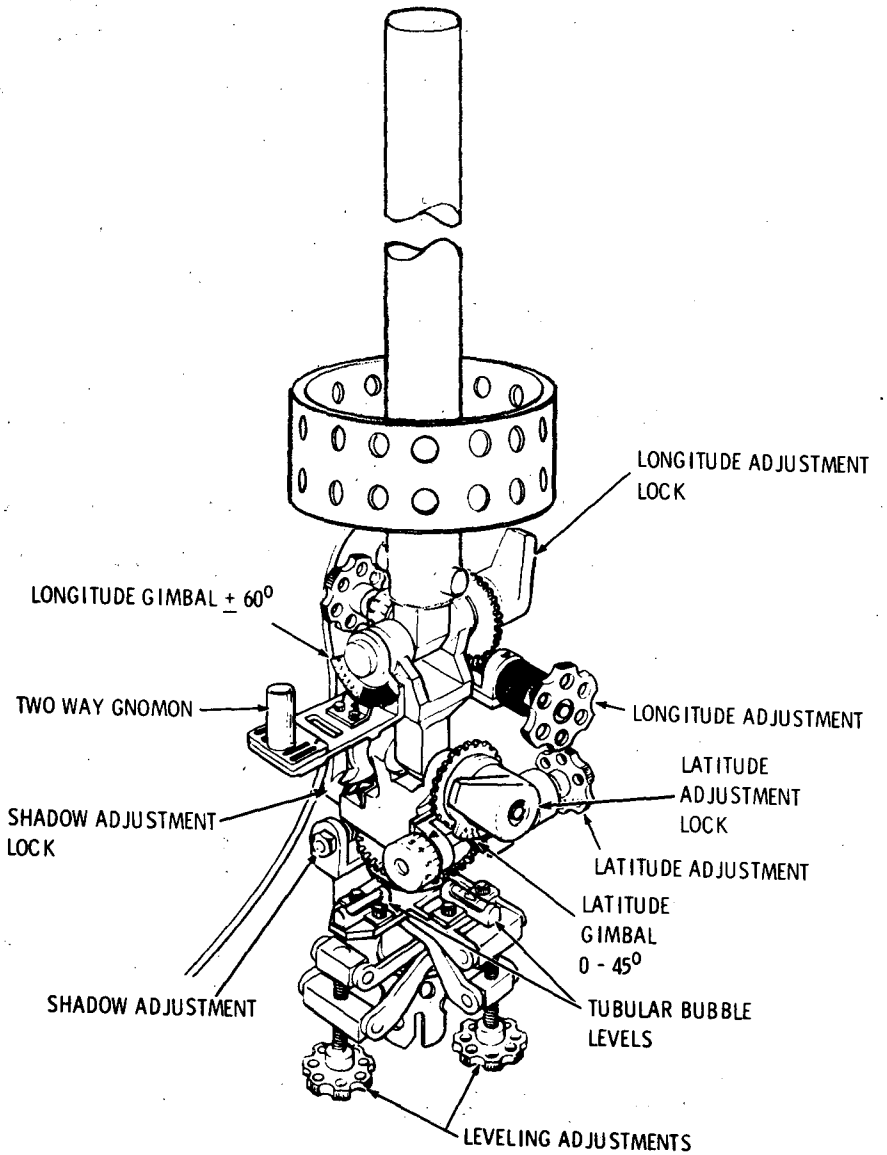
ANTENNA AND AIMING MECHANISM



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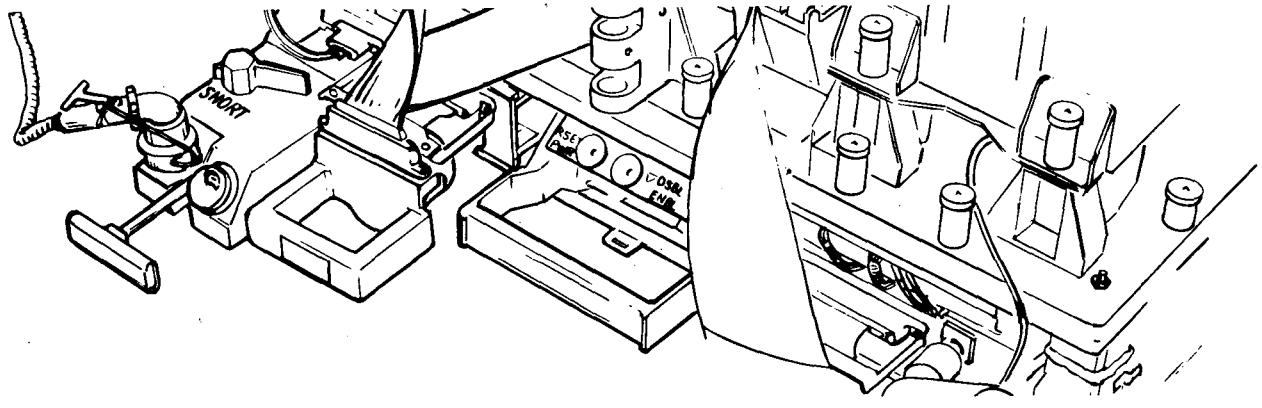
ASTRONAUT SWITCHES



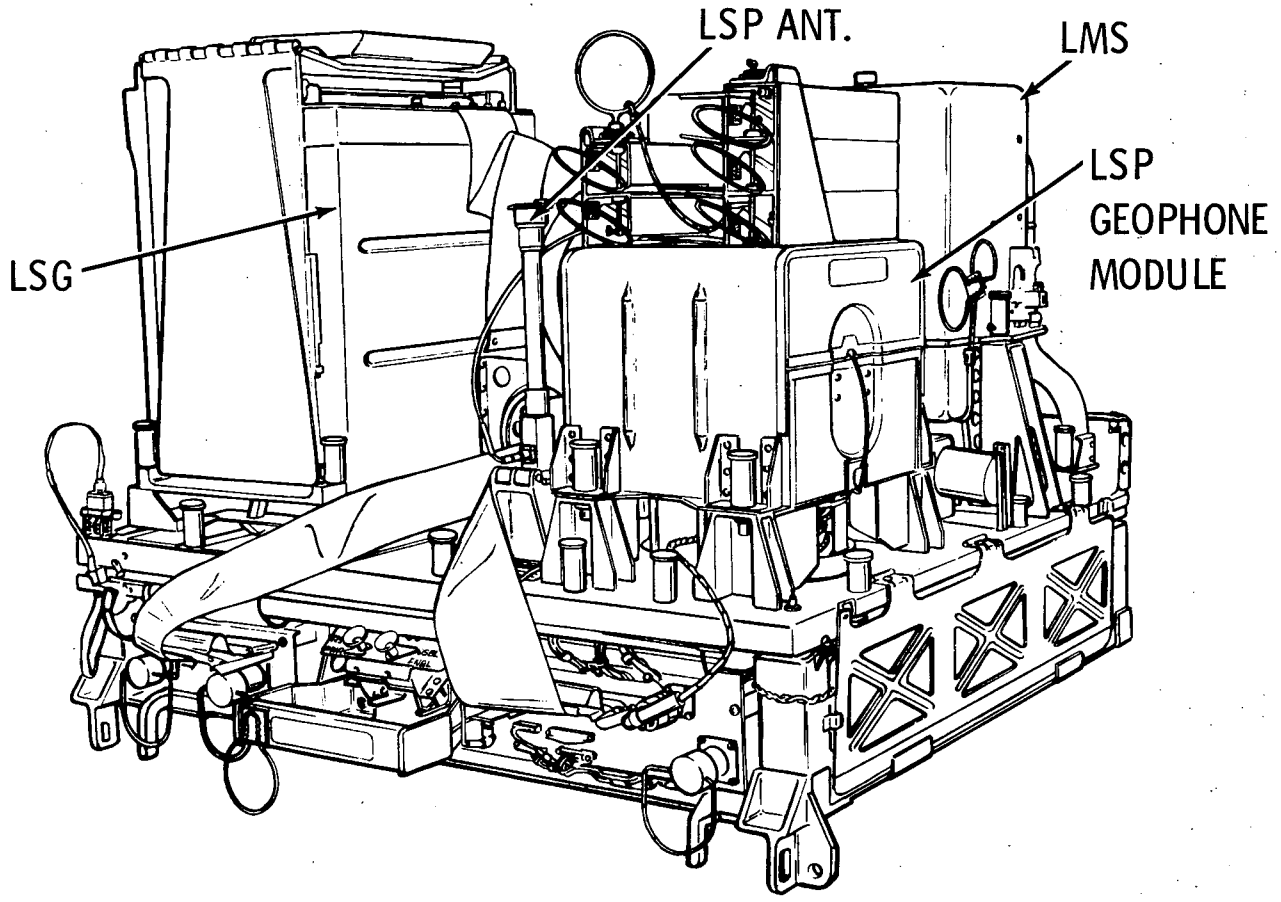
ASTRO SW-1 (BACKUP ONLY)

- PURPOSE: TO ENABLE CREW TO SELECT REDUNDANT POWER CONDITIONER DELIVERED TO THE MOON IN CCW POSITION
- UPON REQUEST, THE ASTRONAUT ROTATES SW-1 FIRST CW THEN CCW (AS FAST AS HE WANTS TO).
- CW ROTATION SIMULTANEOUSLY OPENS RTG POWER LINE AND SIMULATES A COMMAND TO SELECT PCU 2.
- CCW ROTATION CLOSES RTG LINE, (APPLYING RTG PWR TO PCU 2).

ASTRO SW-2 (LSP SAFETY SWITCH)

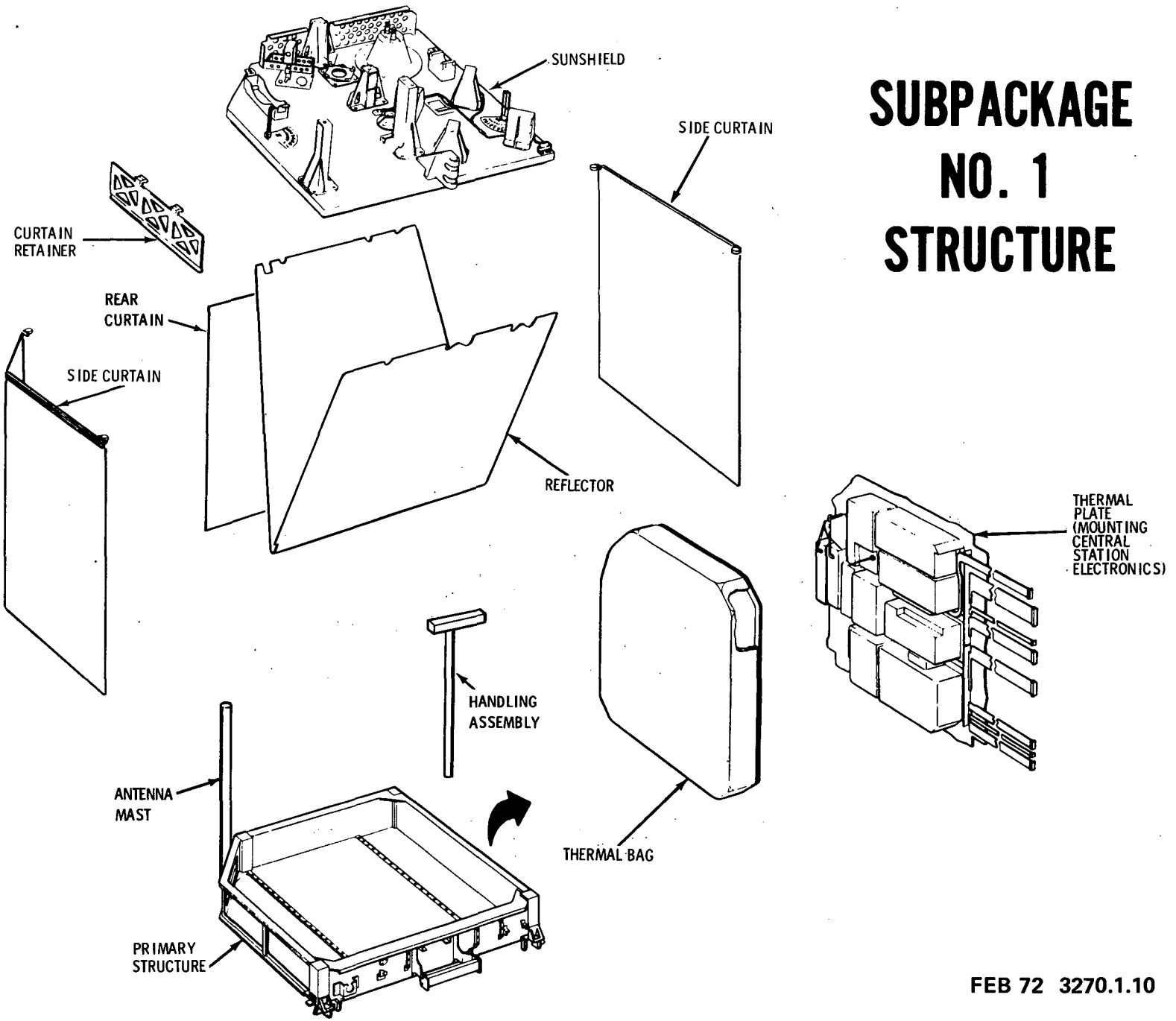
- DELIVERED TO THE MOON IN CCW POSITION
- CLOCKWISE ROTATION OF SW-2 CW ENABLES LSP OPER PWR LINE (29 VDC)
- COUNTER-CLOCKWISE ROTATION INHIBITS LSP OPERATION

ARRAY E SUBPACKAGE NO. 1



APR. 72 3270.1.9

SUBPACKAGE NO. 1 STRUCTURE



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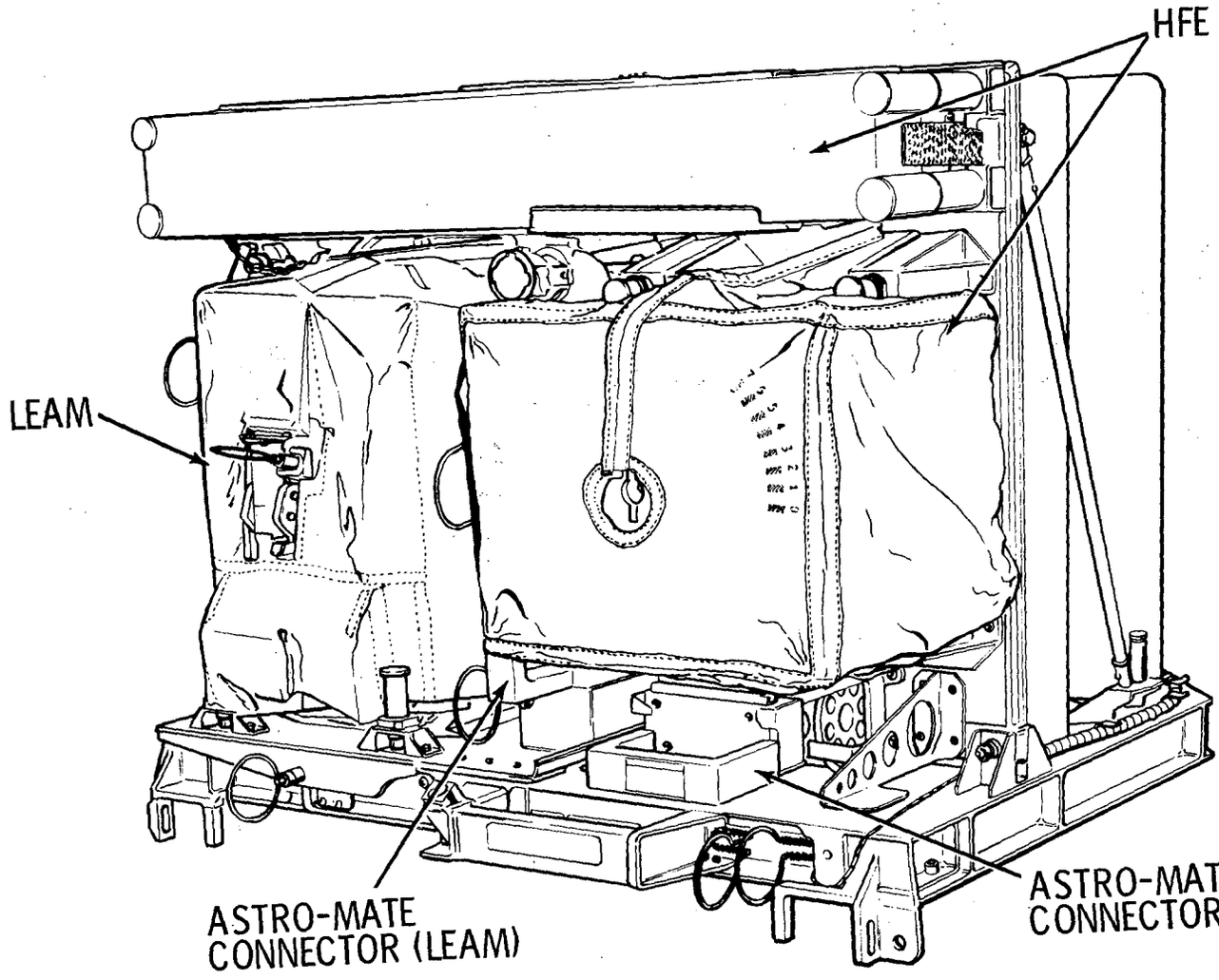
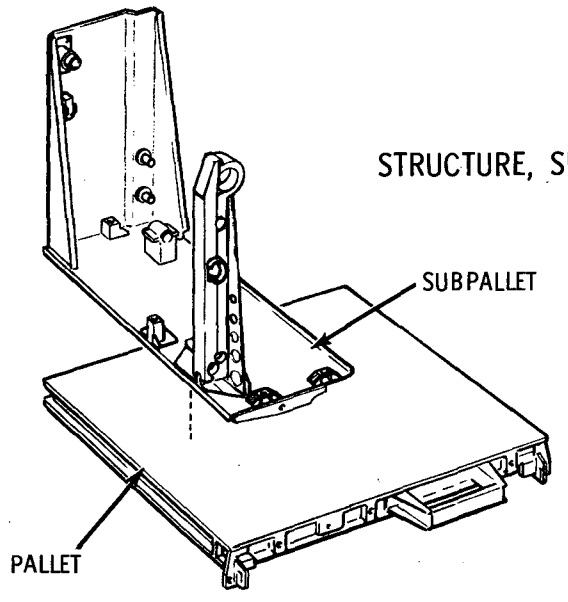
ARRAY E SUBPACKAGE NO. 2



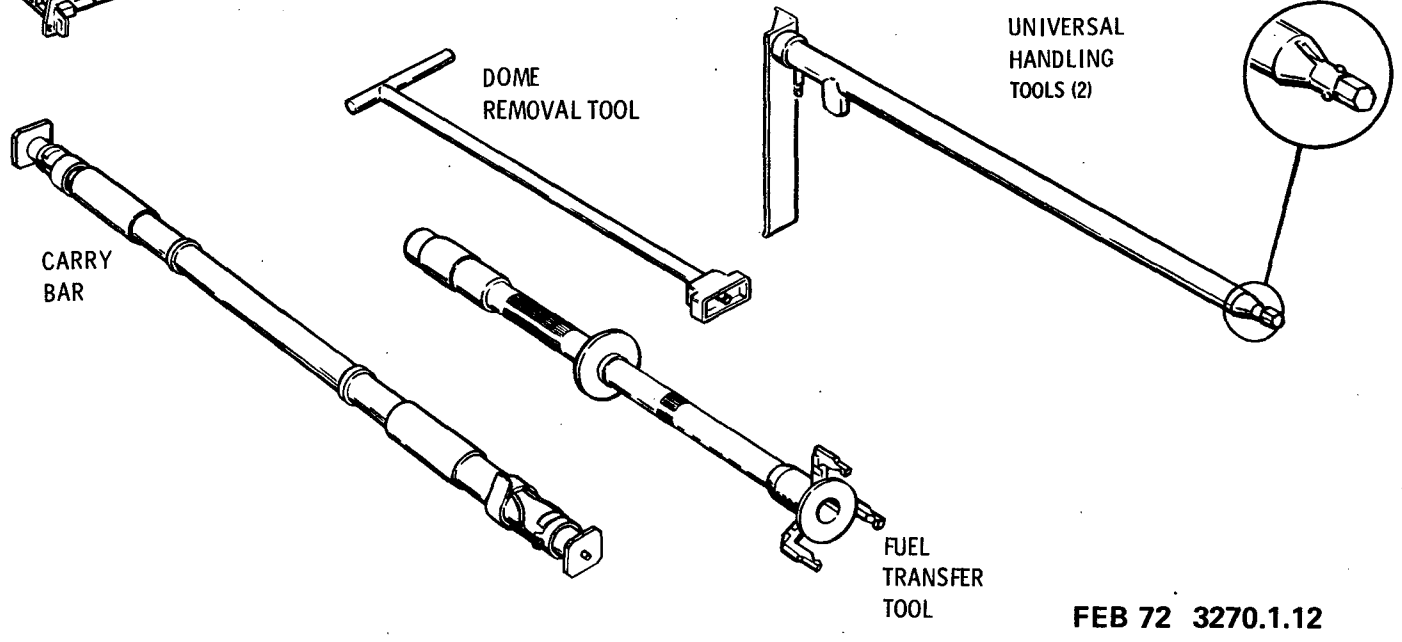
APR. 72 3270.1.11

SUBPACKAGE NO. 2
STRUCTURE AND TOOLS



STRUCTURE, SUBPACKAGE NO. 2

ALSEP HANDLING TOOLS

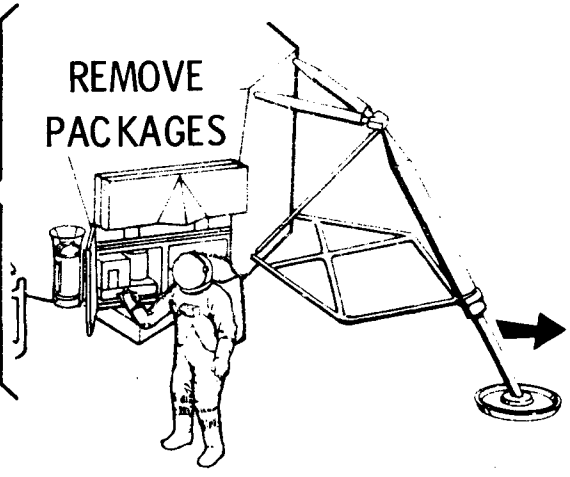


FEB 72 3270.1.12

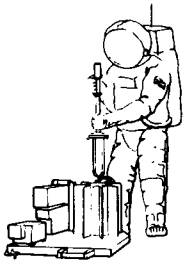
LUNAR SURFACE ACTIVITY

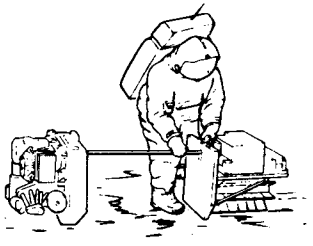
ALSEP DEPLOYMENT TASKS ASSOCIATED WITH LM

REMOVE PACKAGES



FUEL GENERATOR

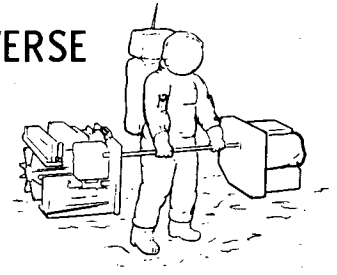




PREPARE FOR TRAVERSE

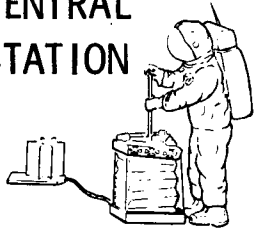
DEPLOYMENT DUST COVERS NOT SHOWN

TRAVERSE

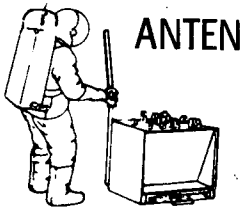


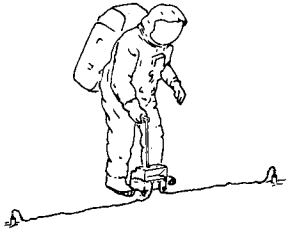
ALSEP DEPLOYMENT TASKS AT EXPERIMENT SITE

DEPLOY CENTRAL STATION



DEPLOY ANTENNA



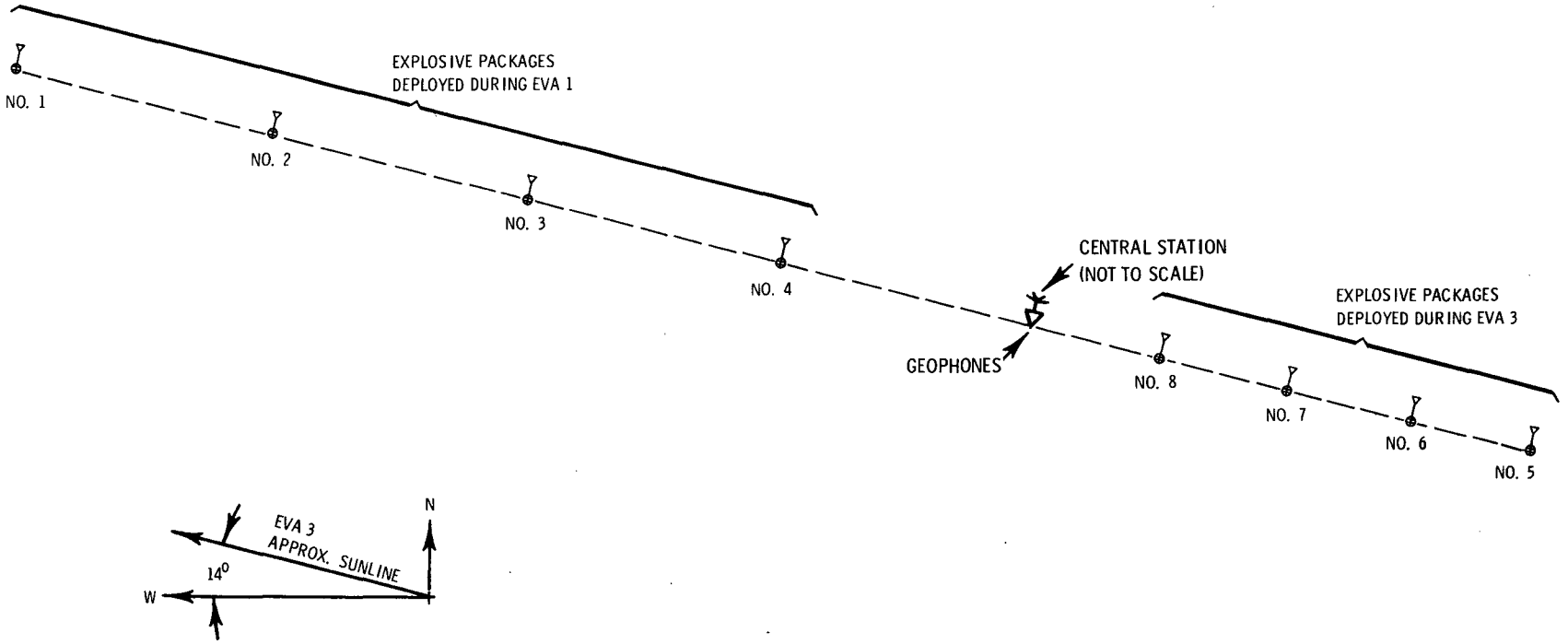


DEPLOY EXPERIMENTS

FEB 72 3270.1.13

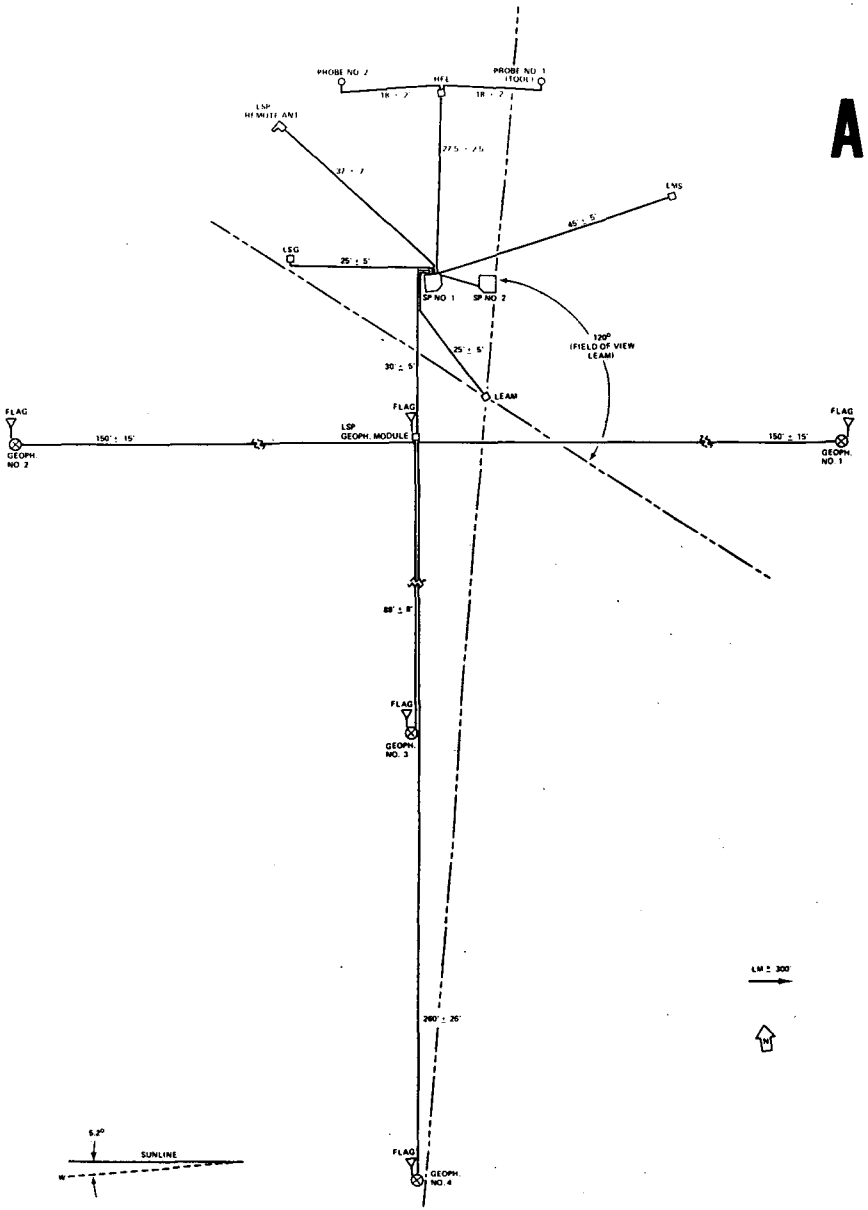
GENERAL DEPLOYMENT CONFIGURATION

(AT TAURUS LITTROW)



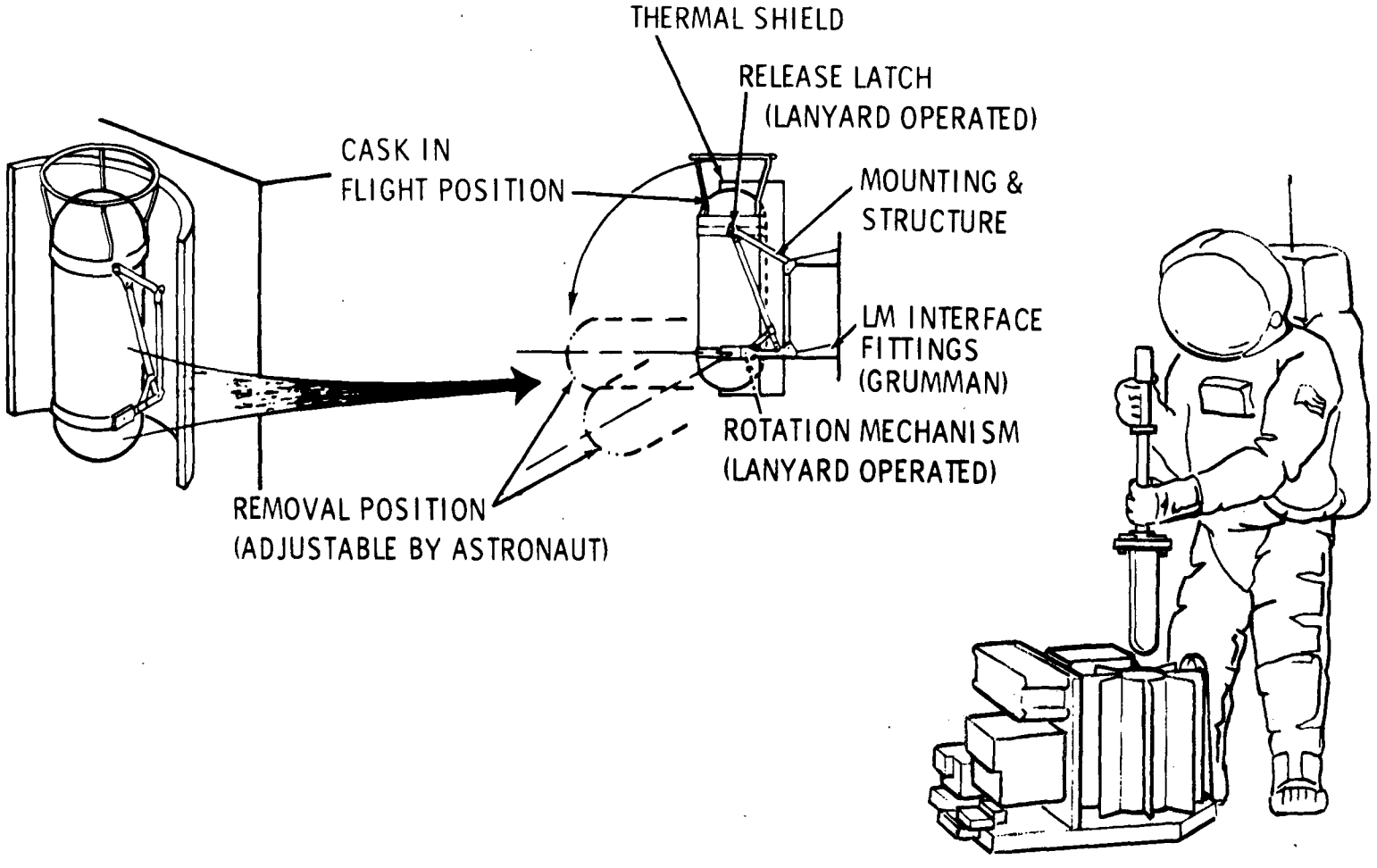
JUNE 72 3270.1.14

APOLLO 17
ALSEP DEPLOYMENT



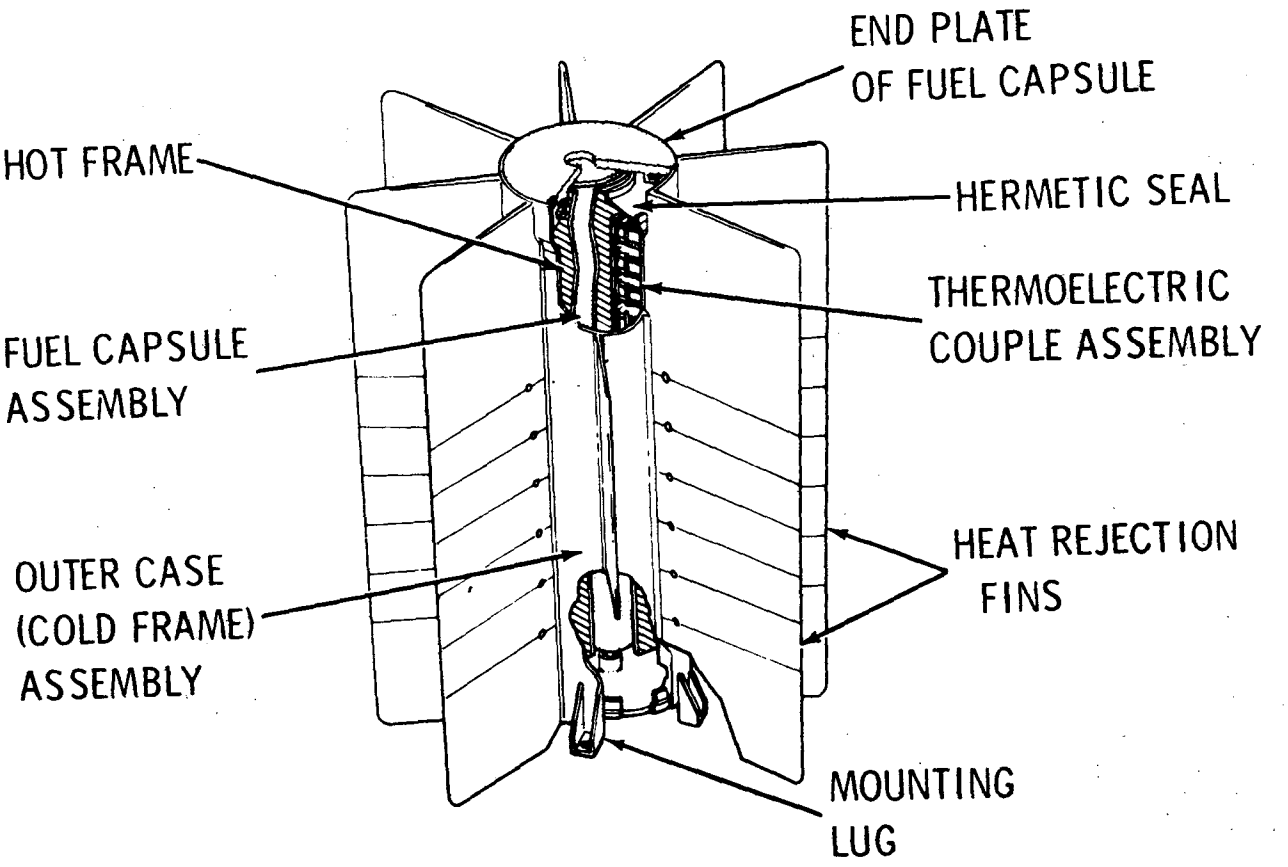
FEB 72 3270.1.15

RTG FUELING



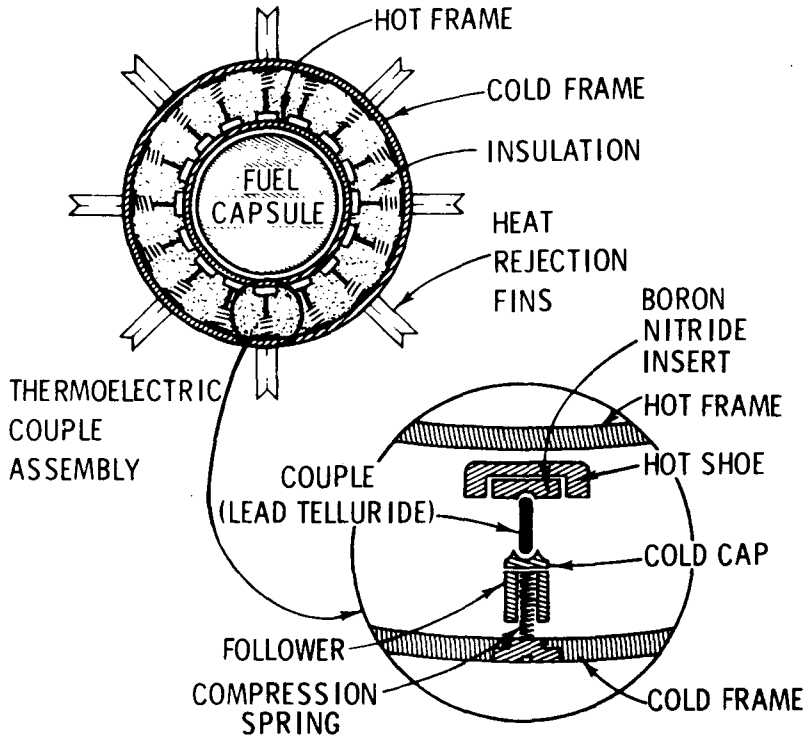
FEB 72 3270.1.16

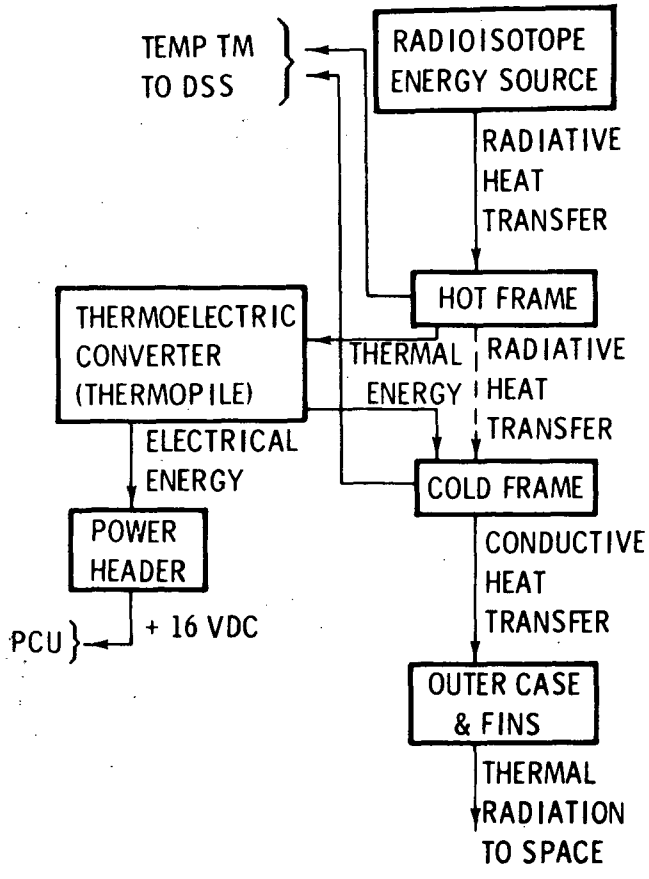
RTG CUTAWAY



FEB 72 3270.1.17

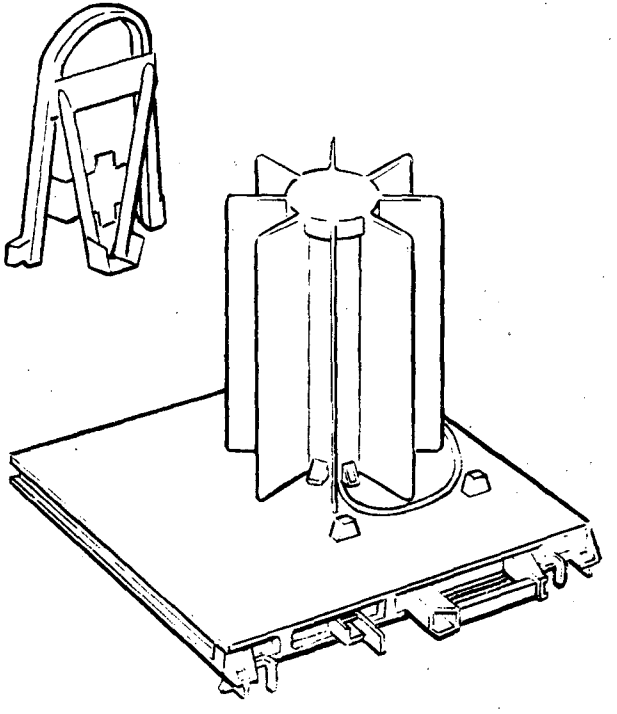
POWER GENERATING FUNCTION





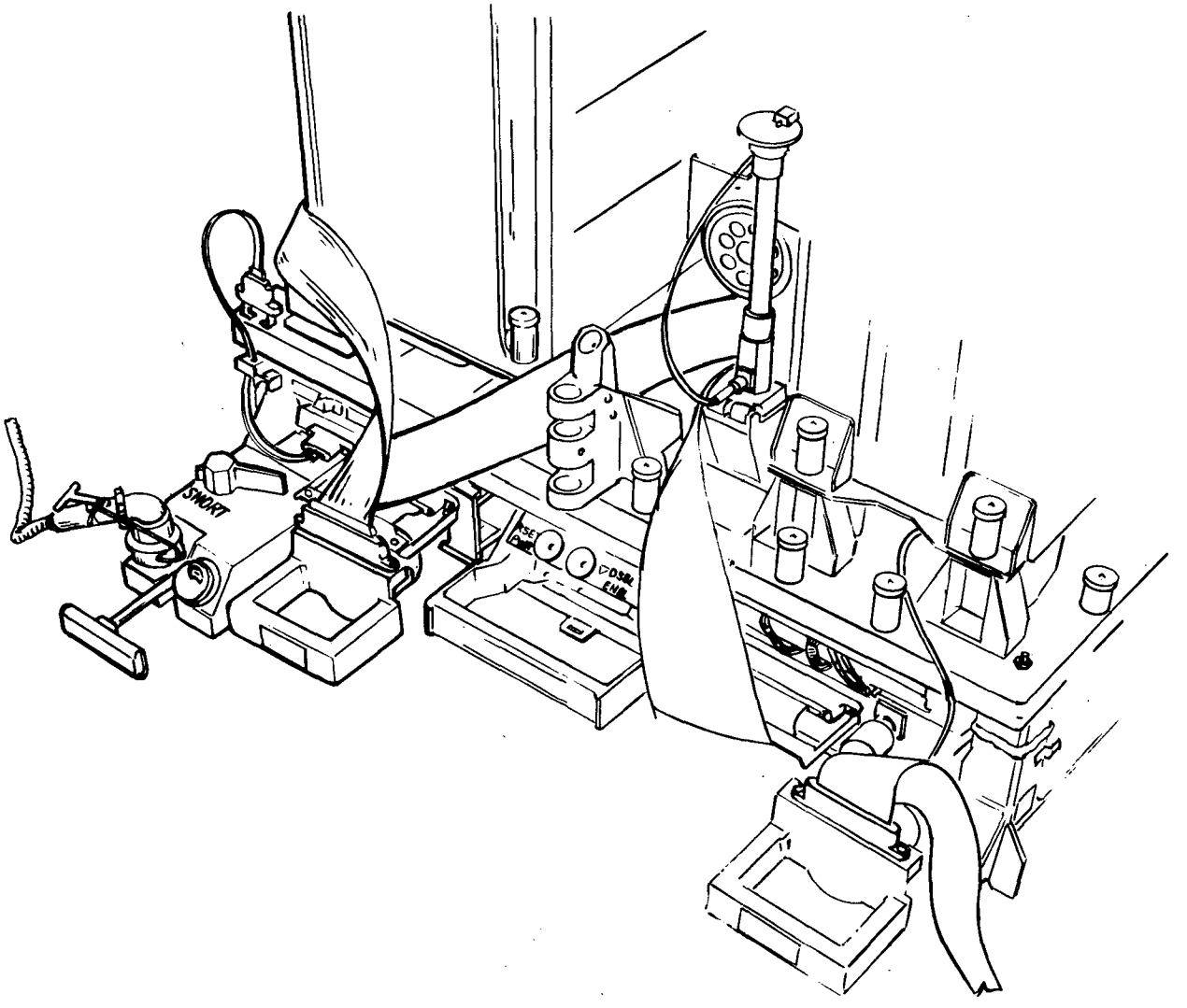
FEB 72 3270.1.18

RTG CABLE



FEB 72 3270.1.19

RTG CABLE CONNECTION



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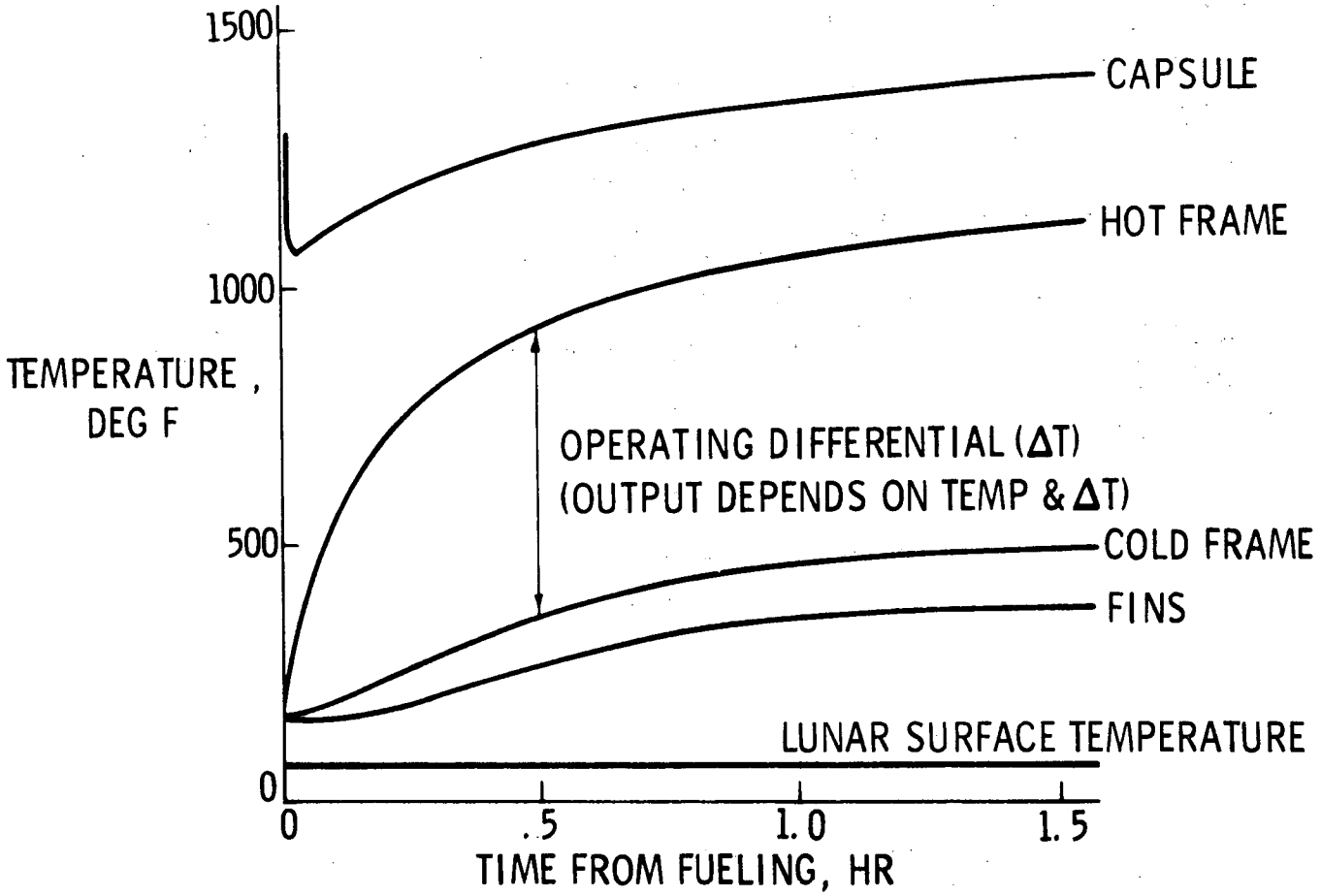
RTG WARM-UP CYCLE



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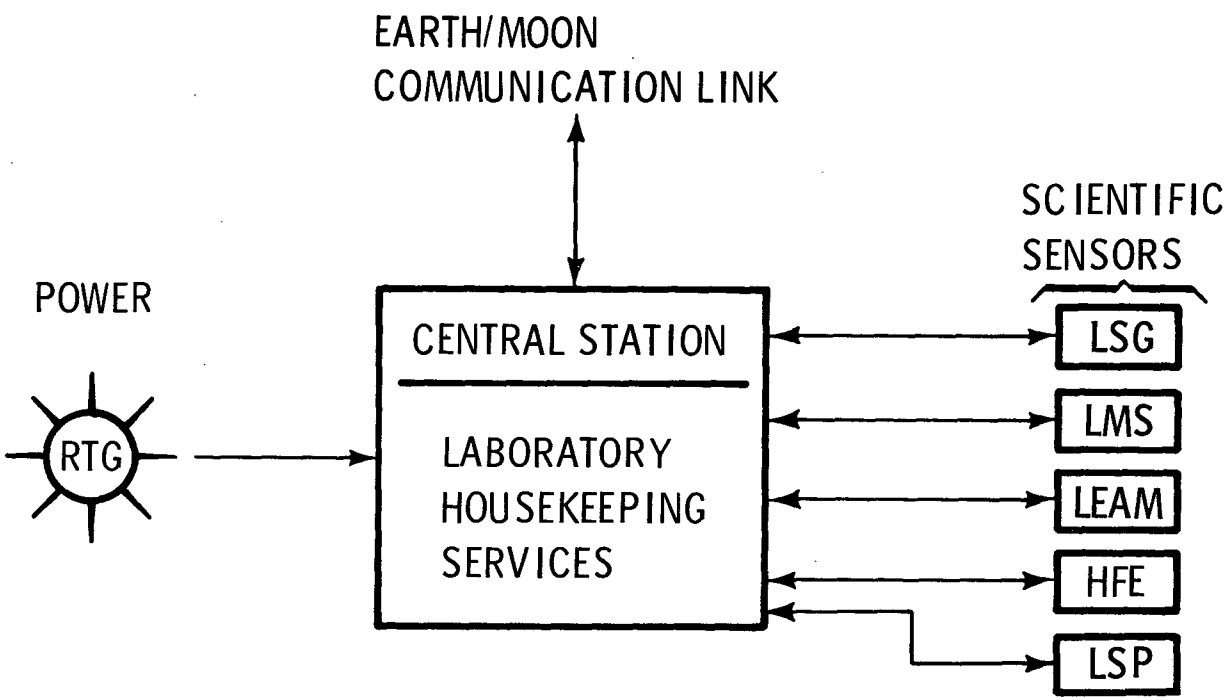
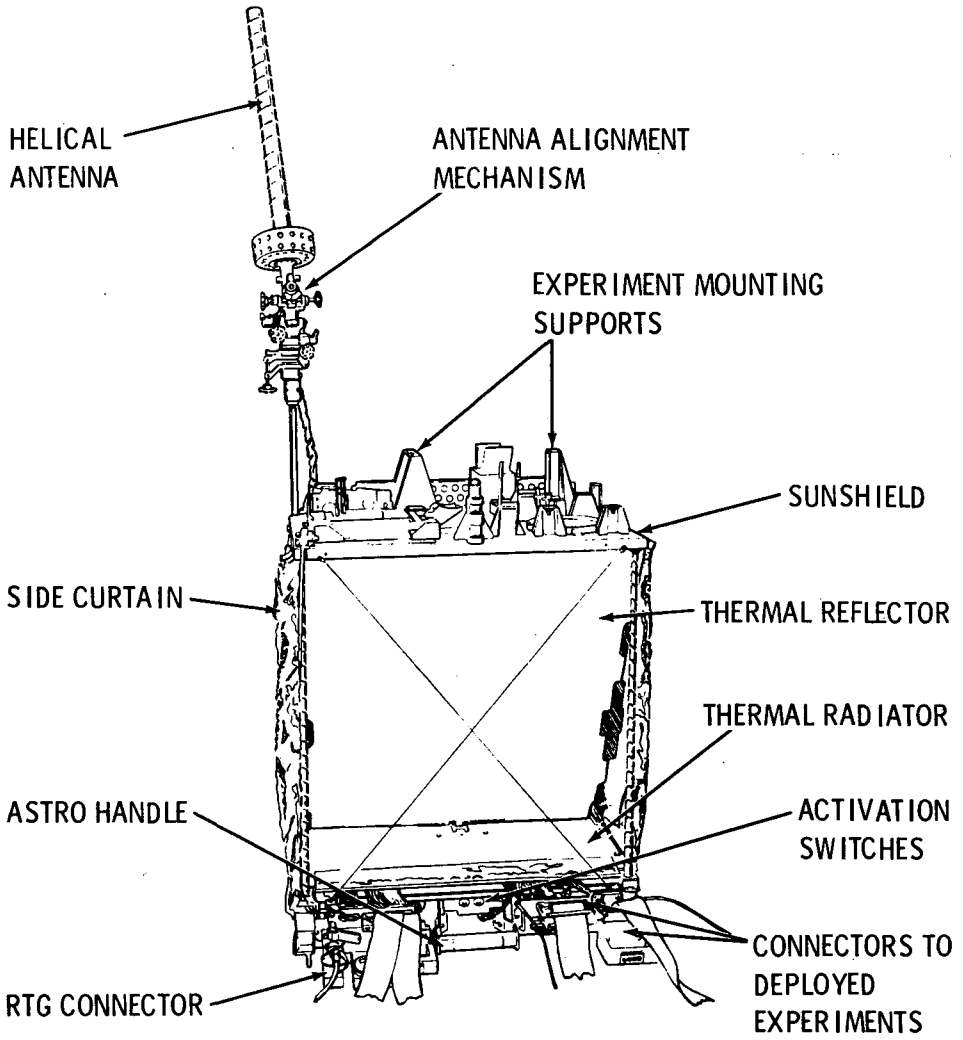
ALSEP COMMUNICATION CENTER



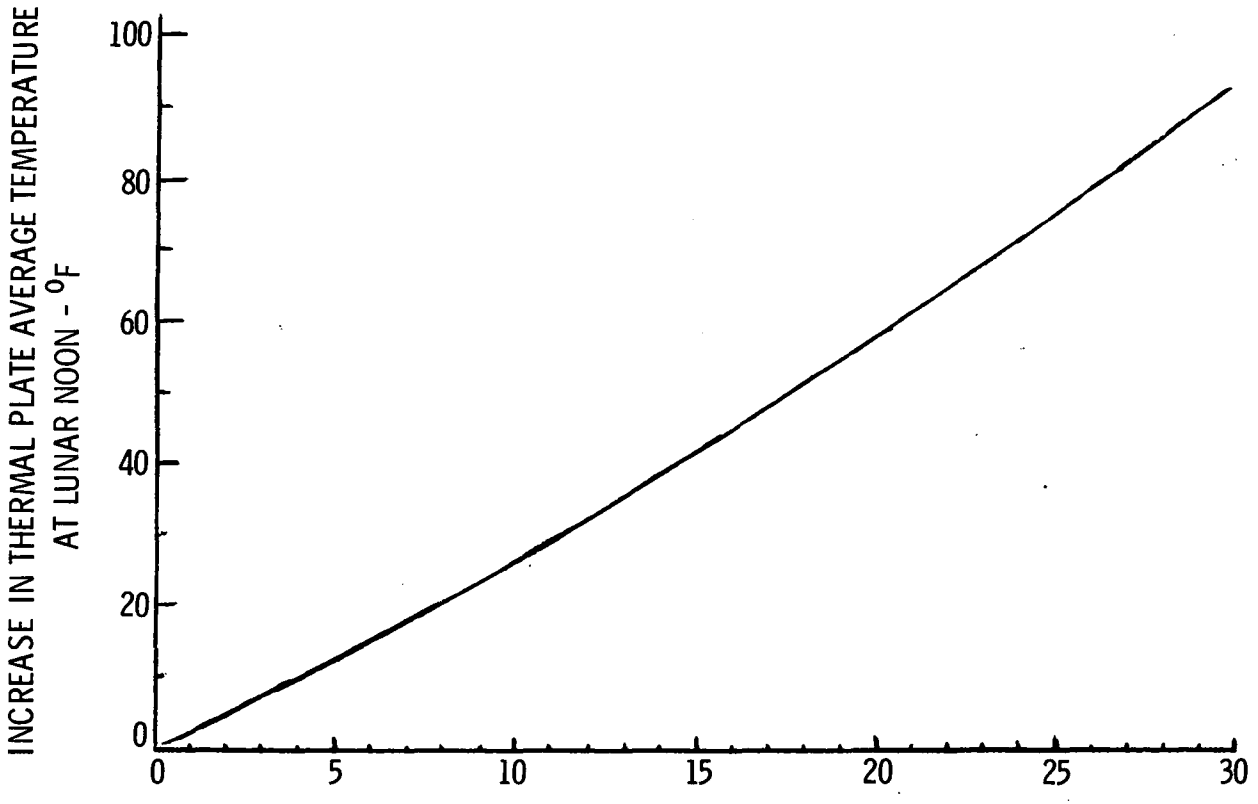
FEB 72 3270.1.22

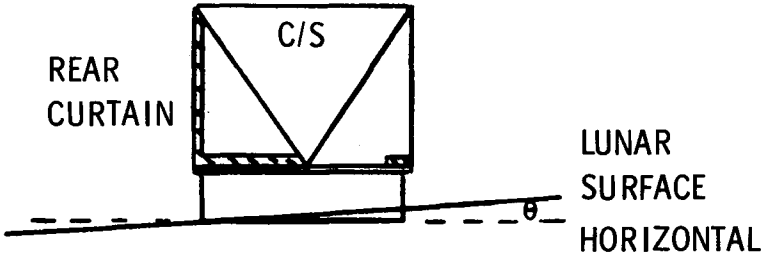
CENTRAL STATION DEPLOYED CONFIGURATION



APR. 72 3270.1.23

EFFECT OF SURFACE SLOPE ON ELECTRONICS TEMPERATURES





FEB 72 3270.1.24

THREE YEARS OF ALSEP OPERATION

	APOLLO 11	APOLLO 12	APOLLO 14	APOLLO 15	APOLLO 16
DEPLOYMENT DATA	JULY '69	NOV '69	FEB '71	JULY '71	APRIL '72
NO. OF EXPERIMENTS	2	5	6	7	4
PRESENTLY OPERATING	NO	YES	YES	YES	YES
DESIGN LIFE (DAYS)	14	365	365	365	365
OPERATION TO DATE*					
- DAYS	71	985	542	366	101
- LUNATIONS	5	34	19	13	4
- YEARS	0.2	2.7	1.5	1.0	0.3
- COMMANDS EXECUTED	1531	14,137	6783	9822	1731

NOTE: EACH ALSEP PROVIDES 9 MILLION MEASUREMENTS PER DAY

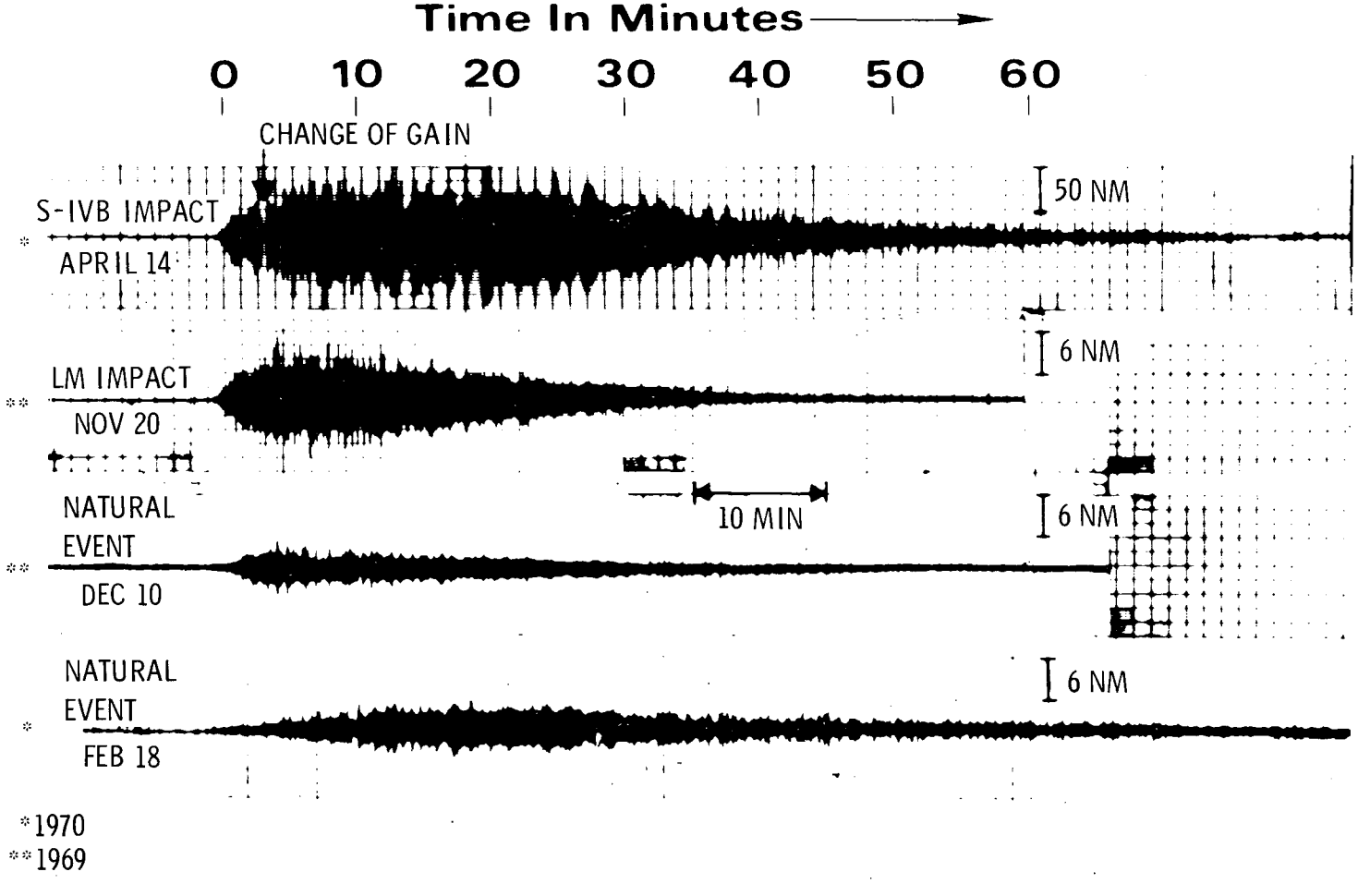
*AS OF 1 AUGUST 1972

FEB 72 3270.1.25

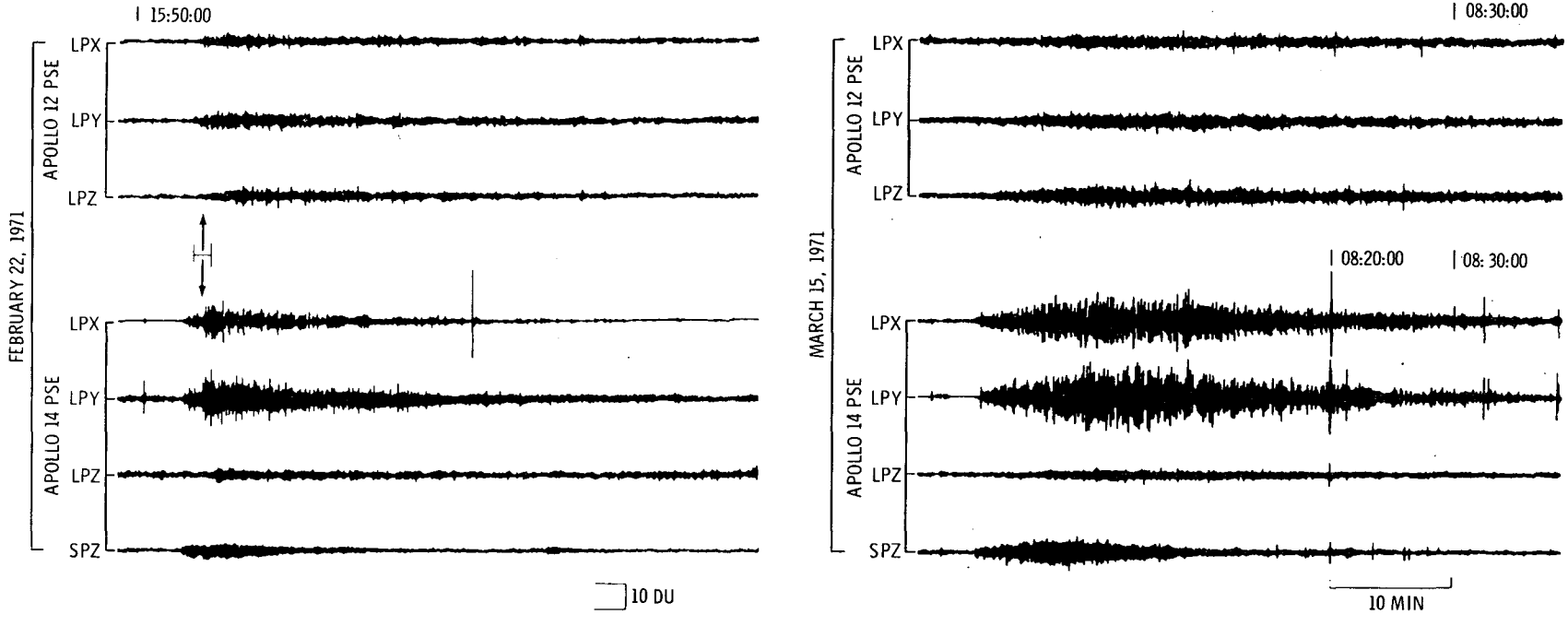
SCIENTIFIC ACHIEVEMENTS (PSE)

- PASSIVE SEISMIC EXPERIMENT (PSE)
  - LUNAR OUTER STRUCTURE IS ROCK CLUMPS, BUT THERE IS A CRUST AND MANTLE (LIKE EARTH) WITH CRUST THICKNESS OF 55 TO 70 KM
  - 2-5 MOONQUAKES PER MONTH – USUALLY NEAR PERIGEE – AT DEPTHS OF 800 KM (DEEPER THAN MOST EARTHQUAKES)
  - DAILY METEOROID IMPACTS
  - UNEXPECTED STRONG "RINGING" FROM MAN-MADE IMPACTS

TYPICAL SEISMIC DATA



MOONQUAKE AND METEOROID IMPACT



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SCIENTIFIC ACHIEVEMENTS (SIDE AND CCIG)

- SUPRATHERMAL ION DETECTOR EXPERIMENT (SIDE)
  - DETECTS SOLAR STORMS AND MAN-MADE IMPACTS, AS EXPECTED
  - ONE GAS CLOUD, BELIEVED TO BE CORRELATED WITH MOONQUAKE ON 7 MARCH 1971, SHOWS EVIDENCE OF WATER
  - UNEXPECTED ION CONCENTRATIONS AT LUNAR SUNRISE AND SUNSET, AND IN GEOMAGNETIC TAIL TRANSITION REGION (FLOWING DOWNSTREAM WITH SOLAR WIND)
- COLD CATHODE ION GAGE (CCIG)
  - NEUTRAL PARTICLE CONCENTRATION VARIES FROM 10^7 ATOMS/CC DURING DAY TO 2×10^5 ATOMS/CC AT NIGHT
  - FREQUENT TRANSIENT INCREASES
  - TRANSIENTS UP TO 2×10^7 WITHIN TWO MINUTES OF SUNRISE

SCIENTIFIC ACHIEVEMENTS (SWS AND LSM)

- SOLAR WIND SPECTROMETER (SWS)
  - BASIC BEHAVIOR OF SOLAR WIND

    SAME AS FREE-SPACE OUTSIDE EARTH'S MAGNETIC TAIL

    SLIGHTLY PERTURBED IN GEOMAGNETIC TRANSITION REGION

    DOES NOT PENETRATE TO CENTER OF TAIL
  - SWS UNEXPECTEDLY DETECTED GAS CLOUD FROM APOLLO 13 S-IVB IMPACT
- LUNAR SURFACE MAGNETOMETER (LSM)
  - 38 GAMMA STEADY FIELD AT APOLLO 12 SITE; 6 GAMMA AT APOLLO 15 SITE
  - TEMPORAL CORRELATION WITH MAGNETOMETER ON EXPLORER 35 ORBITER INDICATES ELECTRICAL CURRENTS DEEP WITHIN MOON
  - CORRESPONDING TEMPERATURE PROFILE ESTIMATES:

    810^{0}K IN SHELL AT 0.6 LUNAR RADIUS

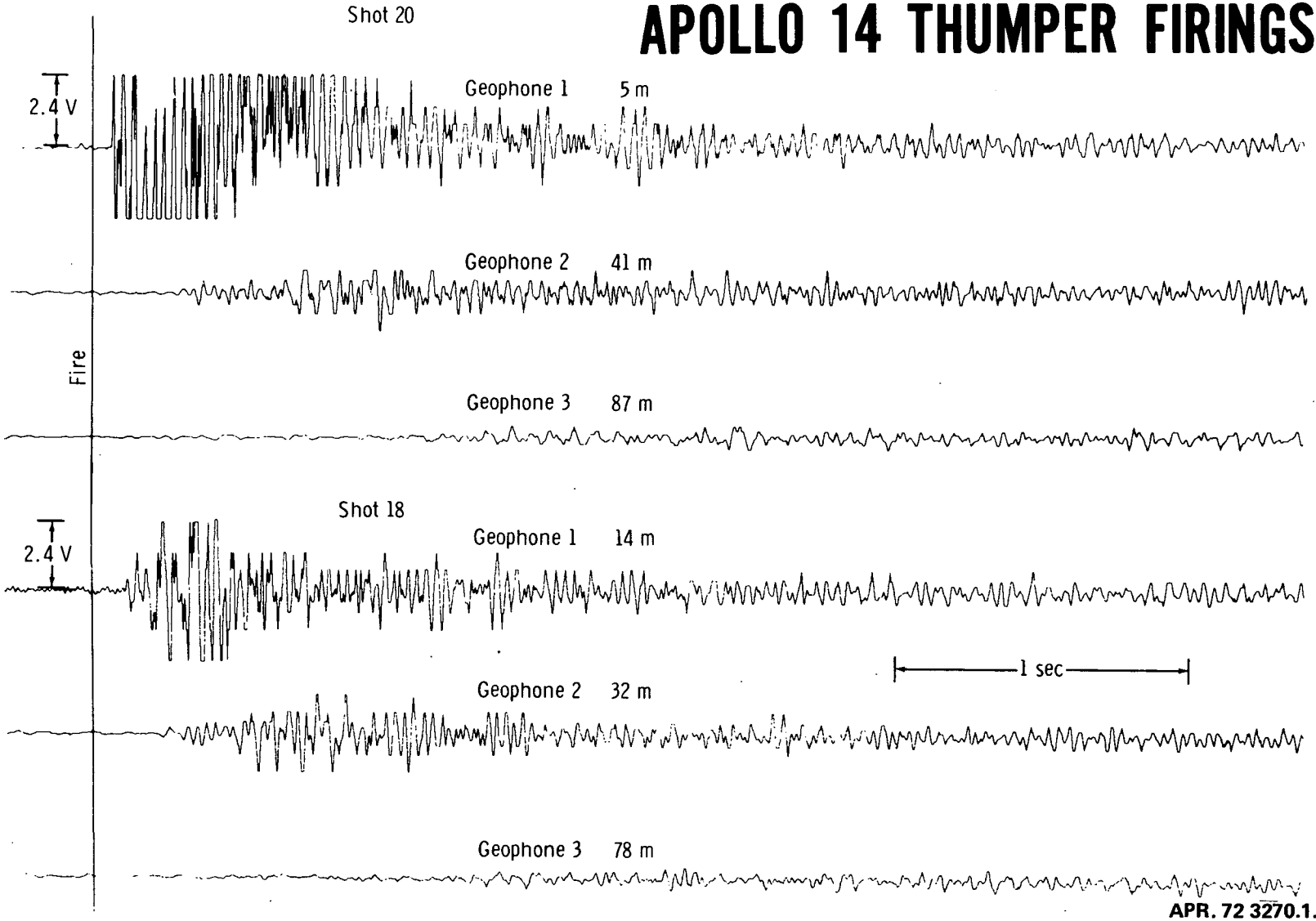
    1240^{0}K AT CORE (3000^{0} TO 5000^{0}K AT CORE OF EARTH)

SCIENTIFIC ACHIEVEMENTS (ASE AND CPLEE)

- ACTIVE SEISMIC EXPERIMENT (ASE)
  - 104 METER/SEC SEISMIC VELOCITY AGREES WITH PSE DATA
  - 8.5 METER SURFACE LAYER (REGOLITH) AT APOLLO 14 SITE

- CHARGED PARTICLE LUNAR ENVIRONMENT EXPERIMENT (CPLEE)
  - DETECTS LARGE CHANGES IN SOLAR WIND FLUX
  - LOW ENERGY PHOTO-ELECTRONS DETECTED DURING LUNAR DAY
  - UNEXPECTED DETECTION OF ELECTRONS WITH TERRESTRIAL AURORAE BAND ENERGIES IN MAGNETOSPHERIC TAIL

SEISMIC SIGNALS PRODUCED BY APOLLO 14 THUMPER FIRINGS



APR. 72 3270.1.32

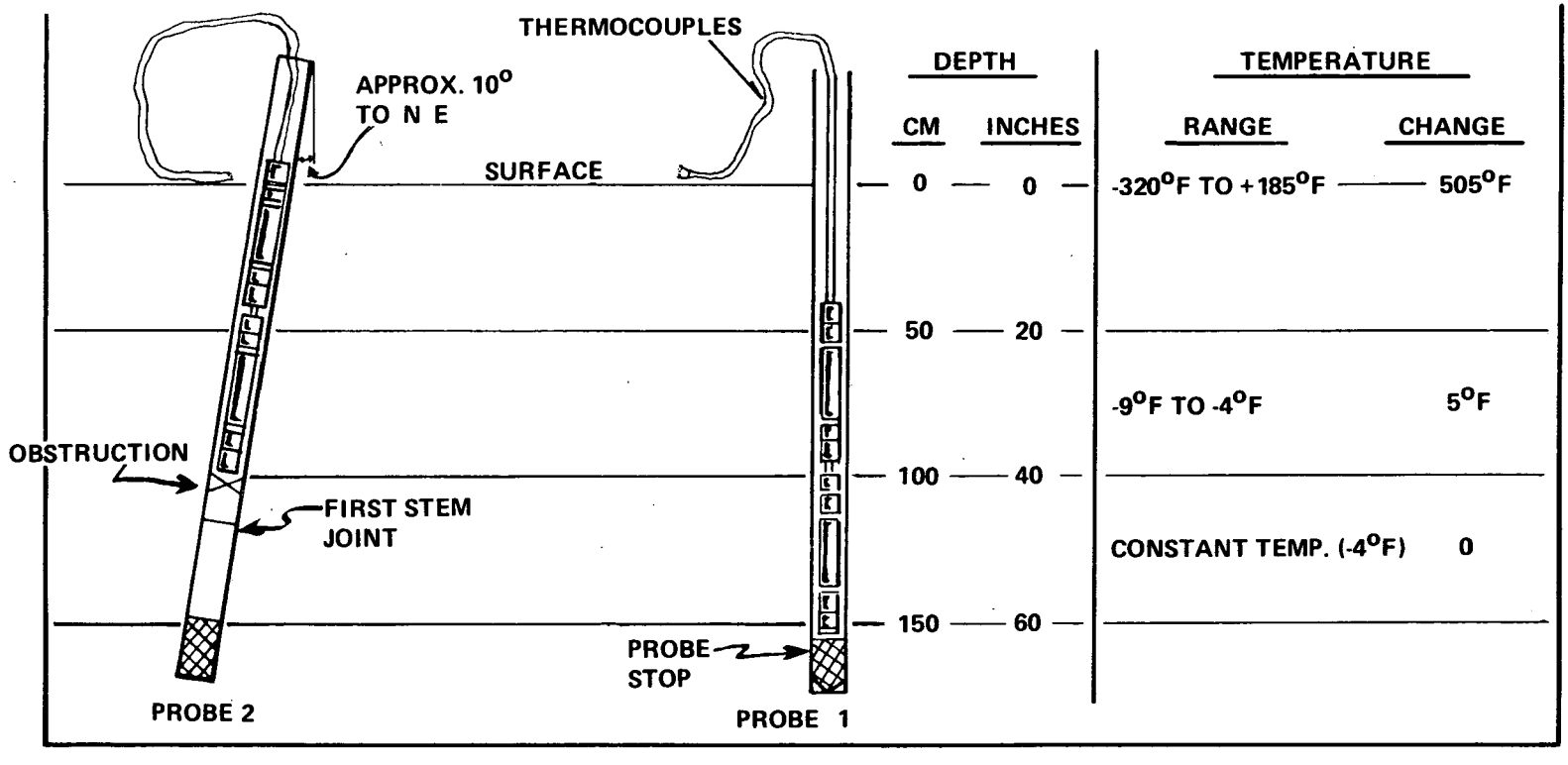
SCIENTIFIC ACHIEVEMENTS (HFE AND LRRR)

- HEAT FLOW EXPERIMENT (HFE)
  - LIMITED PENETRATION HAS NOT COMPROMISED ACHIEVEMENT OF SCIENTIFIC OBJECTIVES
  - PROBE DATA INDICATE SURFACE LAYER IS IDEAL THERMAL BLANKET

NIGHT SURFACE TEMP	76^{0}K (-320^{0}F)
DAY SURFACE TEMP	358^{0}K ($+185^{0}$F)
SUBSURFACE AT 1.5 M VIRTUALLY CONSTANT AT	253^{0}K (-4^{0}F)

  - HEAT FLOW APPROX 3.3×10^{-6} WATT/CM^2 (1/2 THAT OF EARTH)
  - CONDUCTIVITY AT 1.0 TO 1.5M DEPTH IS BETWEEN 1.4 AND 2.5×10^{-4} WATT/CM-^{0}K (7 TO 10 TIMES GREATER THAN AT SURFACE)
  - DATA SUPPORT MAGNETOMETER FINDINGS
- LASER-RANGING RETRO-REFLECTOR (LRRR)
  - PRELIMINARY RESULTS FROM THREE REFLECTORS INDICATE LARGE-SCALE LUNAR SURFACE "WARPING"

HFE PROBE EMPLACEMENT ON APOLLO 15



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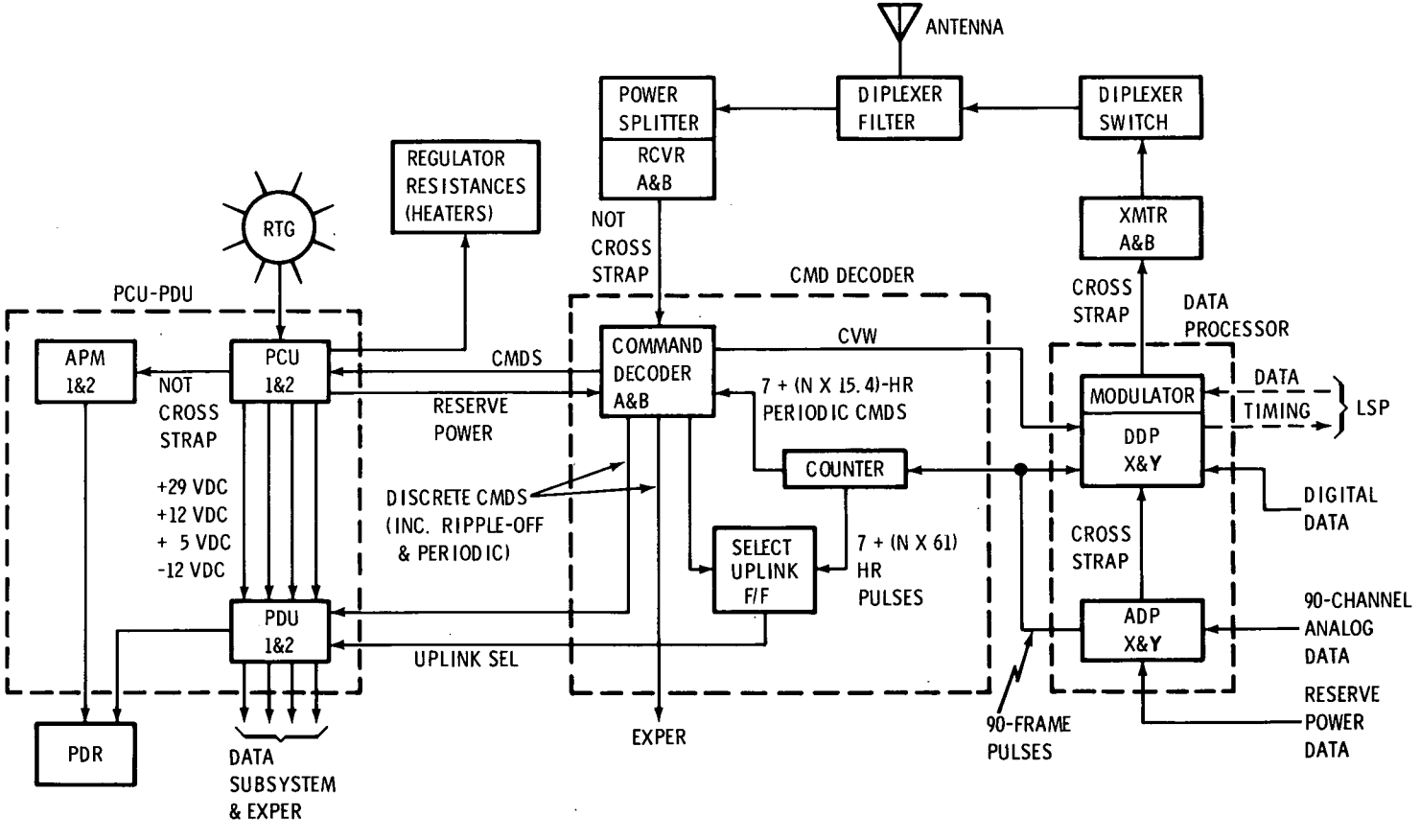
POWER AND DATA SUBSYSTEMS

(CENTRAL STATION FUNCTIONS)

POWER AND DATA FUNCTIONS



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POWER AND DATA COMPONENTS

RADIOISOTOPE THERMOELECTRIC GENERATOR (RTG)
- SUPPLIES ALL ELECTRICAL POWER FOR ALSEP

POWER CONDITIONING UNIT (PCU) AND POWER DISTRIBUTION UNIT (PDU)
- CONVERTS, REGULATES, AND DISTRIBUTES POWER FOR ALSEP COMPONENTS AND EXPERIMENTS WITH SWITCHING AS COMMANDED BY MSFN
- PROVIDES AUTOMATIC POWER MANAGEMENT (APM) AND DIVIDES SURPLUS POWER BETWEEN INTERNAL HEATERS AND EXTERNAL POWER DISSIPATION RESISTORS (PDR) FOR CENTRAL STATION THERMAL CONTROL

ANTENNA
- RECEIVES AND RADIATES UPLINK/DOWNLINK SIGNALS
- MOUNTED ON ANTENNA AIMING MECHANISM FOR POINTING TOWARD THE EARTH

DIPLEXER FILTER
- CONNECTS RECEIVER AND TRANSMITTER TO ANTENNA WITH REQUIRED ISOLATION

COMMAND RECEIVER (RCVR)
- ACCEPTS AND DEMODULATES EARTH-TO-MOON UPLINK SIGNAL

COMMAND DECODER
- PROCESSES RECEIVED SIGNALS AND ISSUES COMMANDS TO ALSEP EQUIPMENT

DATA PROCESSOR
- COLLECTS AND PROCESSES SCIENTIFIC AND ENGINEERING DATA IN SUITABLE FORMAT FOR DOWNLINK TRANSMISSION; USES ANALOG DATA PROCESSOR (ADP) TO MULTIPLEX AND CONVERT ANALOG SIGNALS TO DIGITAL; DIGITAL DATA PROCESSOR (DDP) COLLECTS AND FORMATS THE TOTAL DATA OUTPUT
- SUPPLIES SIGNAL CONDITIONING TO ANALOG LINES, AS REQUIRED

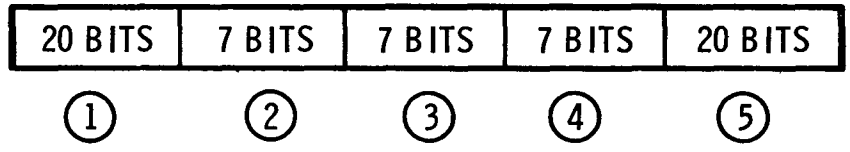
TRANSMITTER (XMTR)
- GENERATES MOON-TO-EARTH DOWNLINK SIGNAL

DIPLEXER SWITCH
- CONNECTS ONE OF THE TWO REDUNDANT TRANSMITTERS TO THE ANTENNA

COMMAND FORMAT

COMMAND FORMAT

- A COMMAND FROM THE MSFN CONSISTS OF THE FOLLOWING:
  - UPLINK FREQUENCY 2119 MHz
  - A 2 KHz SUBCARRIER PHASE MODULATED WITH A 1 KHz SUBCARRIER TO PRODUCE 61 SERIAL BITS (1000 BITS PER SECOND)



(1) PREAMBE: ALL ONES

(2) ADDRESS: 1101001 (OCTAL 151)*

(3) COMMAND COMPLEMENT

(4) TRUE COMMAND

(5) TIMING (EXECUTION): ALL ONES

* NOTE SINGLE ADDRESS FOR ARRAY E
(OTHER ALSEP'S EACH HAVE TWO ADDRESSES)

- OF THE 128 POSSIBLE COMBINATIONS (7 BITS) ONLY 79 ARE USED AS FUNCTIONAL COMMANDS ON ARRAY E

COMMAND INVENTORY APOLLO 17 ALSEP (ARRAY E)

NOTES: (N/INV) = NOT IN INVENTORY; (*) = USED ON OTHER ALSEP's; (CRIT) = CRITICAL;
A = DECODER A; B = DECODER B; C = COMMON DECODER

000	NO CMD (N/INV)	040	TEST (N/INV)	100	TEST (N/INV)	140	HFE MODE/HK SEL
001	TEST (N/INV)	041	LMS OFF	101	(N/INV) (*)	141	HFE SEQ/FUL SEL
002	TEST (N/INV)	042	LEAM ON	102	(N/INV) (*)	142	HFE SEQ/P1 SEL
003	LSP FMT ON	043	LEAM STBY	103	(N/INV) (*)	143	HFE SEQ/P2 SEL
004	TEST (N/INV)	044	LEAM OFF	104	PER CMDS EN	144	HFE LOAD 1 (* ADD 16 B)
005	DP FMT ON	045	HFE ON	105	PER CMDS INH	145	HFE LOAD 2
006	NBR	046	HFE STBY	106	(N/INV) (*)	146	HFE LOAD 3
007	LBR	047	COMP 12 A (N/INV)	107	ADP RPR BKUP	147	COMP 12 B (N/INV)
010	TEST (N/INV)	050	HFE OFF	110	ADP/ULK RPR PRI	150	(N/INV) (*)
011	(N/INV) (*)	051	ADDRESS 13 B (N/INV)	111	LEAM CAL	151	ADDRESS 17 C (N/INV)
012	XMTR A ON	052	LSG ON	112	LEAM MIR CVR GO(* COMP 14 B)	152	HFE HTR STEP (* COMP 14 A)
013	XMTR A OFF	053	LSG STBY	113	APM 2 OFF	153	SPARE 2 (*)
014	XMTR B OFF	054	LSG OFF	114	LEAM SEN CVR GO	154	SPARE 3
015	XMTR B ON	055	LSP ON	115	APM 2 ON (* COMP 16 A)	155	SPARE 4
016	ADDRESS 11/15 B (N/INV)	056	LSP STBY	116	ADDRESS 11/15 A (N/INV)	156	LSP PULSES ON
017	PDR 1 ON	057	LSP OFF	117	LEAM HTR STEP	157	TEST/SPARE (N/INV)
020	TEST (N/INV)	060	PCU 1 SEL	120	PCU AUTO 1 SW	160	SPARE 5
021	PDR 1 OFF	061	COMP 11/15 A (N/INV)	121	PCU AUTO 2 SW	161	COMP 15 B (N/INV)
022	PDR 2 ON	062	PCU 2 SEL (* ADD 16 A)	122	RCVR/DEC SW	162	LSP PULSES OFF
023	PDR 2 OFF	063	LSG HTR ON	123	LMS LOAD 1	163	LSP GAIN NORM
024	ADP X SEL	064	LSG HTR OFF	124	LMS LOAD 2	164	LSP GAIN LOW
025	ADP Y SEL (* ADD 14 A)	065	ADDRESS 14 B (N/INV) (*)	125	LMS LOAD 3	165	(N/INV) (*)
026	COMP 17 C (N/INV)	066	(N/INV) (*)	126	COMP 13 B (N/INV)	166	(N/INV) (*)
027	APM 1 ON	067	LSG CMD EX	127	LMS LOAD 4	167	TEST SPARE (N/INV)
030	ADDRESS 12 B (N/INV)	070	LSG DECODER ON	130	ADDRESS 12 A (N/INV)	170	LSP GEO CAL
031	APM 1 OFF	071	LSG DECODER OFF	131	(N/INV) (*)	171	SPARE 6
032	RIPPLE-OFF RST (CRIT)	072	LSG STEP UP	132	LMS LOAD 5	172	SPARE 7
033	COMP 16 B (N/INV) (*)	073	(N/INV) (*)	133	LMS LOAD 6	173	TEST/SPARE (N/INV)
034	DDP X SEL	074	LSG STEP DN	134	LMS CMD EX	174	RCVR/DEC SW INH
035	DDP Y SEL	075	(N/INV) (*)	135	HFE MODE/G SEL	175	TEST/SPARE (N/INV)
036	LMS ON	076	(N/INV) (*)	136	HFE MODE/LK SEL	176	TEST/SPARE (N/INV)
037	LMS STBY	077	TEST (N/INV)	137	TEST (N/INV)	177	NO CMD (N/INV)

DOWNLINK DATA FORMAT

- DOWNLINK FREQUENCY 2275.5 MHz
- NORMAL OPERATION: DATA PROCESSOR (DP) FORMAT AT 1060 BITS PER SECOND IS 64-WORD FRAME OF 10-BIT WORDS (640 BITS PER FRAME)
- THE SAME DP FORMAT AT 530 BITS PER SECOND CAN BE SELECTED BY COMMAND
- LSP FORMAT, SELECTED BY COMMAND, IS COMPLETELY DIFFERENT (1800 BITS PER FRAME) AT EITHER 3533.3 BITS PER SECOND (NORMAL) OR 1060 BITS PER SECOND (LOW)
- ALL DATA TRANSMITTED WITH MOST SIGNIFICANT BIT (MSB) FIRST
- DATA PROCESSOR FORMAT:

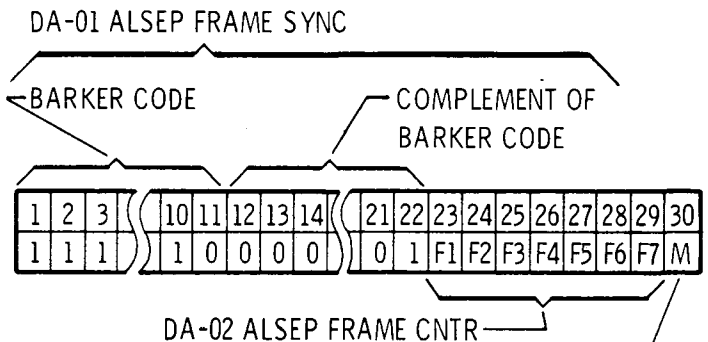
1 X	2 X	3 X	4 G	5 A	6 G	7 CV	8 G
9 B	10 G	11 B	12 G	13 B	14 G	15 B	16 G
17 A	18 G	19 A	20 G	21 A	22 G	23 HF	24 G
25 G	26 G	27 G	28 G	29 G	30 G	31 J	32 G
33 HK	34 G	35 G	36 G	37 G	38 G	39 J	40 G
41 B	42 G	43 B	44 G	45 B	46 G	47 B	48 G
49 B	50 G	51 B	52 G	53 B	54 G	55 B	56 G
57 B	58 G	59 B	60 G	61 B	62 G	63 RP	64 G

LEGEND:

X	CONTROL WORD
A	LUNAR MASS SPECTROMETER EXPERIMENT
CV	COMMAND VERIFICATION WORD
G	LUNAR SURFACE GRAVIMETER EXPERIMENT
HF	HEAT FLOW EXPERIMENT
J	LUNAR EJECTA AND METEORITE EXPERIMENT
HK	HOUSEKEEPING (ENGINEERING) DATA
RP	RESERVE POWER
B	BLANK

CONTROL WORDS AND COMMAND VERIFICATION

CONTROL WORDS
(ALSEP WORDS 1, 2, AND 3)



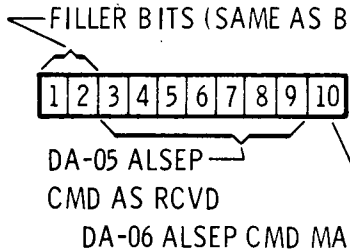
MODE BIT, DEFINED AS FOLLOWS:

FRAME	MODE BIT	MEANING
1	1	NORMAL BIT RATE
2	1	LOW BIT RATE
3	X MSB	DATA PROC ID NO.
4	X	
5	X	
6	NONE	NONE
.	"	"
.	"	"
.	"	"
89	"	"
0	NONE	NONE

DA-03 ALSEP BIT RT ID

DA-04 ALSEP ID: 1 0 0 — DECIMAL 4 FOR APOLLO 17 ALSEP

CMD VERIFICATION
(ALSEP WORD 7)



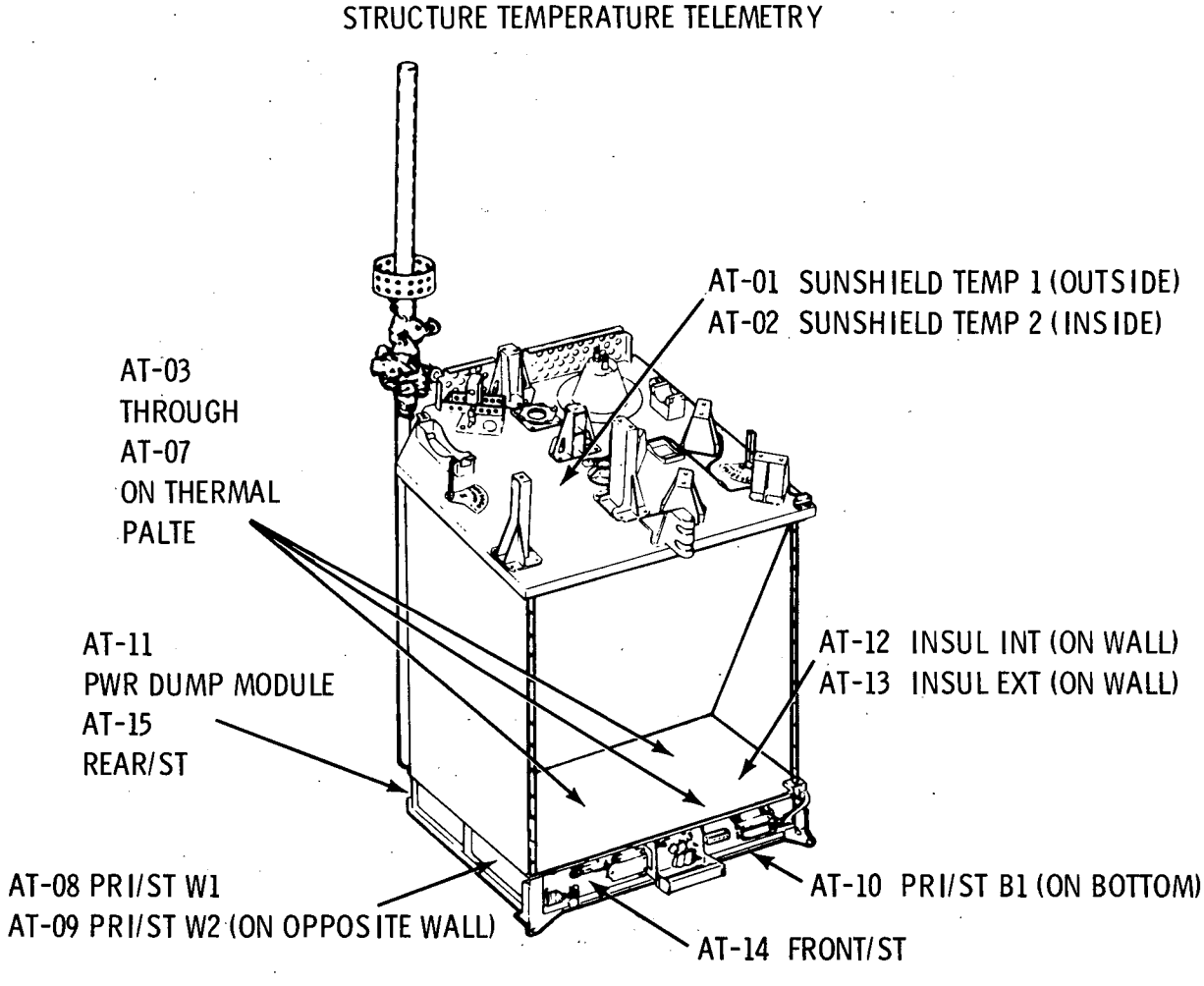
ONE WORD SAMPLE AS EACH COMMAND IS RECEIVED AT ALSEP, AT OTHER TIMES THE SAMPLE IS ALL ZEROS

ANALOG DATA COMMUTATION

- ALSEP WORD 33 CONTAINS 90-CHANNEL COMMUTATED DATA, PRIMARILY ENGINEERING (HOUSEKEEPING) PARAMETERS, PROCESSED BY THE ADP
- ALSEP WORD 63 CONTAINS RESERVE POWER, ALSO PROCESSED BY THE ADP, BUT NOT COMMUTATED
- ADP OUTPUTS ARE 8-BIT BINARY (MSB FIRST) WITH TWO FILLER ZEROS AHEAD OF THE OUTPUT IN THE 10-BIT ALSEP WORD

HK	CODE	DESCRIPTION
1	AB-18	UPLINK SW STA
2	AE-01	ADC 0.25 CAL
3	AE-02	ADC 4.75 CAL
4	AT-03	PLATE TEMP 1
5	AE-04	PCU IN AMPS
6	AR-01	HOT FRAME 1
7	AR-04	COLD FRAME 1
8	AE-03	PCU 1 VOLTS
9	AB-08	RCVR A 1 KC
10	AG-02	LSG TIDE
11	AE-23	PCU 2 VOLTS
12	AB-04	EXPER 1/2 STA
13	AB-16	PC AUTO SW STA
14	AB-05	EXPER 3/4 STA
15	AT-10	PRI/ST B1 TEMP
16	AT-40	RCVR A CASE TEMP
17	AB-09	RCVR B 1 KC
18	AT-23	XMTR A PA TEMP
19	AT-24	XMTR A CASE TEMP
20	AE-07	+29 VOLTS
21	AE-19	RCVR A IN DBM
22	AE-18	XMTR B +23 VOLTS
23	AG-03	LSG FREE MODE
24	AG-07	LSG OSC AMP
25	AP-01	LSP ELECT TEMP
26	AB-06	UPLINK STA
27	AT-01	SUNSHIELD TEMP 1
28	AT-04	PLATE TEMP 2
29	AH-01	HFE +5 VOLTS
30	AE-24	RESERVE AMPS
31	AT-25	XMTR B PA TEMP
32	AT-26	XMTR B CASE TEMP
33	AT-27	DP BASE TEMP
34	AT-28	DP INT TEMP
35	AE-21	APM 1 AMPS
36	AE-20	RCVR B IN DBM
37	AR-02	HOT FRAME 2
38	AG-08	LSG +15 VOLTS
39	AG-01	LSG SEISMIC
40	AM-01/16	LMS 16 CHANNEL
41	AM-41	LMS ELECT TEMP
42	AT-02	SUNSHIELD TEMP 2
43	AT-05	PLATE TEMP 3
44	AM-44	LMS SWEEP VOLTS
45	AH-02	HFE -5 VOLTS
46	AT-14	FRONT/ST TEMP
47	AT-15	REAR/ST TEMP
48	AT-31	DEMOD B TEMP
49	AT-32	DEMOD A TEMP
50	AE-09	+12 VOLTS
51	AE-15	XMTR A REG AMPS
52	AR-03	HOT FRAME 3
53	AG-09	LSG -15 VOLTS
54	AG-06	LSG MASS CHANGE
55	AH-03	HFE +15 VOLTS
56	AE-22	APM 2 AMPS
57	AH-06	HFE HTR/HK STA
58	AT-06	PLATE TEMP 4
59	AT-08	PRI/ST W1 TEMP
60	AT-12	INSUL INT TEMP
61	AT-41	APM 1 TEMP
62	AT-34	PDU 1 TEMP
63	AT-35	PDU 2 TEMP
64	AT-42	APM 2 TEMP
65	AE-10	+5 VOLTS
66	AE-16	XMTR B REG AMPS
67	AR-05	COLD FRAME 2
68	AG-04	LSG HTR BOX TEMP
69	AG-10	LSG +5 VOLTS
70	AB-10	DDP STA
71	AT-07	PLATE TEMP 5
72	AT-13	INSUL EXT TEMP
73	AB-11	EXPER 5 STA
74	AH-04	HFE -15 VOLTS
75	AH-07	HFE HTR/LK STA
76	AB-13	APM STA
77	AT-38	PCU 1 REG TEMP
78	AT-39	PCU 2 REG TEMP
79	AE-11	-12 VOLTS
80	AB-14	PDR STA
81	AE-17	XMTR A +23 VOLTS
82	AR-06	COLD FRAME 3
83	AJ-01/05	LEAM 1-5 CHANNEL
84	AJ-06/10	LEAM 6-10 CHANNEL
85	AJ-11	LEAM SURVIVAL TEMP
86	AB-15	PER CMD EN/INH
87	AT-09	PRI/ST W2 TEMP
88	AT-11	PWR DUMP TEMP
89	AG-05	LSG PRESSURE
90	AB-17	ADP STA

STRUCTURE TEMPERATURE TELEMETRY



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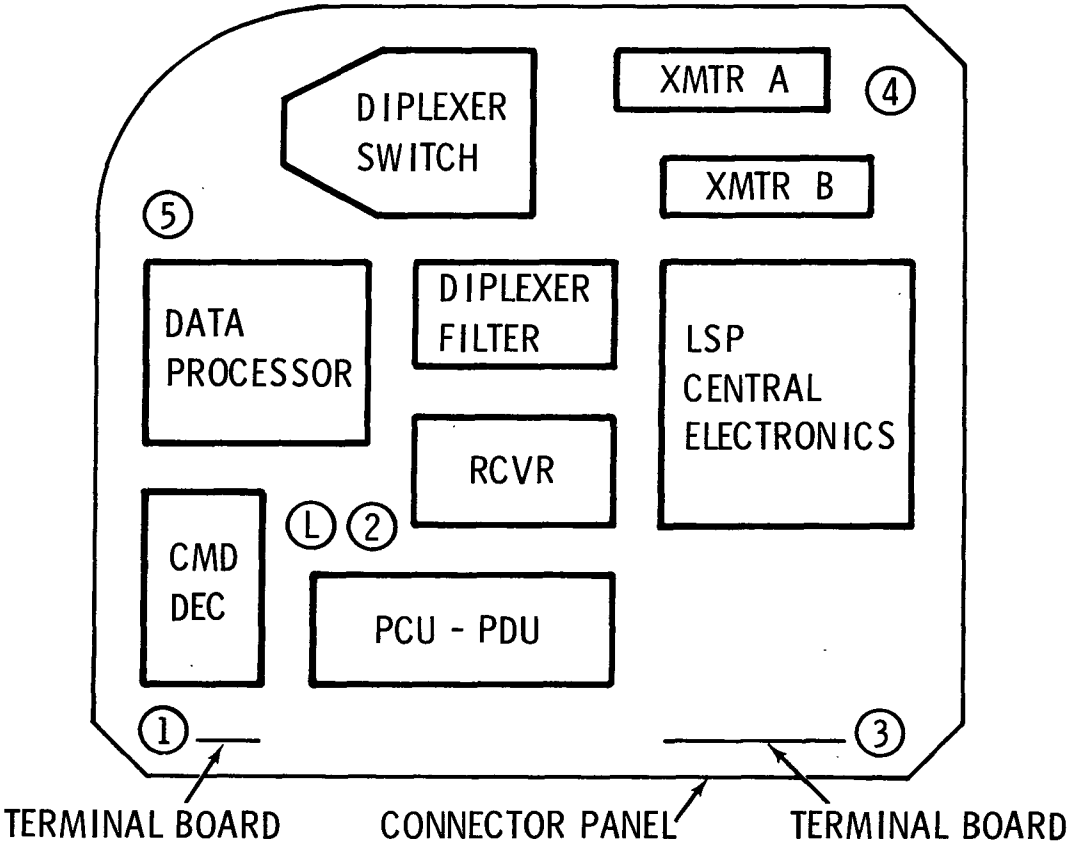
ELECTRONICS COMPARTMENT

◯ THERMAL PLATE TEMP SENSORS (TM)

Ⓛ USED IN LSP MODE



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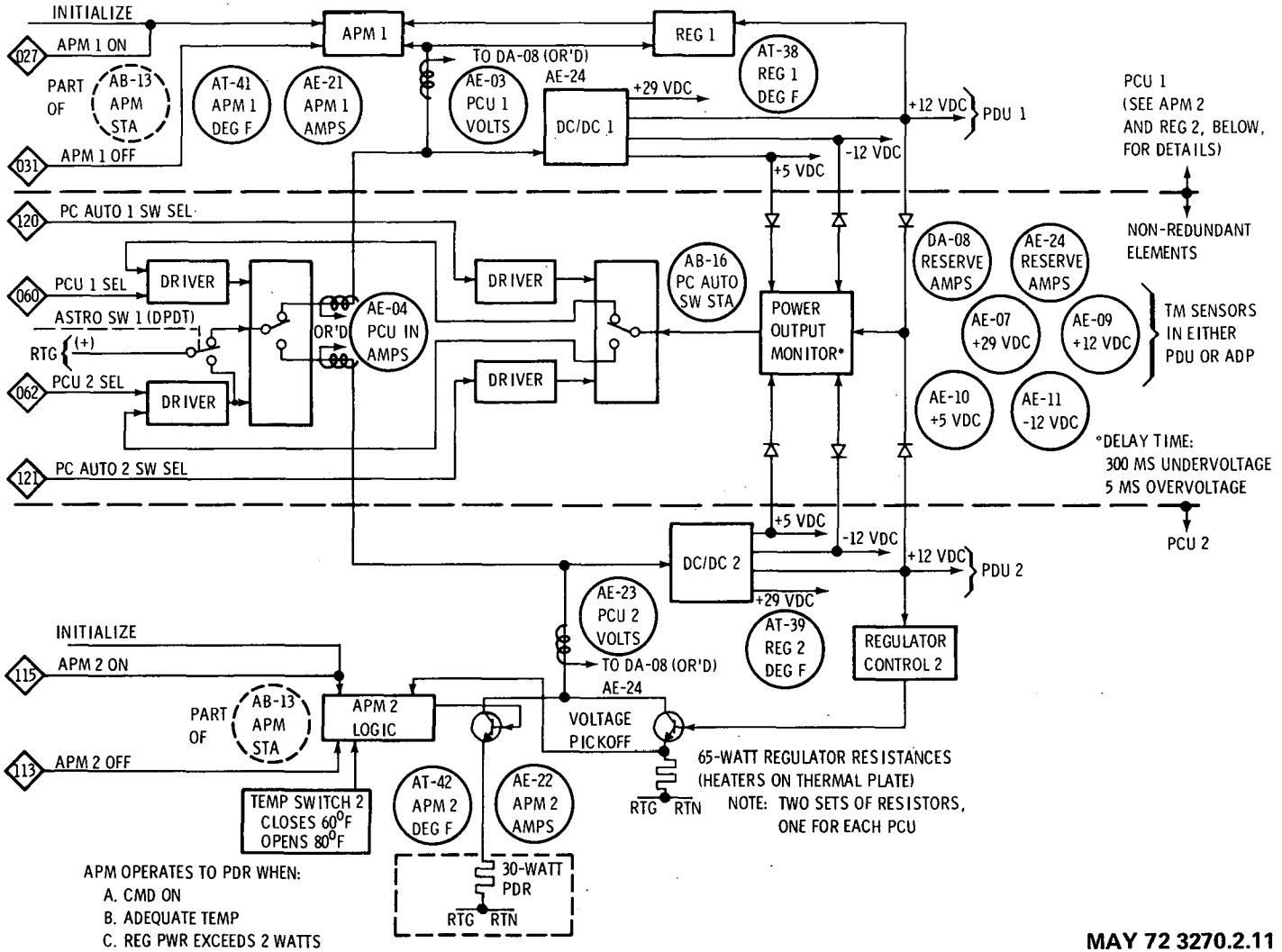
PCU/APM FUNCTIONS



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PCU COMMANDS

OCTAL CMD NUMBER

- 060 PCU 1 SEL

  THIS CMD ACTUATES A LATCHING RELAY IN THE PCU TO THE POSITION THAT APPLIES 16.3 ± 0.5 VDC FROM THE RTG TO PCU 1 AND DISCONNECTS PCU 2 FROM THE RTG. IN THIS POSITION, PCU 1 PROVIDES POWER FOR THE ALSEP SYSTEM VIA PDU 1. REPEATED APPLICATION OF CMD 060 HAS NO FURTHER EFFECT. IN NORMAL OPERATION, CMD 121 SHOULD BE TRANSMITTED BEFORE CMD 060, UNLESS PC AUTO 2 SWITCH IS ALREADY SELECTED. PCU 1 IS PRESET TO BE ENERGIZED AT INITIAL LUNAR ACTIV ATION.

- 062 PCU 2 SEL

  THIS CMD ACTUATES A LATCHING RELAY IN THE PCU TO THE POSITION THAT APPLIES 16.3 ± 0.5 VDC FROM THE RTG TO PCU 2 AND DISCONNECTS PCU 1 FROM THE RTG. IN THIS POSITION, PCU 2 PROVIDES POWER FOR THE ALSEP SYSTEM VIA PDU 2. IN NORMAL OPERATION, CMD 120 SHOULD BE TRANSMITTED BEFORE CMD 062, UNLESS PC AUTO 1 SWITCH IS ALREADY SELECTED. REPEATED APPLICATION OF CMD 062 HAS NO FURTHER EFFECT.

- 120 PC AUTO 1 SW SEL

  THIS CMD ACTIVATES A RELAY IN THE PCU TO THE POSITION THAT ENABLES AUTOMATIC SWITCHOVER FROM PCU 2 TO PCU 1, IF ANY ONE OF THE +12 VDC +5 VDC, OR -12 VDC LINES GOES OVERVOLTAGE LONGER THAN 5 MS OR UNDER-VOLTAGE LONGER THAN 300 MS. IN THIS POSITION, AUTOMATIC SWITCHOVER FROM PCU 1 TO PCU 2 IS INHIBITED. PC AUTO 1 SW SEL IS PRESET TO BE ENERGIZED AT INITIAL LUNAR ACTIVATION; HENCE, IF NORMAL START-UP OCCURS, CMD 121 SHOULD BE TRANSMITTED AS EARLY AS POSSIBLE. RE-PEATED APPLICATION OF CMD 120 HAS NO FURTHER EFFECT. IN NORMAL OPER-ATION, CMD 120 SHOULD BE TRANSMITTED BEFORE CMD 062, UNLESS PC AUTO 1 SW IS ALREADY SELECTED. AN INTERNALLY GENERATED PCU SWITCHOVER IS AN ABNORMAL CONDITION REQUIRING CAUTION IN THE SUBSEQUENT USE OF CMD 120.

- 121 PC AUTO 2 SW SEL

  THIS CMD ACTUATES A RELAY IN THE PCU TO THE POSITION THAT ENABLES AUTOMATIC SWITCHOVER FROM PCU 1 TO PCU 2, IF ANY ONE OF THE +12 VDC, +5 VDC, OR -12 VDC LINES GOES OVERVOLTAGE LONGER THAN 5 MS OR UNDER VOLTAGE LONGER THAN 300 MS. IN THIS POSITION, AUTOMATIC SWITCHOVER FROM PCU 2 TO PCU 1 IS INHIBITED. REPEATED APPLICATION OF CMD 121 HAS NO FURTHER EFFECT. IN NORMAL OPERATION, CMD 121 SHOULD BE TRANSMITTED BEFORE CMD 060, UNLESS PC AUTO 2 SW IS ALREADY SELECTED. AN INTERNALLY GENERATED PCU SWITCHOVER IS AN ABNORMAL CONDITION REQUIRING CAUTION IN THE SUBSEQUENT USE OF CMD 121.

APM COMMANDS

OCTAL CMD NUMBER

- 027 APM 1 ON

  THIS CMD ACTUATES A FLIP-FLOP IN THE PCU TO THE POSITION THAT ALLOWS RTG INPUT POWER TO BE DIVERTED TO A 30-WATT, MAXIMUM, POWER DISSIPATION RESISTOR IF (1) THERE IS MORE THAN (2 TO 4, TBD) WATTS OF RESERVE POWER ON PCU 1, AND (2) THE THERMAL PLATE TEMP IS ABOVE THE TEMP SWITCH 1 VALUE: 60^{0}F CLOSE, 80^{0}F OPEN. THE APPLICATION OF POWER TO PCU 1 CAUSES INITIALIZATION IN THE APM 1 ON CONFIGURATION. REPEATED APPLICATION OF CMD 027 HAS NO FURTHER EFFECT.

- 031 APM 1 OFF

  THIS CMD ACTUATES A FLIP-FLOP IN THE PCU TO THE POSITION THAT INHIBITS APM 1 FROM DISSIPATING RTG POWER. REPEATED APPLICATION OF CMD 031 HAS NO FURTHER EFFECT.

- 115 APM 2 ON

  THIS CMD ACTUATES A FLIP-FLOP IN THE PCU, TO THE POSITION THAT ALLOWS RTG INPUT POWER TO BE DIVERTED TO A 30-WATT, MAXIMUM POWER DISSIPATION RESISISTOR IF (1) THERE IS MORE THAN (2 TO 4, TBD) WATTS OF RESERVE POWER ON PCU 2, AND (2) THE THERMAL PLATE TEMP IS ABOVE THE TEMP SWITCH 2 VALUE: 60^{0}F CLOSE, 80^{0}F OPEN. THE APPLICATION OF POWER TO PCU 2 CAUSES INITIALIZATION IN THE APM 2 ON CONFIGURATION. REPEATED APPLICATION OF CMD 115 HAS NO FURTHER EFFECT.

- 113 APM 2 OFF

  THIS CMD ACTUATES A FLIP-FLOP IN THE PCU TO THE POSITION THAT INHIBITS APM 2 FROM DISSIPATING RTG POWER. REPEATED APPLICATION OF CMD 113 HAS NO FURTHER EFFECT.

RTG/PCU/APM TELEMETRY

THE FOLLOWING PARAMETERS ARE SENSED IN THE RTG, WITH SIGNAL CONDITIONING IN THE DATA PROCESSOR:

- AR-01 HOT FRAME 1 TEMP, DEG F
- AR-02 HOT FRAME 2 TEMP, DEG F
- AR-03 HOT FRAME 3 TEMP, DEG F
- AR-04 COLD FRAME 1 TEMP, DEG F
- AR-05 COLD FRAME 2 TEMP, DEG F
- AR-06 COLD FRAME 3 TEMP, DEG F

THE FOLLOWING PARAMETERS ARE SENSED IN THE PCU/APM, WITH SIGNAL CONDITIONING IN THE DATA PROCESSOR (MEASUREMENT IS ABSENT IF PCU/APM IS OFF):

- AT-38 REG 1 TEMP, DEG F (NEAR THE PCU 1 REGULATOR TRANSISTOR)
- AT-39 REG 2 TEMP, DEG F (NEAR THE PCU 2 REGULATOR TRANSISTOR)
- AT-41 APM 1 TEMP, DEG F (NEAR TEMP SWITCH 1)
- AT-42 APM 2 TEMP, DEG F (NEAR TEMP SWITCH 2)

THE FOLLOWING ELECTRICAL PARAMETERS ARE SENSED IN THE PCU/APM:

- AE-03 PCU 1 INPUT VOLTS (ESSENTIALLY RTG OUTPUT VOLTS, AT PCU 1)
- AE-04 PCU INPUT CURRENT, AMPS (OR'D FROM THE SWITCHED RTG OUTPUT)
- AE-21 APM 1 CURRENT, AMPS (MEASURES CURRENT TO PDR OF APM 1)
- AE-22 APM 2 CURRENT, AMPS (MEASURES CURRENT TO PDR OF APM 2)
- AE-23 PCU 2 INPUT VOLTS (ESSENTIALLY RTG OUTPUT VOLTS, AT PCU 2)
- DA-08, AE-24 RESERVE CURRENT, AMPS (OR'D FROM THE TWO PCU/APM SHUNTS)

THE FOLLOWING ELECTRICAL PARAMETERS ARE SENSED IN THE PDU OR ADP (AFTER COMBINING OUTPUTS OF PCU 1 AND PCU 2) BUT ARE CALIBRATED TO REFLECT VALUES AT THE PCU POWER OUTPUT MONITOR:

- AE-07 +29 VDC OUTPUT
- AE-09 +12 VDC OUTPUT
- AE-10 +5 VDC OUTPUT
- AE-11 -12 VDC OUTPUT

THE FOLLOWING SWITCH STATUS PARAMETERS ARE SENSED IN THE PCU:

- AB-13 APM STATUS (INDICATES WHETHER THE APM OF THE ACTIVE PCU IS ENABLED OR IS INHIBITED BY CMD)
- AB-16 PC AUTO SW STATUS (INDICATES WHETHER OR NOT THE INACTIVE PCU IS SELECTED FOR AUTOMATIC BACKUP)

CIRCUIT PROTECTION

- PCU AUTO SWITCH

  IN CASE OF OVERVOLTAGE/UNDERVOLTAGE IN THE PCU OUTPUT, AUTOMATIC SWITCHOVER FROM THE ACTIVE PCU TO THE ALTERNATE PCU WILL OCCUR IF VOLTAGE, TIME, AND SWITCH SETTING CONDITIONS ARE SATISFIED.

  - VOLTAGES (AS SENSED BY THE POWER OUTPUT MONITOR IN THE PCU)

    +12 V INCREASES TO +13.2 $\pm$ 0.25 V OR DECREASES TO + 10.8 $\pm$ 0.25 V

    + 5 V DECREASES TO 0.9 V

    -12 V DECREASES NUMERICALLY TO - 4.7 V

  - TIME

    AN INCREASE (OVERVOLTAGE) ON ONE OF THESE LINES INDICATES A PROBABLE REGULATOR FAILURE AND IF IT CONTINUES FOR 5 MS, A SWITCHOVER SIGNAL IS GENERATED.

    A DECREASE (UNDERVOLTAGE) ON ONE OF THESE LINES COULD BE DUE TO AN OVERLOAD IN SOME COMPONENT. FUSES, CIRCUIT BREAKERS, AND RIPPLE-OFF ARE PROVIDED IN SWITCHED LINES TO MOST COMPONENTS. TO ALLOW ACTION OF THESE PROTECTION FEATURES, THE SWITCHOVER SIGNAL IS GENERATED AFTER 300 $\pm$ 50 MS OF CONTINUOUS UNDERVOLTAGE.

  - SWITCH SETTING

    AUTO SWITCHOVER CAN OCCUR IN EITHER DIRECTION (PCU 1-TO-2 OR PCU 2-TO-1) UNDER THE CONTROL OF A COMMAND-SELECTABLE RELAY. INCORRECT SETTING OF THE RELAY INHIBITS AUTOMATIC SWITCHOVER.

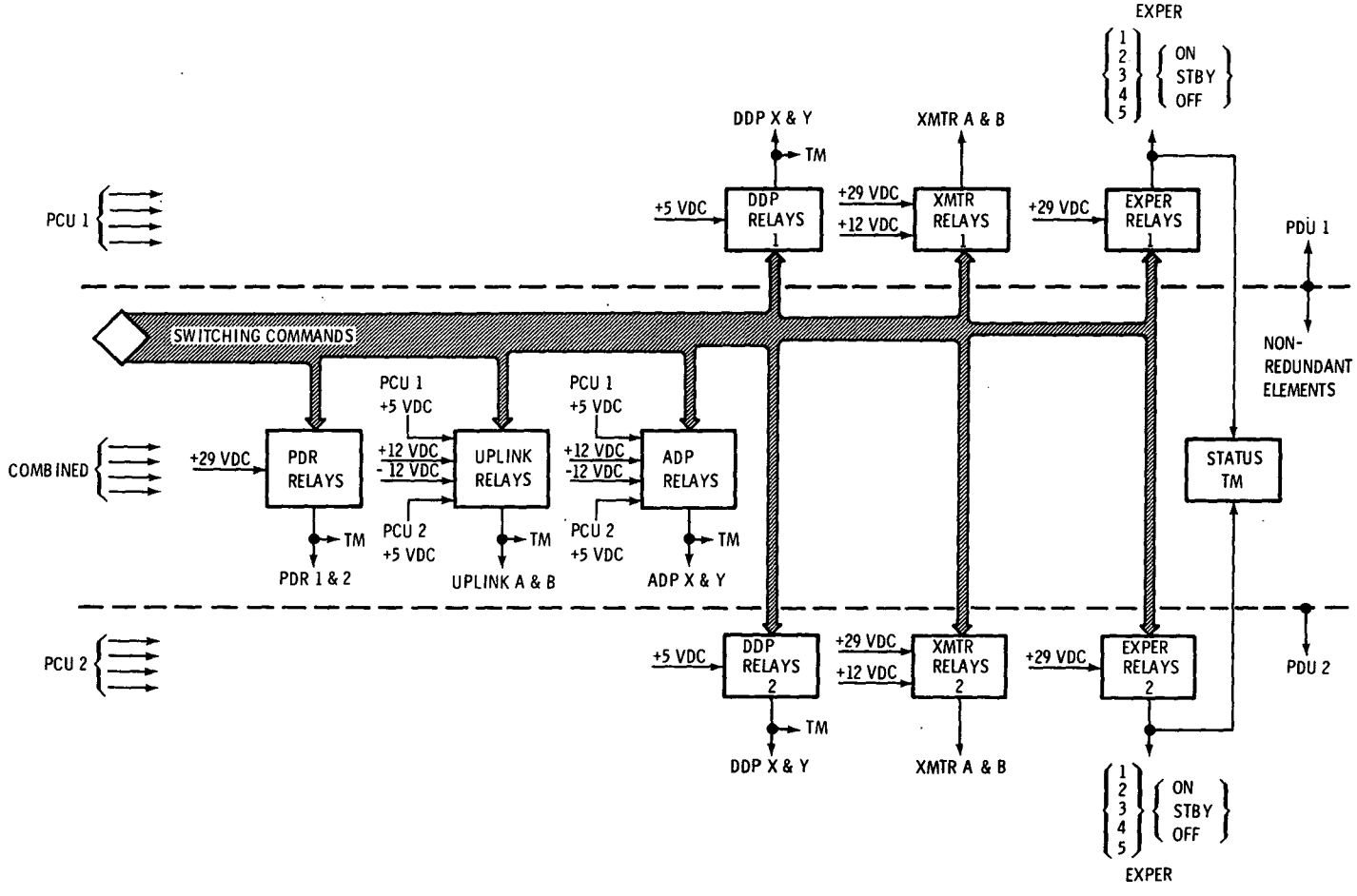
- RIPPLE-OFF

  IN CASE OF SYSTEM OVERLOAD, AS SENSED BY MARGINAL RESERVE POWER (NOMINALLY 0.8 W), AN AUTOMATIC SEQUENCER IN THE COMMAND DECODER WAITS 121 MS (FOR FUSES AND CIRCUIT BREAKERS TO RELIEVE THE OVERLOAD), THEN SWITCHES COMMANDABLE LOADS TO OFF (OR STANDBY, FOR EXPERIMENTS), AT $\approx$8 MS INTERVALS.

- FUSES AND CIRCUIT BREAKERS

  ALL NON-ESSENTIAL SWITCHABLE LOADS ARE ON FUSED LINES. OTHER SWITCHABLE LOADS HAVE CIRCUIT BREAKERS WHICH ARE RESET BY APPLICATION OF THE NORMAL ON CMD. THERE ARE UNSWITCHED LOADS (USUALLY SMALL) WITH NO CIRCUIT PROTECTION.

PDU FUNCTIONS



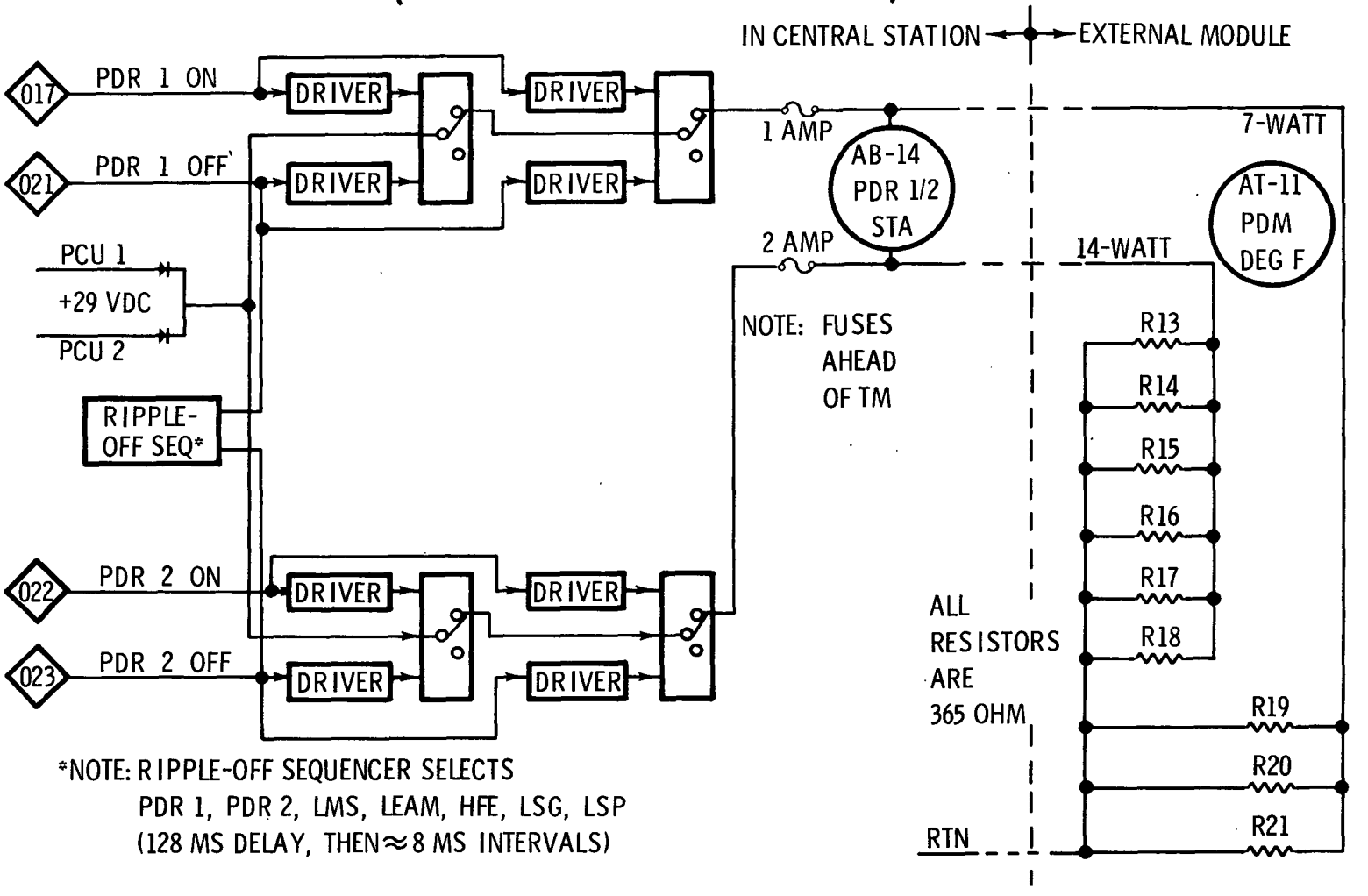
MAY 72 3270.2.16

PDU TRACKING

- WITH THE REDUNDANT PCU-PDU DESIGN, THERE ARE PROVISIONS FOR THE REDUNDANT POWER SWITCHING RELAYS TO "TRACK"; THAT IS, COMMANDS ACTUATE PDU 1 AND PDU 2 IN PARALLEL. WITH THIS TRACKING, A PCU SWITCHOVER SHOULD CAUSE NO OTHER CHANGE IN THE ALSEP OPERATIONAL CONFIGURATION.
- EXCEPTIONS MAY OCCUR WHEN POWER SWITCHING RESULTS FROM INTERNAL CAUSES INSTEAD OF UPLINK COMMANDS. THE INTERNAL CAUSES AND THEIR EFFECT ON TRACKING ARE AS FOLLOWS:
  - RIPPLE-OFF AND UPLINK SWITCH SEQUENCER OPERATE THROUGH GATES ON NORMAL COMMAND LINES; HENCE, TRACKING IS MAINTAINED.
  - CIRCUIT BREAKERS SENSE OVERLOAD ON AN ACTIVE LINE AND ACTUATE POWER SWITCHING RELAYS TO EITHER SELECT THE ALTERNATE COMPONENT OR TURN OFF THE ACTIVE COMPONENT. TRACKING DEPENDS ON THE LOCATION OF THE CIRCUIT BREAKER:
    1. IF THE CIRCUIT BREAKER OPERATES ON A "COMBINED" POWER LINE, THE SYSTEM WILL TRACK (UPLINK AND ADP)
    2. IF THE CIRCUIT BREAKER OPERATES ON AN INDIVIDUAL POWER LINE, PCU 1 OR PCU 2, THE SYSTEM WILL NOT TRACK (DDP, XMTR, AND EXPERIMENT OPERATIONAL OVERLOAD)
  - FUSES ARE SIMILAR, IN THAT "COMBINED" LINES TRACK (PDR 1 AND PDR 2) WHILE INDIVIDUAL LINES WILL NOT TRACK (EXPERIMENT STANDBY OVERLOAD)
- NOTE THAT THE APM FOR EACH PCU IS INITIALIZED TO THE ON STATE WHEN THE PCU IS SELECTED; HENCE, THE APM OFF COMMAND DOES NOT TRACK, IN TERMS OF MAINTAINING STATUS THROUGH A PCU SWITCHOVER
- THE ABNORMAL CONDITION OF "RIPPLE-OFF SEQUENCER LOCK-OUT" MAY POSSIBLY BE CLEARED BY PCU SWITCHOVER (UNPREDICTABLE TRACKING)

PDR POWER CONTROL

(NON-REDUNDANT PDU RELAYS)



*NOTE: RIPPLE-OFF SEQUENCER SELECTS
PDR 1, PDR 2, LMS, LEAM, HFE, LSG, LSP
(128 MS DELAY, THEN≈8 MS INTERVALS)

MAY 72 3270.2.18

PDR COMMANDS

OCTAL CMD NUMBER

- 017 PDR 1 ON

  THIS CMD ACTUATES TWO LATCHING RELAYS (IN SERIES) IN THE NON-REDUNDANT SECTION OF THE PDU, TO THE POSITION THAT APPLIES +29 VDC TO A 7-WATT POWER DISSIPATION RESISTOR, AND IS USED AS A BACKUP MEANS OF PWR/THERMAL CONTROL IF THE APM CANNOT COPE WITH THE LOAD. REPEATED APPLICATION OF CMD 017 HAS NO FURTHER EFFECT.

- 021 PDR 1 OFF

  THIS CMD ACTUATES TWO LATCHING RELAYS (IN SERIES) IN THE NON-REDUNDANT SECTION OF THE PDU, TO THE POSITION THAT REMOVES +29 VDC FROM THE 7-WATT POWER DISSIPATION RESISTOR. PDR 1 IS PRESET TO BE IN THE OFF CONDITION AT INITIAL LUNAR ACTIVATION. REPEATED APPLICATION OF CMD 021 HAS NO FURTHER EFFECT.

- 022 PDR 2 ON

  THIS CMD ACTUATES TWO LATCHING RELAYS (IN SERIES) IN THE NON-REDUNDANT SECTION OF THE PDU, TO THE POSITION THAT APPLIES +29 VDC TO A 14-WATT POWER DISSIPATION RESISTOR, AND IS USED AS A BACKUP MEANS OF PWR/THERMAL CONTROL IF THE APM CANNOT COPE WITH THE LOAD. REPEATED APPLICATION OF CMD 022 HAS NO FURTHER EFFECT.

- 023 PDR 2 OFF

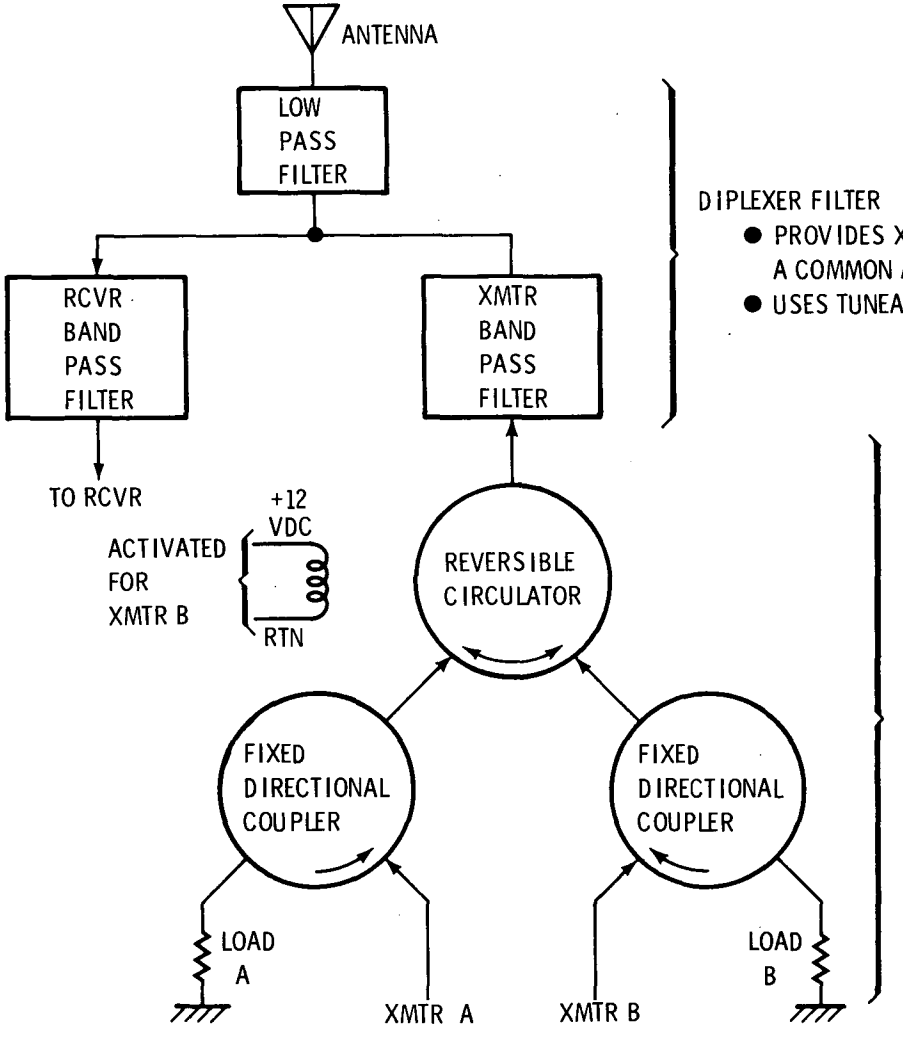
  THIS CMD ACTUATES TWO LATCHING RELAYS (IN SERIES) IN THE NON-REDUNDANT SECTION OF THE PDU, TO THE POSITION THAT REMOVES +29 VDC FROM THE 14-WATT POWER DISSIPATION RESISTOR. PDR 2 IS PRESET TO BE IN THE OFF CONDITION AT INITIAL LUNAR ACTIVATION. REPEATED APPLICATION OF CMD 023 HAS NO FURTHER EFFECT.

PDR TELEMETRY

AT-11 PDM TEMP, DEG F (SENSED ON THE POWER DISSIPATION MODULE WITH SIGNAL CONDITIONING IN THE DATA PROCESSOR)

AB-14 PDR 1/2 STATUS (INDICATES THE ON/OFF STATUS OF BOTH PDR 1 AND PDR 2, WITH AN OFF INDICATION IN THE CASE OF A BLOWN FUSE)

DIPLEXER FILTER AND SWITCH FUNCTIONS



DIPLEXER FILTER

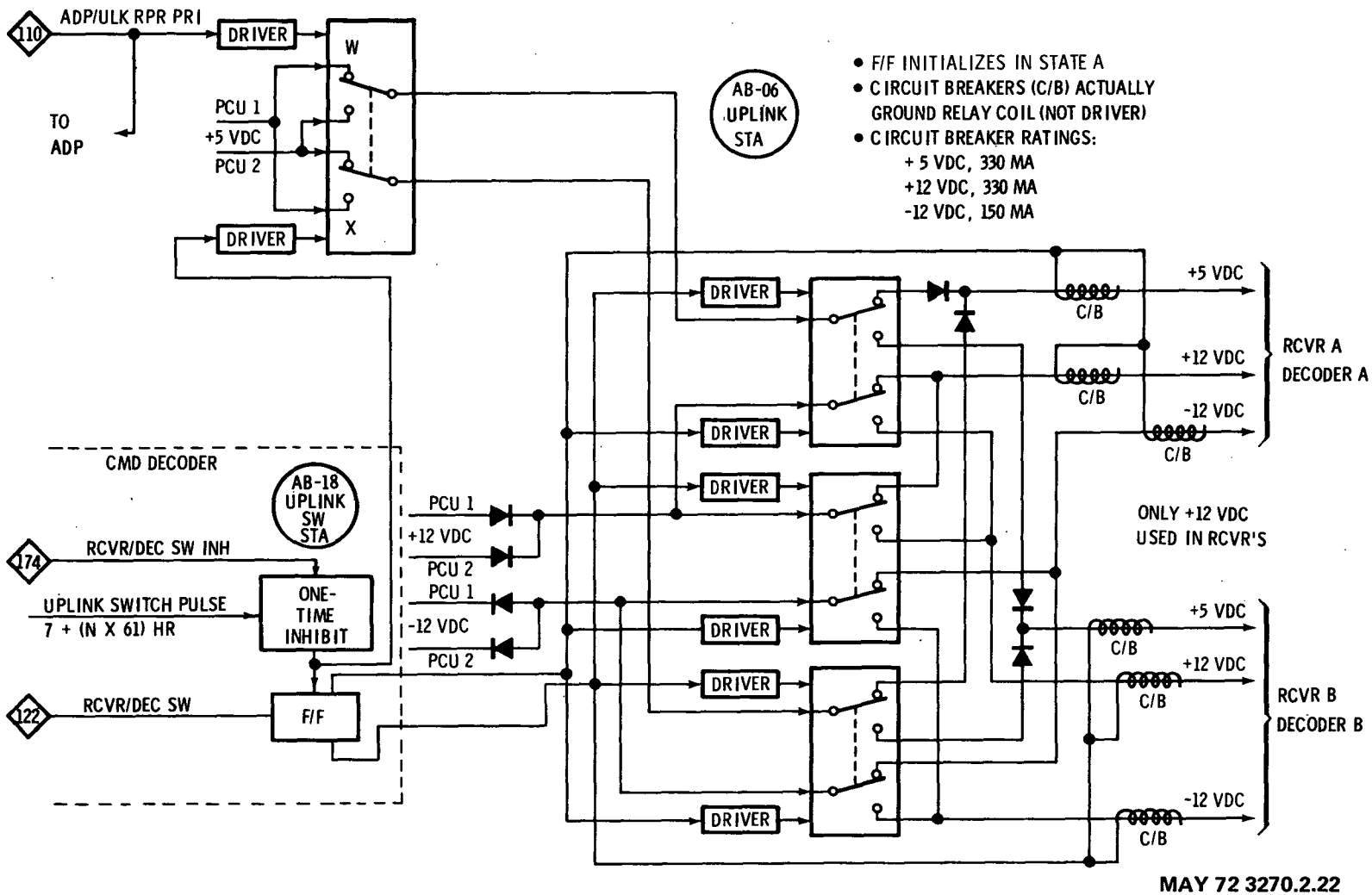
- PROVIDES XMTR/RCVR ISOLATION WITH A COMMON ANTENNA
- USES TUNEABLE CAVITY BANDPASS FILTERS

DIPLEXER SWITCH

- USED TO COUPLE THE SELECTED TRANSMITTER THROUGH THE DIPLEXER FILTER TO THE ANTENNA
- TWO CIRCULATORS ARE USED TO PROVIDE TRANSMITTER ISOLATION AND PROTECTION (AGAINST OPENS OR SHORTS), AND THE THIRD CIRCULATOR IS REVERSIBLE TO SERVE AS A SWITCH
- +12 VDC APPLICATION SELECTS XMTR B; ABSENCE OF +12 VDC SELECTS XMTR A
- IF BOTH XMTR'S ARE OPERATING, THE ONE NOT SELECTED IS APPLIED TO A LOAD.

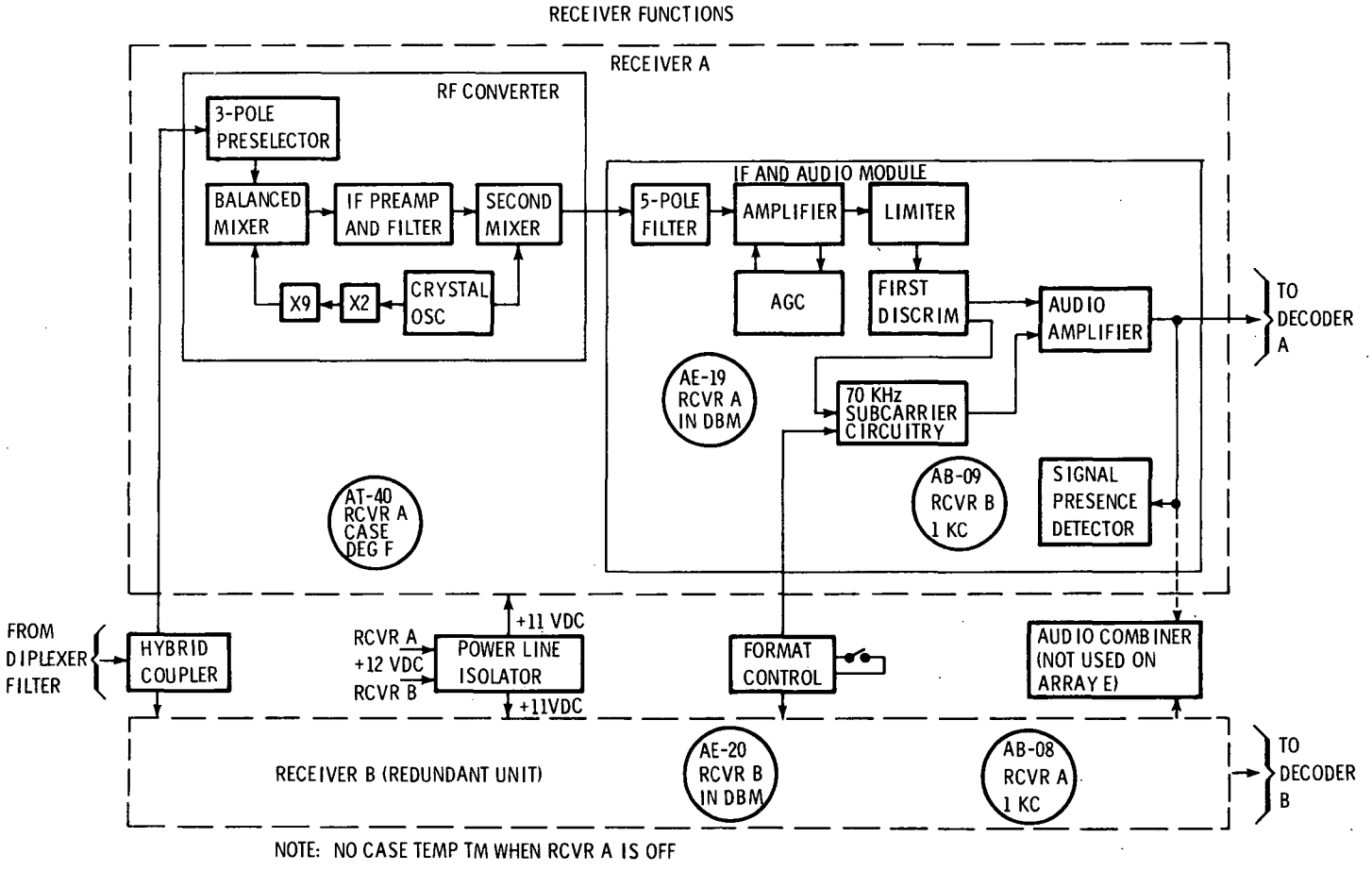
MAY 72 3270.2.21

UPLINK POWER CONTROL
(NON-REDUNDANT PDU RELAYS)



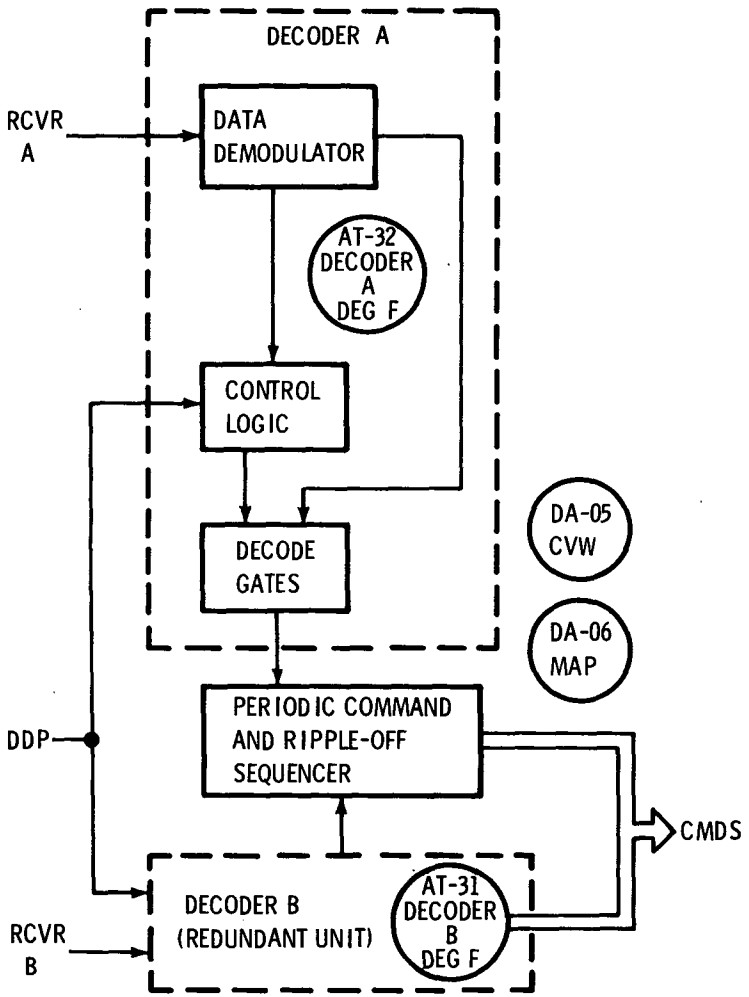
MAY 72 3270.2.22

RECEIVER FUNCTIONS



MAY 72 3270.2.23

COMMAND DECODER FUNCTIONS

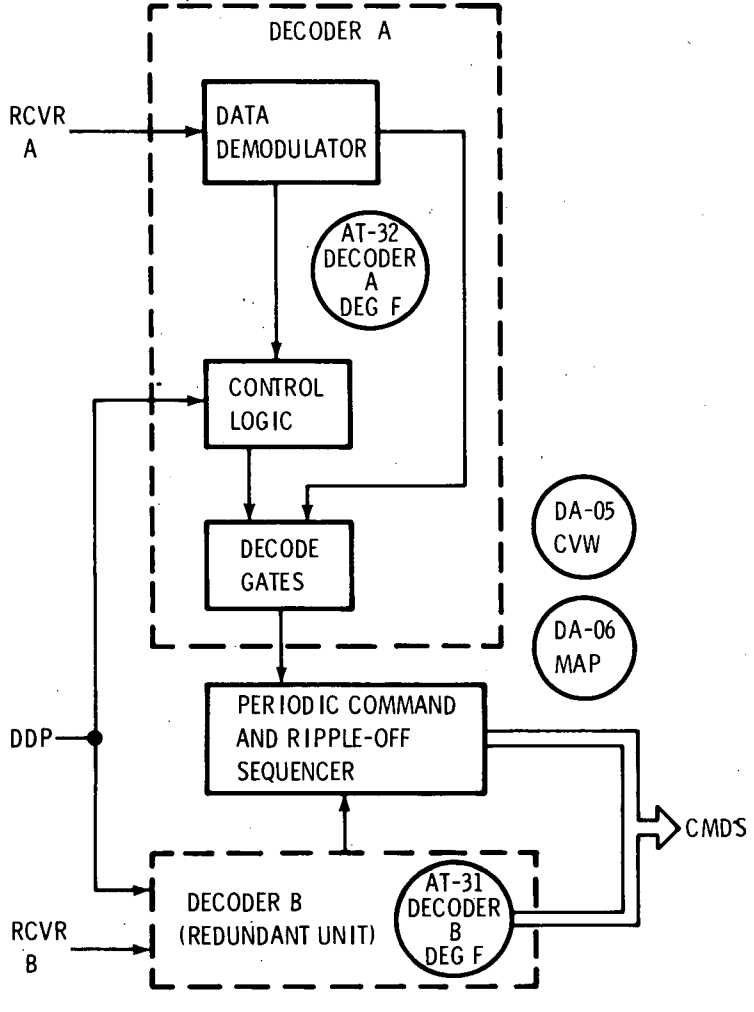


- DATA DEMODULATOR

  CONVERTS THE MESSAGE INTO DIGITAL FORMAT USING A PHASE LOCK LOOP AND CLOCK GENERATOR, A DATA DETECTOR, AND THRESHOLD CIRCUITS

  - THE PHASE LOCK LOOP USES A FREE-RUNNING VOLTAGE CONTROLLED OSCILLATOR (VCO) AT 8 KHz WITH A DIVIDE-BY-4 RING COUNTER TO GENERATE FOUR PHASES OF A 1 KHz SQUARE WAVE. ONE OF THESE IS USED TO CONTROL THE VCO. THE PHASES OF THE 1 KHz ARE ALSO GATED TOGETHER FOR THE CONTROL LOGIC CLOCKS AND DATA DETECTOR.
  - THE DATA DETECTOR HAS TWO DETECTION CHAINS, FOR ZEROS AND ONES, WITH "INTEGRATE AND DUMP CIRCUITS". THE OUTPUTS ARE USED IN THE THRESHOLD CIRCUITS AND, IF ACCEPTABLE, ARE CLOCKED INTO THE CONTROL LOGIC COMMAND REGISTER.
  - THE THRESHOLD CIRCUITS REQUIRE AT LEAST FOUR CONSECUTIVE VALID DATA BITS BEFORE ACCEPTING INPUTS FOR THE COMMAND REGISTER. IN THE EVENT OF SUBSEQUENT DATA DROPOUT, INPUT TO THE REGISTER IS INHIBITED AND THE CONTROL LOGIC IS RESET.

COMMAND DECODER FUNCTIONS (CONT'D)



- CONTROL LOGIC

  THE CONTROL LOGIC CONSISTS OF AN 8-BIT SHIFT REGISTER, TWO COUNTERS, AND RESET CIRCUITRY. OPERATION IS AS FOLLOWS:

  1. DATA PASSES THROUGH THE REGISTER (1000 BITS PER SECOND) AND THE FIRST 7 BITS ARE CHECKED FOR THE ADDRESS (1101001).
  2. RECOGNITION OF ADDRESS STARTS A TIMING SEQUENCE. THE FIRST COUNTER COUNTS 7 PULSES WHICH SHIFT THE COMMAND COMPLEMENT INTO THE REGISTER. AS THE NEXT 7 BITS (TRUE COMMAND) ARE SHIFTED INTO THE REGISTER, AN "EXCLUSIVE OR" GATE CHECKS BITS 1 AND 8 OF THE REGISTER FOR COMMAND/COMPLEMENT "PARITY". FAILURE OF THIS TEST SETS A PARITY MEMORY.
  3. AFTER THE SECOND 7 PULSES, DURING WHICH THE TRUE COMMAND HAS BEEN SHIFTED INTO THE REGISTER, THERE IS A PERIOD OF 21 PULSES (21 MS) FOR COMMAND EXECUTION WITH THE FOLLOWING LOGIC:
     - A LATCH IS SET TO TIME THE EXECUTE GATE AND A SECOND LATCH INHIBITS NEW DATA INTO THE REGISTER (THE RECEIVED COMMAND IS IN THE LAST 7 BITS OF THE REGISTER).
     - THE COMMAND LINE IS SELECTED IN THE DECODING GATES.
     - THE PARITY BIT IS ENTERED IN THE FIRST BIT OF THE REGISTER AND, IF PARITY IS VALID, THE COMMAND IS EXECUTED.
  4. AT THE END OF THE 21 TIMING PULSES, A SIGNAL IS SENT TO THE DATA PROCESSOR, INDICATING DATA AVAILABILITY, CALLED VERIFICATION WORD ENABLE (VWE). THE DATA PROCESSOR READS OUT THE COMMAND VERIFICATION WORD AT THE PROPER TIME IN THE NEXT TELEMETRY DATA FRAME.
  5. AT THE END OF THE DATA PROCESSOR DEMAND PULSE, THE COMMAND DECODER AUTOMATICALLY RETURNS TO THE ADDRESS SEARCH MODE (RESET). IN LSP MODE OF OPERATION, RESET OCCURS AT EXECUTION BIT 21.

- DECODE GATES

  OUTPUT DECODING USES TWO-INPUT GATES, SO THAT EACH INDIVIDUAL COMMAND LINE IS DEPENDENT ON (1) THE STATE OF ALL 7 COMMAND BITS AND (2) THE PRESENCE OF THE COMMAND EXECUTE PULSE.

- PERIODIC COMMAND AND RIPPLE-OFF SEQUENCER

  TO BE DESCRIBED LATER

OCTAL CMD NUMBER

● 110 ADP/UPLINK REDUNDANT POWER ROUTING, PRIMARY SELECT

THIS CMD ACTUATES A PAIR OF LATCHING RELAYS IN THE NON-REDUNDANT SECTION OF THE PDU, TO THE POSITION THAT PROVIDES THE BASIC, REDUNDANT, ROUTING OF +5 VDC FROM PCU 1 AND PCU 2 TO THE ADP/UPLINK SELECTION RELAYS. THIS CMD HAS THE OPPOSITE EFFECT OF CMD 107 FOR ADP PWR ROUTING AND OF A 61-HR PULSE FOR UPLINK PWR ROUTING. THIS CMD WOULD SERVE TO CLEAR A MALFUNCTION IN EITHER THE DECODER OR THE ADP SELECTION RELAY, IF ONE SHOULD OCCUR IN THE BACKUP ROUTING. THE PRIMARY ROUTING IS PRESET TO BE ENERGIZED AT INITIAL LUNAR ACTIVATION. REPEATED APPLICATION OF CMD 110 HAS NO FURTHER EFFECT.

● 122 RCVR/DECODER SWITCH

THIS CMD, THROUGH THE UPLINK SWITCH FLIP-FLOP IN THE CMD DECODER, ACTUATES LATCHING RELAYS IN THE NON-REDUNDANT SECTION OF THE PCU TO REMOVE POWER FROM WHICHEVER SET OF UPLINK COMPONENTS IS IN USE AND APPLY POWER TO THE ALTERNATE, REDUNDANT, COMPONENTS. THREE VOLTAGES (+5, +12 AND -12) ARE SWITCHED FOR THE CMD DECODERS AND +12 VDC FOR RCVR'S. REPEATED APPLICATION OF CMD 122 CAUSES REPEATED SELECTION, ALTERNATING BETWEEN RCVR/DECODER A AND B. TRANSMISSION OF CMD 122 DOES NOT ACTUATE THE BACKUP POWER ROUTING OF +5 VDC TO THE DECODER AS DOES AUTOMATIC SWITCHOVER. AFTER A PCU SWITCHOVER, CMD 122 MAY BE REQUIRED TWICE FOR THE NEXT SWITCHOVER (IF IT IS FROM UPLINK B TO UPLINK A). NOTE THAT CMD 122 AND CMD 174 HAVE NO EFFECT ON EACH OTHER. CMD 122 ALSO ENABLES PERIODIC CMDS.

● 174 RCVR/DECODER SWITCH DELAY

THIS CMD SETS A ONE-TIME INHIBIT CIRCUIT IN THE CMD DECODER SUCH THAT THE NEXT 61-HR PULSE DOES NOT CAUSE SWITCHOVER TO THE OPPOSITE RCVR/DECODER. REPEATED APPLICATION OF CMD 174, PRIOR TO ARRIVAL OF A 61-HR PULSE, HAS NO FURTHER EFFECTS; ONLY ONE PULSE IS INHIBITED. RESETTING TO THE NO-DELAY CONDITION OCCURS 3.5 MINUTES AFTER THE 61-HR AUTOSWITCH PULSE IS GENERATED, WHETHER OR NOT THE SWITCHOVER IS ACTUALLY INHIBITED OR ENABLED. THE APPLICATION OF POWER TO ALSEP CAUSES INITIALIZATION IN THE NO-DELAY CONFIGURATION. NOTE THAT CMD 174 AND CMD 122 HAVE NO EFFECT ON EACH OTHER.

UPLINK SWITCHING COMMANDS

(INCLUDING ADP POWER ROUTING)

UPLINK TELEMETRY

THE FOLLOWING TEMPERATURES ARE SENSED IN THE UPLINK COMPONENTS, WITH SIGNAL CONDITIONING IN THE DATA PROCESSOR (MEASUREMENT IS ABSENT IF RCVR/DECODER UNIT IS OFF):

AT-31 DECODER B TEMP, DEG F (SENSED IN THE DATA DEMODULATOR)
AT-32 DECODER A TEMP, DEG F (SENSED IN THE DATA DEMODULATOR)
AT-40 RCVR A CASE TEMP, DEG F (NO TM WHEN RCVR B IS OPERATING)

THE FOLLOWING ELECTRICAL PARAMETERS ARE SENSED IN THE RECEIVERS:

AE-19 RCVR A INPUT SIGNAL LEVEL, DBM (SENSED IN AGC)
AE-20 RCVR B INPUT SIGNAL LEVEL, DBM (SENSED IN AGC)

THE FOLLOWING STATUS PARAMETERS ARE SENSED IN THE UPLINK COMPONENTS:

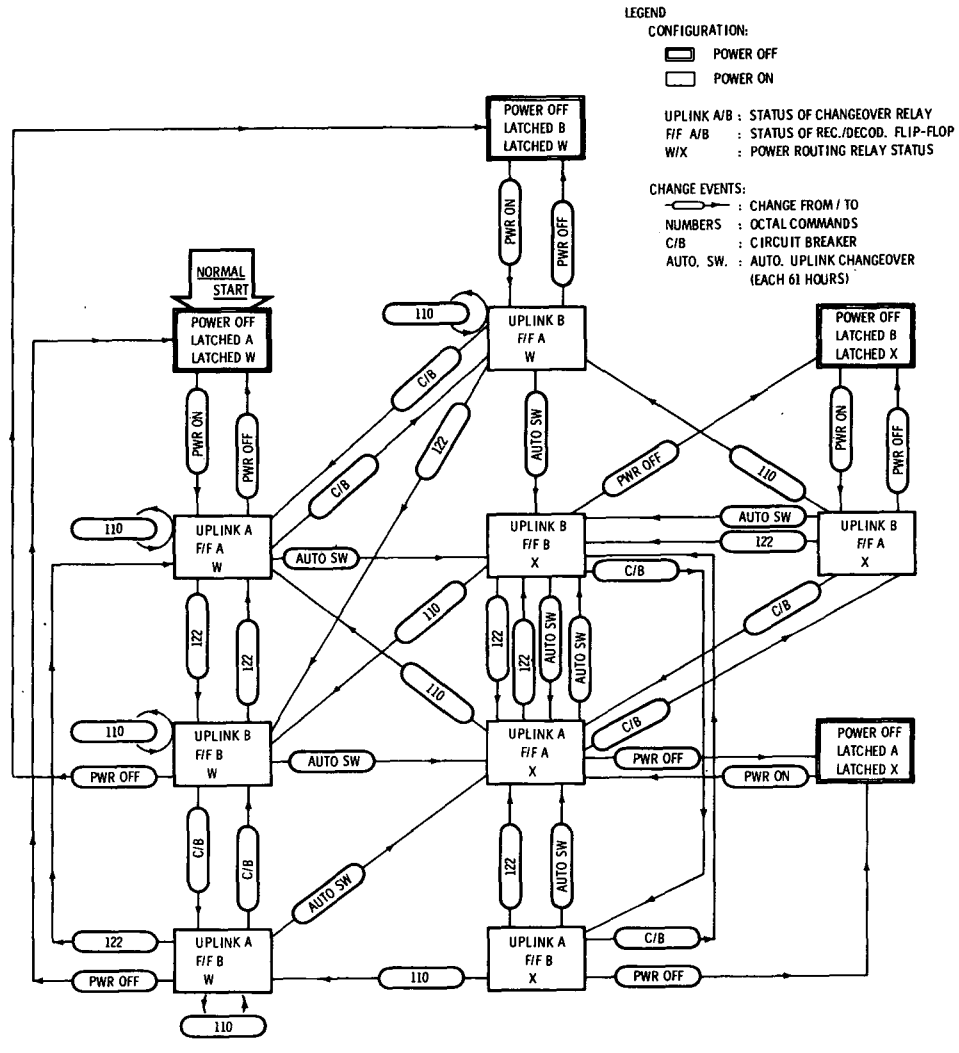
AB-06 UPLINK STATUS (A OR B COMPONENTS PLUS PRIMARY OR BACKUP ROUTING)
AB-08 RCVR A 1 KC (PRESENT OR ABSENT)
AB-09 RCVR B 1 KC (PRESENT OR ABSENT)
AB-18 UPLINK SWITCH STATUS (ACCEPT OR DELAY THE 61-HR SWITCHOVER SIGNAL)

THE COMMAND VERIFICATION WORD (CVW) IS READ OUT IN WORD 7 OF THE ALSEP TELEMETRY FRAME:

DA-05 ALSEP COMMAND, AS RECEIVED (BITS 3 THROUGH 9 OF WORD 7)
DA-06 ALSEP CMD MAP (MESSAGE ACCEPTANCE PULSE, IN BIT 10, INDICATES "ONE" IF COMMAND/COMPLEMENT AGREED)
BITS 1 AND 2 ARE FILLER AND WILL BE THE SAME AS BIT 3. THE CVW APPEARS ONLY ONCE, IN THE FRAME FOLLOWING COMMAND RECEIPT, OTHERWISE WORD 7 IS ALL ZEROS. WHEN SWITCHING BY COMMAND BETWEEN REDUNDANT DATA SUBSYSTEM COMPONENTS, THE CVW MAY BE UNAVAILABLE.

NOTE THAT COMPONENT TEMPERATURES AND ELECTRICAL PARAMETERS ARE OFF-SCALE WHEN THE COMPONENT IS NOT IN USE.

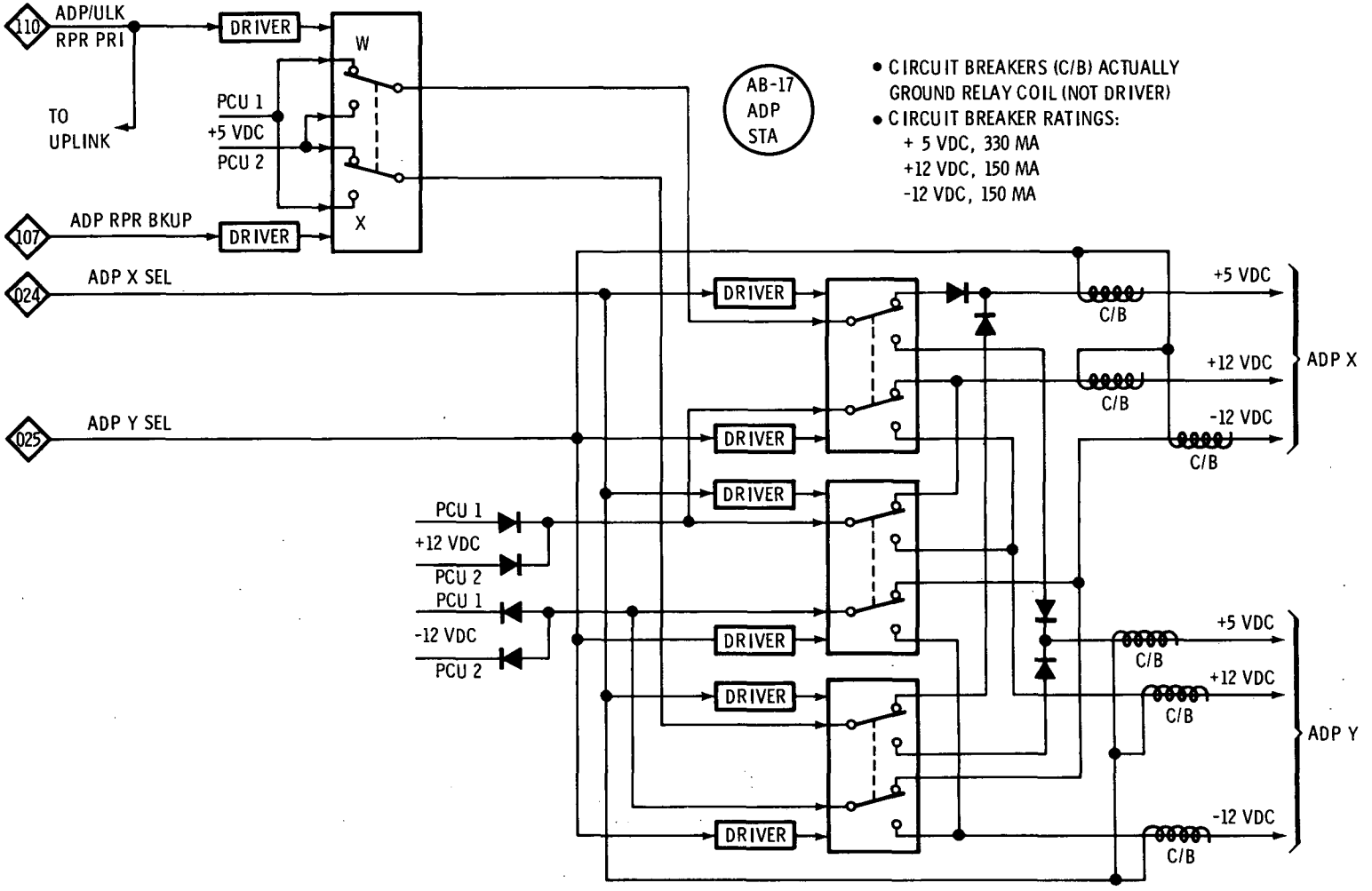
UPLINK CONFIGURATION SWITCHING



MAY 72 3270.2.28

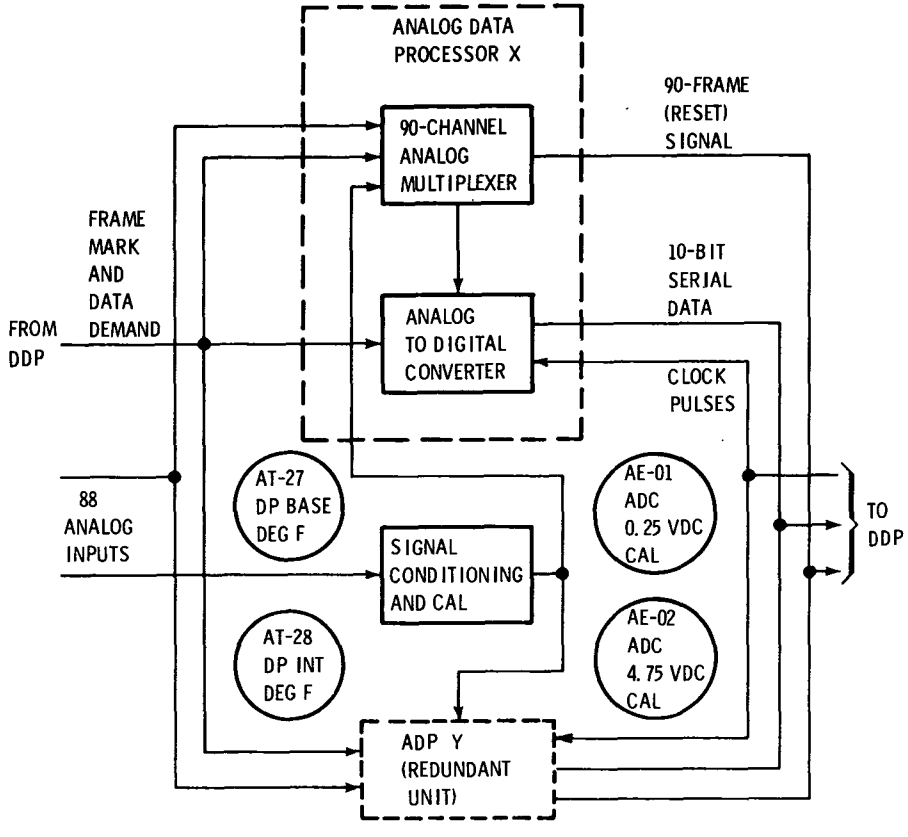
ADP POWER SWITCHING

(NON-REDUNDANT PDU RELAYS)



MAY 72 3270.2.29

ADP FUNCTIONS

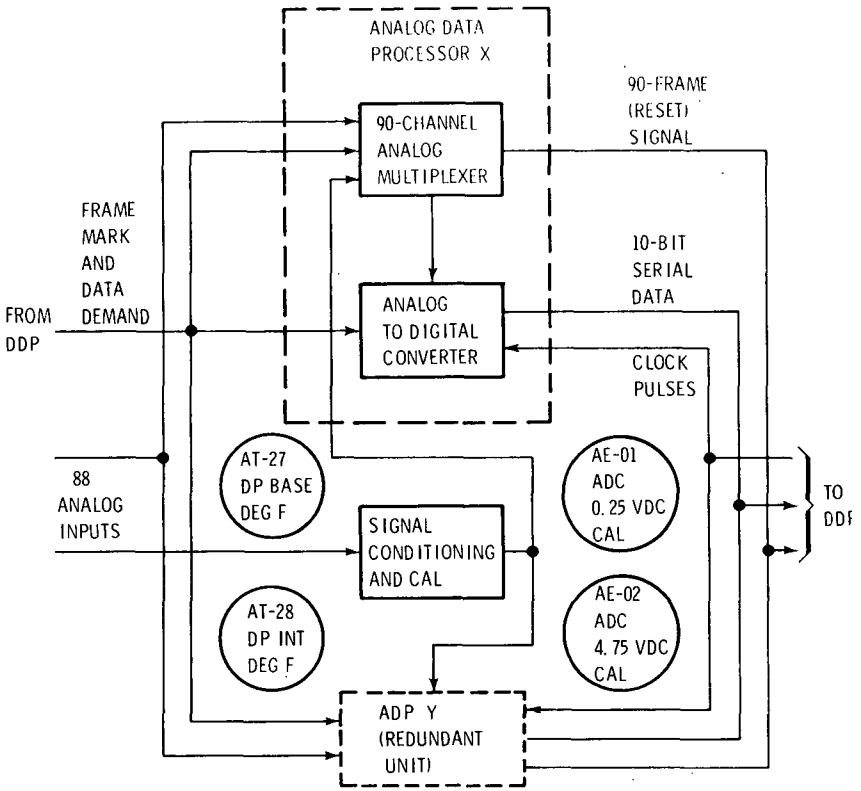


- 90-CHANNEL ANALOG MULTIPLEXER

  SAMPLES THROUGH 90 INPUT CHANNELS OF ANALOG ENGINEERING (HOUSEKEEPING) DATA IN ASCENDING NUMERICAL ORDER, ADVANCING ONE CHANNEL PER ALSEP TELEMETRY FRAME. BETWEEN EACH OF THE 90 SAMPLES, A SEPARATE SAMPLE IS TAKEN OF THE ALSEP RESERVE CURRENT WHICH IS ALSO ONE OF THE 90 INPUTS. TWO OF THE INPUTS ARE INTERNAL CALIBRATION SIGNALS AND THE OTHER 88 ARE OBTAINED FROM THE CENTRAL STATION AND THE EXPERIMENTS. NOTE THAT SOME OF THE EXPERIMENT INPUTS ARE COMMUTATED, SAMPLING A SERIES OF PARAMETERS ON A SINGLE INPUT LINE TO THE ADP.

  - THE MULTIPLEXER CONTAINS A SELF-RESETTING COUNTER (1 TO 90) AND A 90-INPUT MATRIX SWITCH FOR ROUTING THE ANALOG SIGNALS SEQUENTIALLY TO THE ANALOG-TO-DIGITAL CONVERTER (ADC).
  - AT THE START OF THE 64TH (FINAL) WORD OF EACH ALSEP TELEMETRY FRAME, AN "ADVANCE" PULSE FROM THE DDP SETS THE SWITCHING MATRIX TO THE NEXT POSITION, AND ONE WORD LATER THE DDP "FRAME MARK" PULSE APPLIES THE ANALOG SIGNAL TO THE ADC.
  - AT ALSEP WORD 33, THE ANALOG-TO-DIGITAL CONVERSION IS PERFORMED AFTER WHICH A FLIP-FLOP IS RESET TO APPLY THE RESERVE POWER ANALOG SIGNAL TO THE ADC.
  - THE RESERVE POWER ANALOG-TO-DIGITAL CONVERSION IS PERFORMED DURING ALSEP WORD 63.
  - DURING THE ENTIRE PERIOD THAT THE MULTIPLEXER IS SAMPLING CHANNEL 90, A 90-FRAME PULSE SIGNAL IS GENERATED AND SUPPLIED TO THE DDP. IT RESETS THE INDEPENDENT FRAME COUNTER IN THE DDP WHICH OTHERWISE WOULD COUNT TO 128 (7-BIT COUNTER). WHEN SWITCHING BETWEEN REDUNDANT DDP'S, THE FRAME COUNTER INDICATION IS MEANINGLESS UNTIL RECEIPT OF THE FIRST 90-FRAME PULSE FROM THE ADP (THAT IS, WORD 33 IS OUT OF SYNC). THIS CONDITION WILL EXIST FOR LESS THAN 90 FRAMES (54 SECONDS). A SIMILAR TEMPORARY OUT-OF-SYNC CONDITION FOR WORD 33 WILL FOLLOW AN ADP SWITCHOVER.

ADP FUNCTIONS (CONT.)



- ANALOG TO DIGITAL CONVERTER (ADC)
  THE ADC ACCEPTS ANALOG SIGNALS FROM THE MULTIPLEXER AND CONVERTS THEM INTO 10-BIT DIGITAL DATA (INCLUDING TWO FILLER BITS) TO BE FORWARDED IN SERIAL FORMAT TO THE DDP.
  - THE ADC USES A RAMP GENERATOR-COMPARATOR TECHNIQUE FOR CONVERSION, IN WHICH THE INPUT ANALOG SIGNAL (VOLTAGE) IS COMPARED TO A LINEAR RAMP VOLTAGE WHILE A COUNTER ADVANCES ONE BIT PER UNIT VOLTAGE INCREMENT. THE COUNTER IS STOPPED WHEN THE RAMP VOLTAGE EXCEEDS THE INPUT VOLTAGE. THE NUMBER IN THE COUNTER IS THEN READ OUT TO A BUFFER STORAGE REGISTER AS THE BINARY EQUIVALENT OF THE MAGNITUDE OF THE INPUT ANALOG VOLTAGE. THE 8-BIT BINARY SCALE HAS A DECIMAL RANGE OF ZERO-TO-255, WITH ONE-TO-254 REPRESENTING A VOLTAGE BETWEEN ZERO AND +5 VDC. ZERO OUTPUT REPRESENTS NEGATIVE VOLTAGE INPUT AND 255 REPRESENTS GREATER THAN +5 VDC.
  - THE CONVERSION STARTS AT THE TRAILING EDGE OF A "START CONVERSION" SIGNAL FROM THE ADC CONTROL LOGIC SECTION AND IS COMPLETED WITHIN 140 MICRO-SECONDS, MAXIMUM. READOUT TO THE BUFFER REGISTER CLEARS THE COUNTER AND RESETS THE RAMP GENERATOR.
  - TIMING PULSES FOR THE COUNTER ADVANCE ARE SUPPLIED BY THE DDP AT 2.035 MHz ($\pm$ 0.005%).
- SIGNAL CONDITIONING AND CALIBRATION
  TEMPERATURE MEASUREMENTS OF THE CENTRAL STATION STRUCTURE, THE RTG, AND ONE EACH FROM LMS, LSP, AND LEAM, ARE CONDITIONED IN THE NON-REDUNDANT SECTION OF THE ADP TO PROVIDE ZERO TO +5 VDC SIGNALS FOR INPUT TO THE ANALOG MULTIPLEXERS/CONVERTERS. PRECISION SIGNALS AT 0.25 AND 4.75 VDC ARE GENERATED FOR ADC CALIBRATION, AND PCU OUTPUT VOLTAGES ARE MONITORED/CONDITIONED IN THE ADC. (PCU 1 AND PCU 2 OUTPUTS ARE COMBINED INTO ONE MEASUREMENT FOR EACH OF THE FOUR VOLTAGE LEVELS.)

ADP COMMANDS

OCTAL CMD NUMBER

- 024 ADP X SEL

  THIS CMD ACTUATES LATCHING RELAYS IN THE NON-REDUNDANT SECTION OF THE PDU TO THE POSITION THAT APPLIES +5 VDC, +12 VDC, AND -12 VDC TO THE X UNIT OF THE ANALOG DATA PROCESSOR AND REMOVES +5 VDC, +12 VDC AND -12 VDC FROM THE Y UNIT. ADP X IS PRESET TO BE ENERGIZED AT INITIAL LUNAR ACTIVATION. REPEATED APPLICATION OF CMD 024 HAS NO FURTHER EFFECT.

- 025 ADP Y SEL

  THIS CMD ACTUATES LATCHING RELAYS IN THE NON-REDUNDANT SECTION OF THE PDU TO THE POSITION THAT APPLIES +5 VDC, +12 VDC AND -12 VDC TO THE Y UNIT OF THE ANALOG DATA PROCESSOR AND REMOVES +5 VDC, +12 VDC AND -12 VDC FROM THE X UNIT. REPEATED APPLICATION OF CMD 025 HAS NO FURTHER EFFECT.

- 107 ADP REDUNDANT POWER ROUTING, BACKUP SELECT

  THIS CMD ACTUATES A LATCHING RELAY IN THE NON-REDUNDANT SECTION OF THE PDU TO THE POSITION THAT PROVIDES AN ALTERNATE, REDUNDANT ROUTING OF +5 VDC FROM PCU 1 AND PCU 2 TO THE ADP SELECTION RELAYS. THIS CMD WOULD BE APPLIED IF IT APPEARED THAT BOTH ADP'S WERE OPERATING SIMULTANEOUSLY. AN ALTERNATIVE WOULD BE TO SWITCH PCU'S. THE 61-HR PULSE DOES NOT SWITCH ADP ROUTING. REPEATED APPLICATION OF CMD 107 HAS NO FURTHER EFFECT.

ADP TELEMETRY

THE FOLLOWING TEMPERATURES ARE SENSED AND CONDITIONED IN THE ADP:

AT-27 DP BASE TEMP, DEG F (REPRESENTS THE MOUNTING PLATE TEMP FOR BOTH THE ADP AND DDP)

AT-28 DP INT TEMP, DEG F (SENSED IN THE ADP TO MONITOR INTERNAL ELECTRONICS TEMP OF THE DATA PROCESSOR

THE FOLLOWING ELECTRICAL PARAMETERS ARE SENSED IN THE ADP:

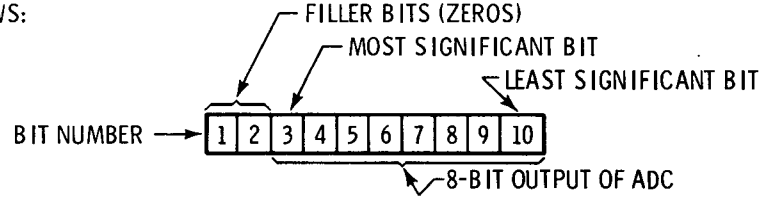
AE-01 ADC 0.25 VDC CAL (A PRECISION SOURCE OF 0.25 VDC IN THE ADP TO VERIFY ACCURATE FUNCTIONING OF THE ANALOG-TO-DIGITAL CONVERSION)

AE-02 ADC 4.75 VDC CAL (A PRECISION SOURCE OF 4.75 VDC IN THE ADP TO VERIFY ACCURATE FUNCTIONING OF THE ANALOG-TO-DIGITAL CONVERSION)

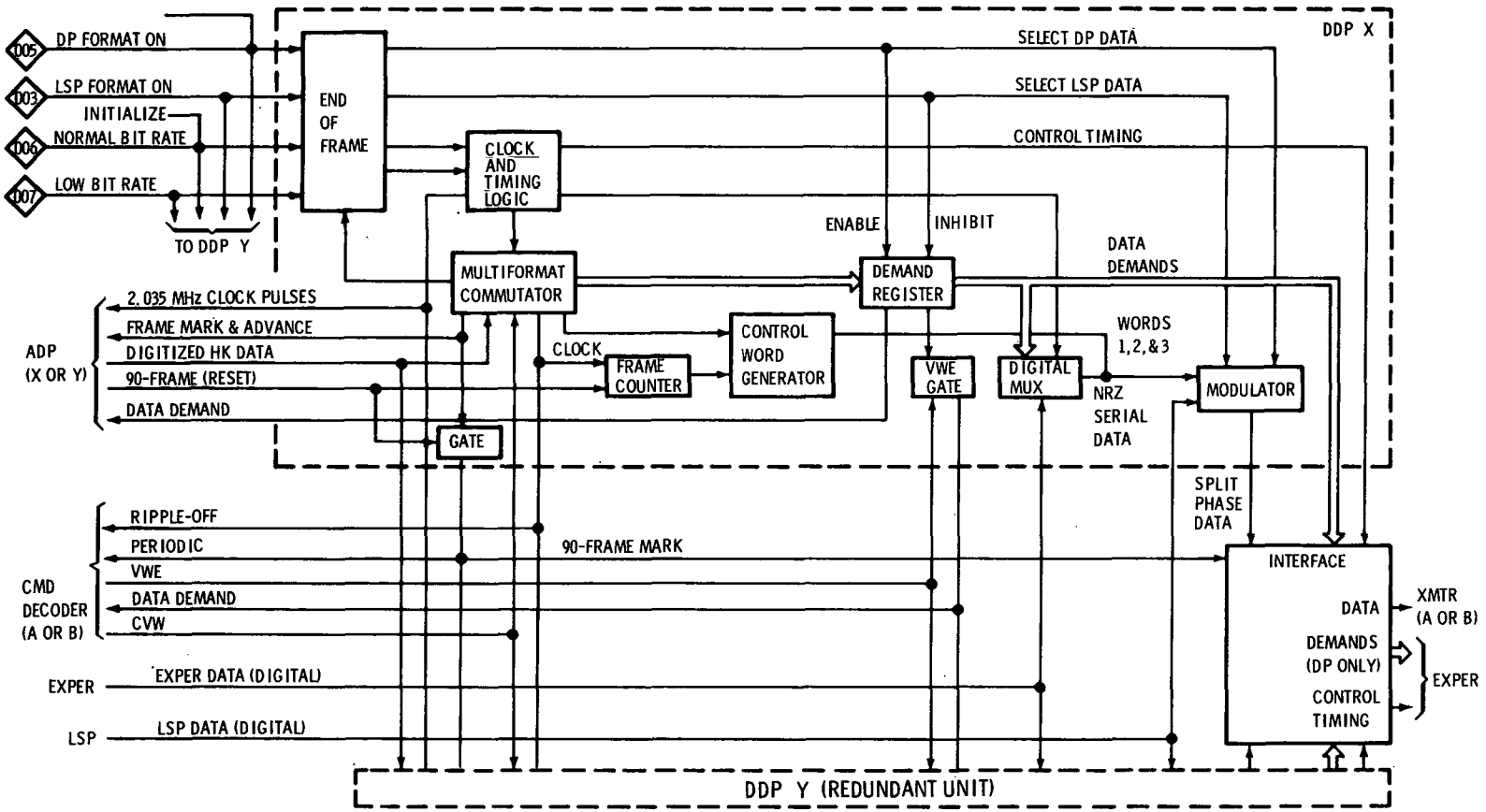
THE FOLLOWING STATUS PARAMETER IS GENERATED IN THE UPLINK POWER CIRCUITS:

AB-17 ADP STATUS (X OR Y COMPONENT PLUS PRIMARY OR BACKUP ROUTING)

THE 90-CHANNEL ANALOG OUTPUT, WITH VARIOUS DESIGNATIONS, APPEARS IN WORD 33 OF THE ALSEP TELEMETRY FRAME AND RESERVE CURRENT (PROCESSED BY THE ADP) APPEARS AS PARAMETER DA-08 IN ALSEP WORD 63. IN BOTH CASES, THE 10-BIT DATA WORD IS PRESENTED AS FOLLOWS:

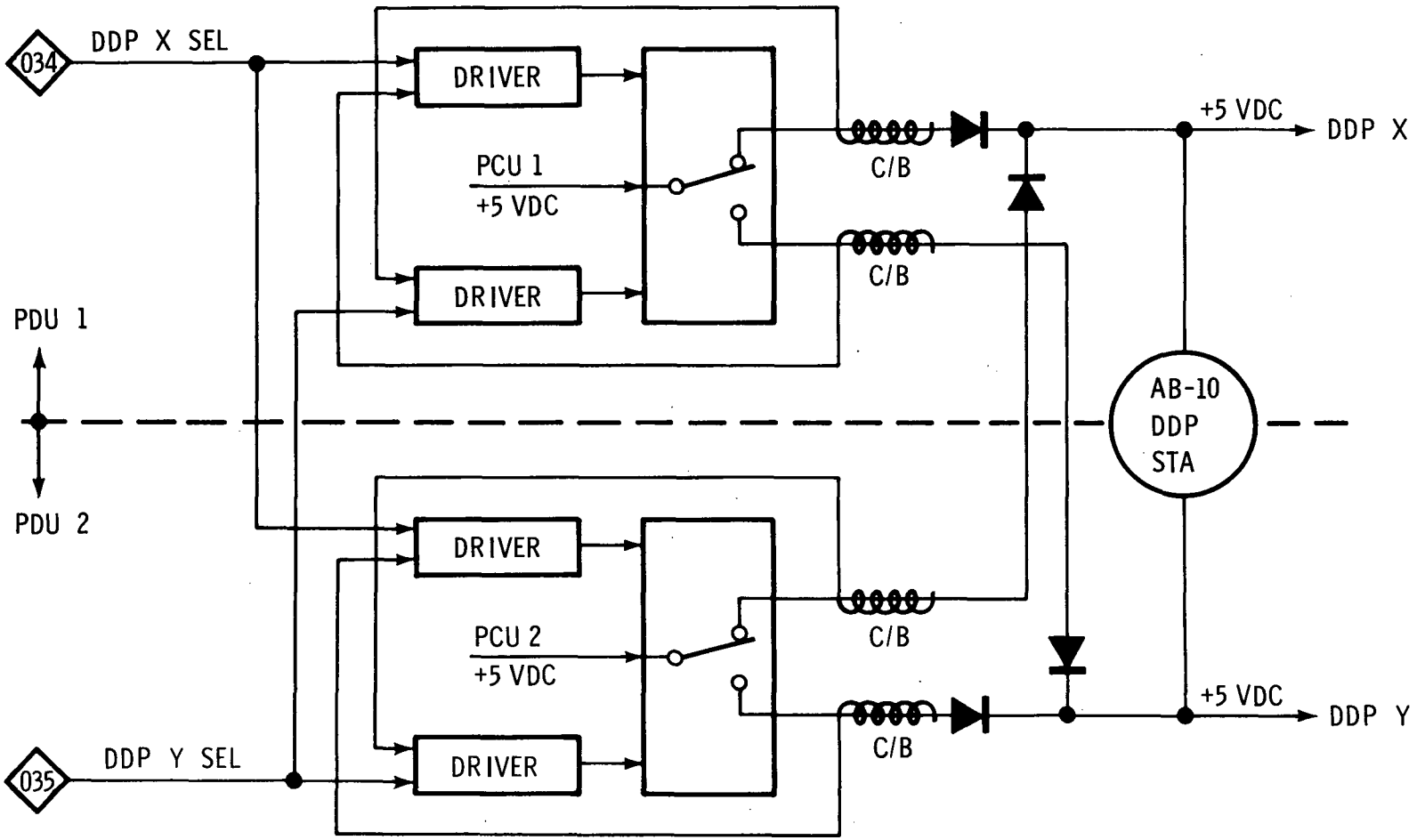


DDP FUNCTIONS



MAY 72 3270.2.34

DDP POWER CONTROL



CIRCUIT BREAKERS (C/B) ISSUE SWITCHOVER SIGNAL AT 270 ± 27 MA
CIRCUIT BREAKERS ACTUALLY GROUND RELAY COIL (NOT DRIVER)

MAY 72 3270.2.35

DDP POWER COMMANDS

OCTAL CMD NUMBER

- 034 DDP X SEL

  THIS CMD ACTUATES TWO LATCHING RELAYS, ONE IN EACH PDU, TO THE POSITION THAT APPLIES +5 VDC TO THE X UNIT OF THE DIGITAL DATA PROCESSOR AND REMOVES +5 VDC FROM THE Y UNIT. DDP X IS PRESET TO BE ENERGIZED AT INITIAL LUNAR ACTIVATION. REPEATED APPLICATION OF CMD 034 HAS NO FURTHER EFFECT. SWITCHING DDP'S IN EITHER THE DP OR LSP FORMAT, NORMAL OR SLOW DATA RATE, RESULTS IN NORMAL DATA RATE IN THE SAME FORMAT.

- 035 DDP Y SEL

  THIS CMD ACTUATES TWO LATCHING RELAYS, ONE IN EACH PDU, TO THE POSITION THAT APPLIES +5 VDC TO THE Y UNIT OF THE DIGITAL DATA PROCESSOR AND REMOVES +5 VDC FROM THE X UNIT. REPEATED APPLICATION OF CMD 035 HAS NO FURTHER EFFECT. SWITCHING DDP'S IN EITHER THE DP OR LSP FORMAT, NORMAL OR SLOW DATA RATE, RESULTS IN NORMAL DAT RATE IN THE SAME FORMAT.

DDP MODE AND BIT RATE COMMANDS

OCTAL CMD NUMBER

- 006 NORMAL BIT RATE SEL

  THIS CMD SELECTS THE DDP TIMING CONFIGURATION SUCH THAT IN THE DP FORMAT MODE THE DOWNLINK DATA RATE IS 1060 BPS. IN THE LSP FORMAT MODE THE DOWNLINK DATA RATE IS 3533.3 BPS. THE APPLICATION OF PWR TO ALSEP CAUSES INITIALIZATION IN THE NORMAL BIT RATE CONFIGURATION. WHEN A CHANGE FROM LOW BIT RATE TO NORMAL BIT RATE IS COMMANDED, IN EITHER DP OR LSP FORMAT, THE CHANGE TAKES EFFECT AT THE END OF THE 64-WORD DATA FRAME, FOLLOWING RECEIPT OF CMD 006, FOR WHICHEVER DDP IS OPERATIONAL. REPEATED APPLICATION OF CMD 006 HAS NO FURTHER EFFECT.

- 007 LOW BIT RATE SEL

  THIS CMD SELECTS THE DDP TIMING CONFIGURATION SUCH THAT IN THE DP FORMAT MODE THE DOWNLINK DATA RATE IS 530 BPS. IN THE LSP FORMAT MODE THE DOWNLINK DATA RATE IS 1060 BPS. WHEN A CHANGE FROM NORMAL BIT RATE TO LOW BIT RATE IS COMMANDED, IN EITHER DP OR LSP FORMAT, THE CHANGE TAKES EFFECT AT THE END OF THE 64-WORD DATA FRAME, FOLLOWING RECEIPT OF CMD 007, FOR WHICHEVER DDP IS OPERATIONAL. REPEATED APPLICATION OF CMD 007 HAS NO FURTHER EFFECT.

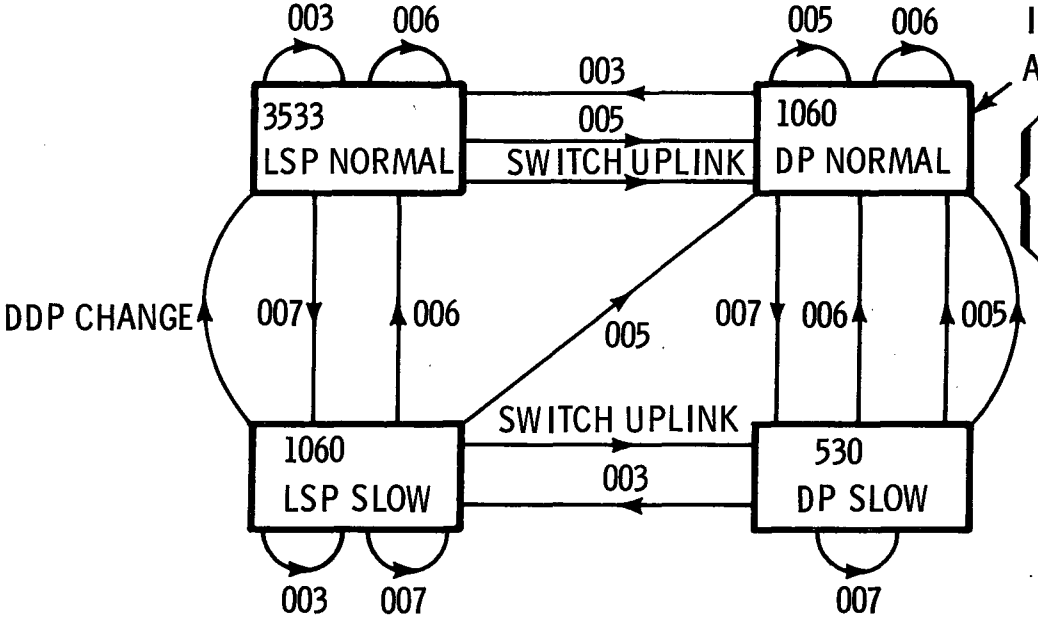
- 005 DP FORMAT ON

  THIS CMD SELECTS THE DDP CONFIGURATION THAT INHIBITS INPUTS FROM THE LSP TO THE MODULATOR, ENABLES INPUTS FROM THE DIGITAL MUX AND THE OTHER EXPERIMENTS, AND ENABLES DATA DEMANDS TO THOSE EXPERIMENTS. WHEN SWITCHING FROM LSP FORMAT TO DP FORMAT BY CMD 005, IN EITHER LSP NORMAL DATA RATE (3533.3 BPS) OR LSP LOW DATA RATE (1060 BPS) THE RESULTING DP DATA RATE WILL BE NORMAL (1060 BPS). CMD 005 TAKES EFFECT AT THE END OF THE 64-WORD DATA FRAME, FOLLOWING RECEIPT, FOR WHICHEVER DDP IS OPERATIONAL (BUT IS NOT OUTPUTTING DATA). THE APPLICATION OF PWR TO ALSEP CAUSES INITIALIZATION IN THE DP FORMAT CONFIGURATION. REPEATED APPLICATION OF CMD 005 HAS NO FURTHER EFFECT.

- 003 LSP FORMAT ON

  THIS CMD SELECTS THE DDP CONFIGURATION THAT ENABLES INPUTS FROM THE LSP TO THE MODULATOR, INHIBITS INPUTS FROM THE DIGITAL MUX AND OTHER EXPERIMENTS, AND INHIBITS DATA DEMANDS TO THE EXPERIMENTS. WHEN SWITCHING FROM DP FORMAT TO LSP FORMAT BY CMD 003, THE RESULTING LSP DATA RATE WILL BE NORMAL OR LOW (3533.3 BPS OR 1060 BPS) DEPENDING ON WHETHER THE DP DATA RATE WAS NORMAL OR LOW (1060 BPS OR 530 BPS). CMD 003 TAKES EFFECT AT THE END OF THE 64-WORD DATA FRAME, FOLLOWING RECEIPT, FOR THE DDP IN OPERATION AT THAT TIME. REPEATED APPLICATION OF CMD 003 HAS NO FURTHER EFFECT.

MODE AND BIT RATE CONFIGURATION SWITCHING



LEGEND:

BOXES INDICATE MODE AND BIT RATE CONFIGURATIONS

LINES INDICATE SWITCHING PATHS (NUMBERS ON LINES ARE OCTAL COMMANDS)

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DDP TELEMETRY

THE DDP COLLECTS AND FORMATS THE DATA OUTPUT OF ALL EXPERIMENTS (EXCEPT THE LSP), THE ADP OUTPUT, AND THE CVW (WHEN PRESENT), AND PROVIDES A MODULATION SIGNAL FOR DOWNLINK TRANSMISSION. IN THE DATA PROCESSOR FORMAT, THE OUTPUT IS A 640-BIT DATA FRAME (64 10-BIT DATA WORDS) AT TWO RATES:

1060 BITS PER SECOND: NORMAL BIT RATE
530 BITS PER SECOND: LOW BIT RATE
} IDENTICAL FORMATS

IN THE LSP FORMAT, THE DATA COLLECTION AND FORMATTING IS PERFORMED BY THE LSP WITH ONLY TIMING AND MODULATION PERFORMED BY THE DDP. THE OUTPUT IS AN 1800-BIT MAIN DATA FRAME (60 30-BIT DATA WORDS) AT TWO DATA RATES:

3533.3 BITS PER SECOND: NORMAL BIT RATE
1060 BITS PER SECOND: LOW BIT RATE
} IDENTICAL FORMATS

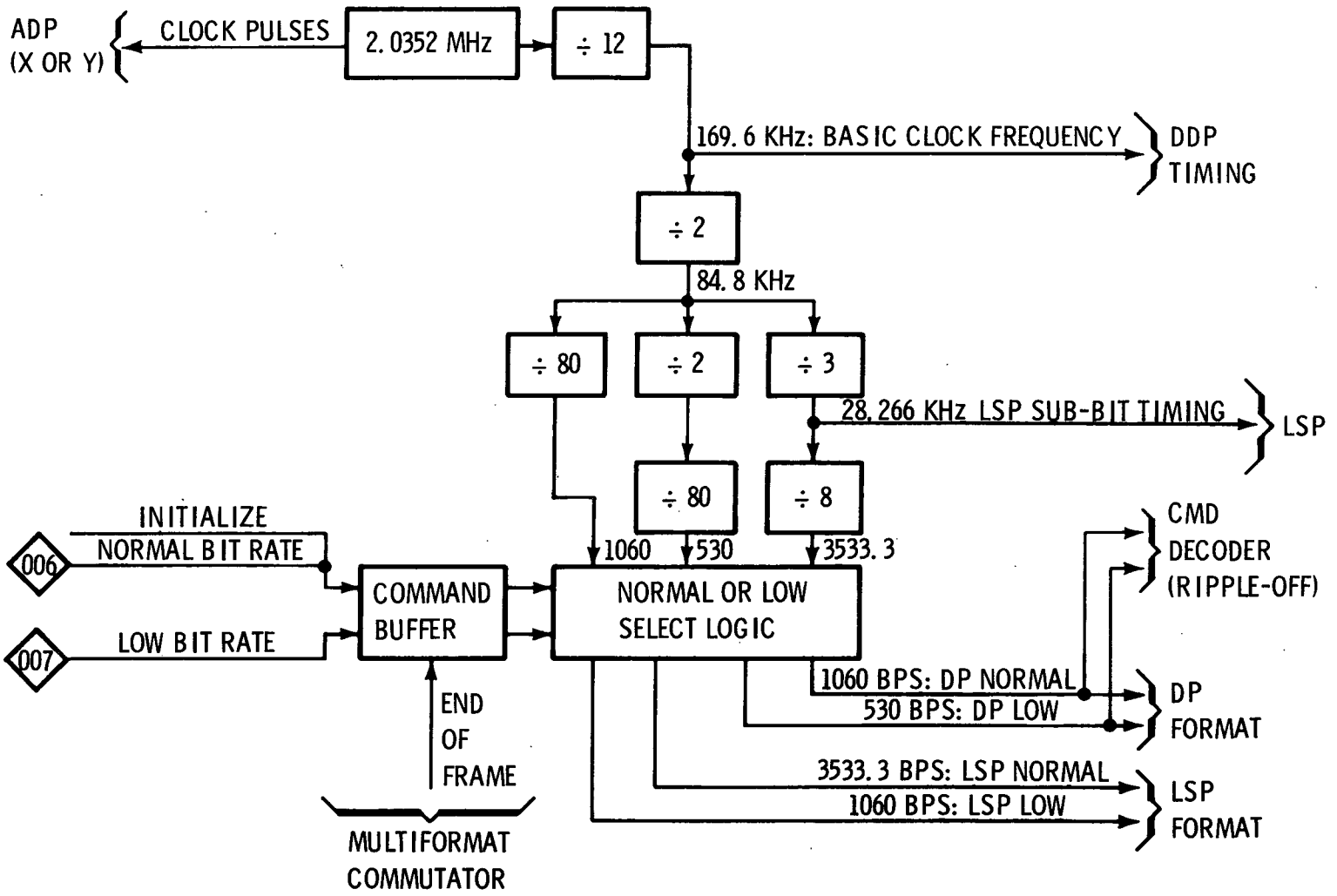
IN THE DATA PROCESSOR FORMAT, THE DDP GENERATES THE CONTROL WORDS (WORDS 1, 2, AND 3 IN EACH FRAME) WHICH CONTAIN:

DA-01 ALSEP FRAME SYNC (22 BITS: BARKER CODE AND COMPLEMENT)
DA-02 ALSEP FRAME CNTR (7 BITS: IDENTIFYING 90 SEQUENTIAL FRAMES)
DA-03 ALSEP BIT RATE ID (30TH BIT IN THE FIRST AND SECOND FRAME)
DA-04 ALSEP ID (30TH BIT IN FRAMES 3, 4, AND 5; BINARY 100 FOR APOLLO 17 ALSEP)

THE FOLLOWING STATUS PARAMETER IS SENSED IN THE DDP:

AB-10 DDP STATUS (X OR Y)

DDP BASIC CLOCK LOGIC



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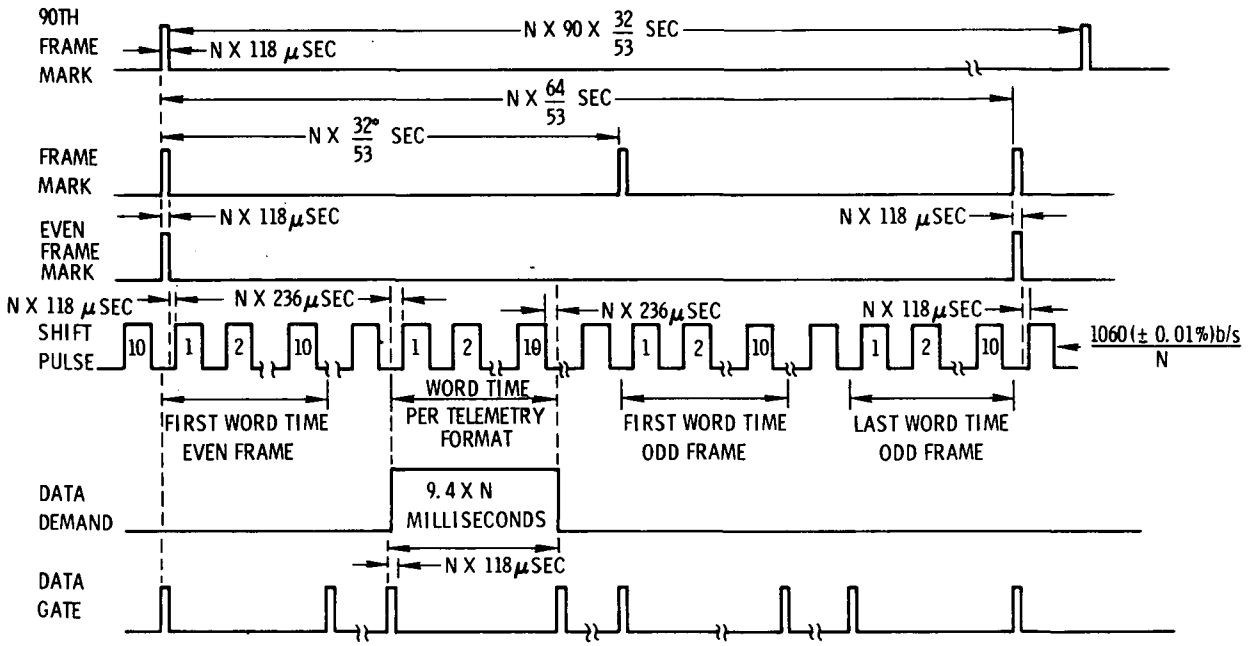
DATA PROCESSOR TIMING/CONTROL SIGNALS



N = 1 FOR NORMAL MODE OF 1060 bps

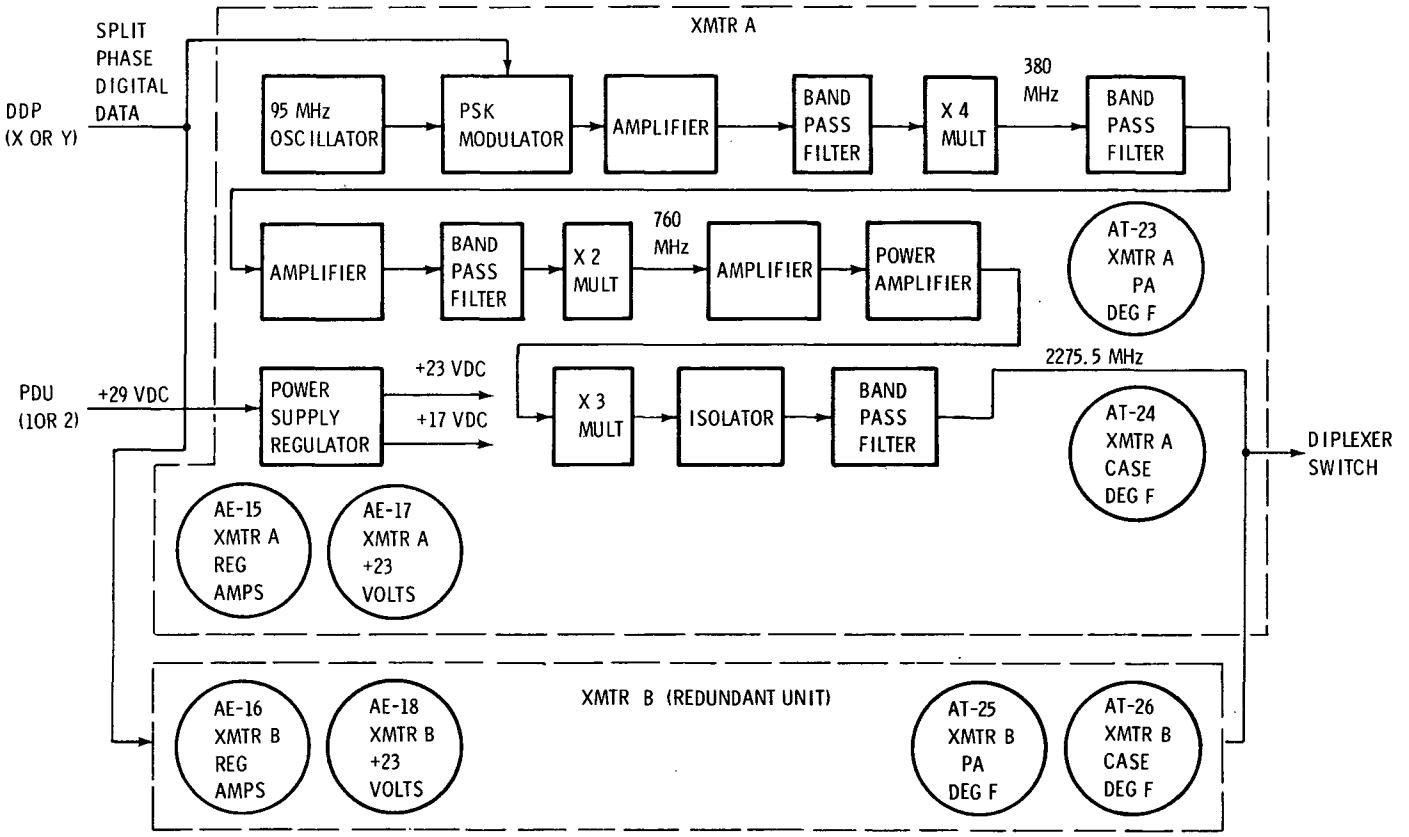
N = 2 FOR SLOW MODE OF 530 bps

LOGIC LEVELS: "ONE", + 4.0 ± 1.5 VOLTS; "ZERO", + 0.2 ± 0.2 VOLTS

*$\frac{32}{53}$ SEC = $\frac{640 \text{ BITS PER FRAME}}{1060 \text{ bps}}$ ALL OTHER TIMES ARE ACCURATE ONLY TO THE SIGNIFICANT FIGURE SHOWN.

TRANSMITTER FUNCTIONS

SPECIFICATIONS:
OUTPUT: 1 WATT INTO A 50-OHM LOAD
FREQUENCY: +0.000, -0.0005% ON INITIAL SETTING
+0.0005%, -0.0000 DRIFT OVER TWO-YEAR PERIOD
± 0.002% DUE TO ENVIRONMENTAL EFFECTS
MODULATION INDEX: ± 1.25 RADIANS ± 5%



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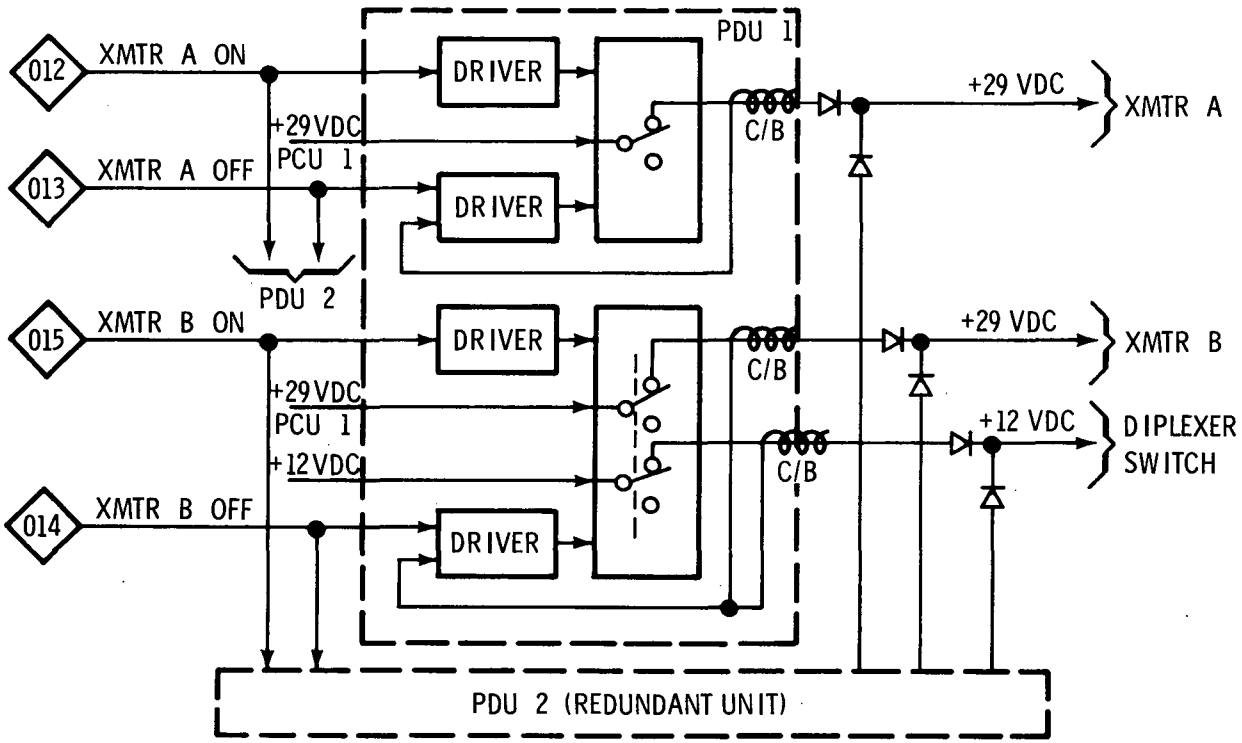
TRANSMITTER POWER CONTROL



NOTES:

- CIRCUIT BREAKERS (C/B) ISSUE OFF SIGNALS AT 760 MA FOR +29 VDC AND 150 MA FOR +12 VDC
- CIRCUIT BREAKERS ACTUALLY GROUND RELAY COIL (NOT DRIVER)
- UNLIKE PREVIOUS ALSEP'S, THERE ARE NO BACKUP HEATERS PLACED ON-LINE WHEN BOTH XMTR'S ARE OFF; ALSO, THERE IS NO AUTOMATIC SWITCHOVER FROM ONE XMTR TO THE OTHER (XMTR'S ARE CONTROLLED INDEPENDENTLY)

MAY 72 3270.2.43

XMTR POWER COMMANDS

OCTAL CMD NUMBERS

- 012 XMTR A ON

THIS CMD ACTUATES A PAIR OF LATCHING RELAYS, ONE IN EACH PDU, TO THE POSITION THAT APPLIES +29 VDC TO XMTR A. XMTR A IS PRESET TO BE ENERGIZED AT INITIAL LUNAR ACTIVATION. REPEATED APPLICATION OF CMD 012 HAS NO FURTHER EFFECT.

- 013 XMTR A OFF

THIS CMD ACTUATES A PAIR OF LATCHING RELAYS, ONE IN EACH PDU, TO THE POSITION THAT REMOVES +29 VDC FROM XMTR A. NOTE THAT THERE IS NO XMTR HEATER TO REPLACE THE LOAD IN THE CENTRAL STATION WHEN BOTH XMTR'S ARE OFF, BUT APM COMPENSATION WILL OCCUR IF NECESSARY. REPEATED APPLICATION OF CMD 013 HAS NO FURTHER EFFECT.

- 014 XMTR B OFF

THIS CMD ACTUATES A PAIR OF LATCHING RELAYS, ONE IN EACH PDU, TO THE POSITION THAT REMOVES +29 VDC FROM XMTR B AND +12 VDC FROM THE DIPLEXER SWITCH. NOTE THAT THERE IS NO XMTR HEATER TO REPLACE THE LOAD IN THE CENTRAL STATION WHEN BOTH XMTR'S ARE OFF BUT APM COMPENSATION WILL OCCUR IF NECESSARY. XMTR B IS PRESET TO BE DEENERGIZED AT INITIAL LUNAR ACTIVATION. REPEATED APPLICATION OF CMD 014 HAS NO FURTHER EFFECT.

- 015 XMTR B ON

THIS CMD ACTUATES A PAIR OF LATCHING RELAYS, ONE IN EACH PDU, TO THE POSITION THAT APPLIES +29 VDC TO XMTR B AND +12 VDC TO THE DIPLEXER SWITCH. IN THE ENERGIZED STATE, THE DIPLEXER SWITCH CONNECTS XMTR B TO THE ANTENNA; HENCE, IF BOTH XMTR'S ARE COMMANDED ON SIMULTANEOUSLY, THE OUTPUT OF XMTR B WILL BE RADIATED DOWNLINK. THE OUTPUT OF XMTR A WILL BE DISSIPATED IN A DUMMY LOAD IN THE DIPLEXER SWITCH. REPEATED APPLICATION OF CMD 015 HAS NO FURTHER EFFECT.

TRANSMITTER TELEMETRY

THE FOLLOWING TEMPERATURES ARE SENSED IN THE TRANSMITTERS WITH POWER SUPPLIED IN THE XMTR AND SIGNAL CONDITIONING IN THE ADP (MEASUREMENTS ABSENT IF XMTR IS OFF):

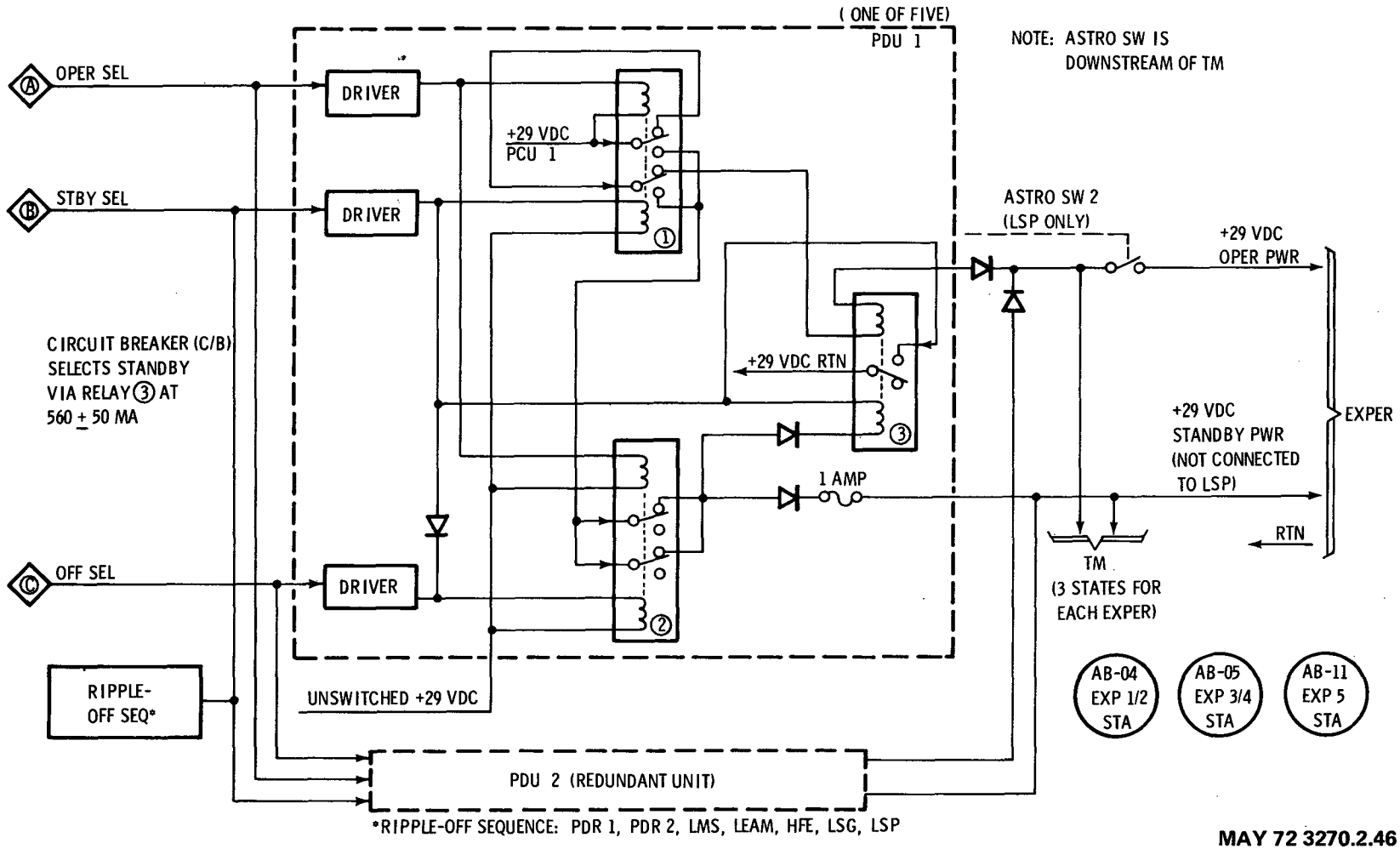
AT-23 XMTR A POWER AMPLIFIER TEMP, DEG F
AT-24 XMTR A CASE TEMP, DEG F
AT-25 XMTR B POWER AMPLIFIER TEMP, DEG F
AT-26 XMTR B CASE TEMP, DEG F

THE FOLLOWING ELECTRICAL PARAMETERS ARE SENSED IN THE TRANSMITTERS (MEASUREMENTS ABSENT WHEN XMTR IS OFF):

AE-15 XMTR A REGULATOR CURRENT, AMPS (SENSED IN THE +17 VDC LINE)
AE-16 XMTR B REGULATOR CURRENT, AMPS (SENSED IN THE +17 VDC LINE)
AE-17 XMTR A +23 VDC OUTPUT, VOLTS (SENSED AT THE POWER SUPPLY REGULATOR)
AE-18 XMTR B +23 VDC OUTPUT, VOLTS (SENSED AT THE POWER SUPPLY REGULATOR)

EXPERIMENT POWER CONTROL

(ONE OF FIVE)



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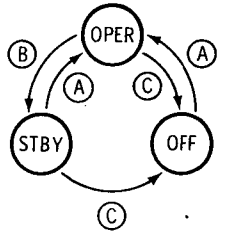
EXPERIMENT POWER CONTROL (CONT'D)

- SELECTION COMMANDS (OCTAL):

EXPER	(A) OPER	(B) STBY	(C) OFF
#1, LMS	036	037	041
#2, LEAM	042	043	044
#3, HFE	045	046	050
#4, LSG	052	053	054
#5, LSP	055	056	057

- POWER SWITCHING FROM OFF TO STBY IS INHIBITED:



- NORMAL OPERATING SEQUENCES:

SEQUENCE	RELAY CONTACT POSITION		
	①	②	③
OFF TO OPER	UP	UP	DOWN
OPER TO STBY	DOWN	UP	DOWN
STBY TO OFF	DOWN	DOWN	DOWN
OPER TO OFF	DOWN	DOWN	DOWN

- OVERLOAD (CIRCUIT BREAKER) SEQUENCE:

SEQUENCE	RELAY CONTACT POSITION			
	①	②	③	
OPER (INITIAL)	UP	UP	DOWN	
OPER TO OVERLOAD 1	UP	UP	UP	
OVERLOAD 1 TO OVERLOAD 2	DOWN	UP	UP	
OVERLOAD 2 TO STBY	DOWN	UP	DOWN	←RESET OF C/B

EXPERIMENT POWER SWITCHING

OCTAL CMD NUMBERS

- 036 EXPER 1 OPER (LMS)

  THIS CMD ACTUATES LATCHING RELAYS, IN BOTH PDU'S, TO THE POSITION THAT APPLIES +29 VDC TO THE OPERATING LINE OF THE LMS. REPEATED APPLICATION OF CMD 036 HAS NO FURTHER EFFECT.

- 037 EXPER 1 STBY (LMS)

  THIS CMD ACTUATES LATCHING RELAYS, IN BOTH PDU'S, TO THE POSITION THAT REMOVES +29 VDC OPERATIONAL POWER FROM THE LMS, IF IT WAS IN THE OPERATE MODE, AND APPLIES +29 VDC TO THE STANDBY LINE. IN THE OFF MODE, CMD 037 DOES NOT CONTROL PWR AND THE EXPERIMENT REMAINS OFF. REPEATED APPLICATION OF CMD 037 HAS NO FURTHER EFFECT.

- 041 EXPER 1 OFF (LMS)

  THIS CMD ACTUATES LATCHING RELAYS, IN BOTH PDU'S, TO THE POSITION THAT REMOVES ALL +29 VDC PWR FROM THE LMS, WHETHER IT WAS PREVIOUSLY IN THE OPERATE MODE OR THE STANDBY MODE. THE EXPERIMENT RELAYS ARE PRESET TO BE IN THE OFF MODE AT INITIAL LUNAR ACTIVATION. REPEATED APPLICATION OF CMD 041 HAS NO FURTHER EFFECT.

EXPERIMENT POWER SWITCHING (CONT'D)

OCTAL CMD NUMBERS

- 042 EXPER 2 OPER (LEAM)

  THIS CMD ACTUATES LATCHING RELAYS, IN BOTH PDU'S, TO THE POSITION THAT APPLIES +29 VDC TO THE OPERATING LINE OF THE LEAM. REPEATED APPLICATION OF CMD 042 HAS NO FURTHER EFFECT.

- 043 EXPER 2 STBY (LEAM)

  THIS DMC ACTUATES LATCHING RELAYS, IN BOTH PDU'S, TO THE POSITION THAT REMOVES +29 VDC OPERATIONAL POWER FROM THE LEAM, IF IT WAS IN THE OPERATE MODE, AND APPLIES +29 VDC TO THE STANDBY LINE. IN THE OFF MODE, CMD 043 DOES NOT CONTROL PWR AND THE EXPERIMENT REMAINS OFF. REPEATED APPLICATION OF CMD 043 HAS NO FURTHER EFFECT.

- 044 EXPER 2 OFF (LEAM)

  THIS CMD ACTUATES LATCHING RELAYS, IN BOTH PDU'S,TO THE POSITION THAT REMOVES ALL +29 VDC PWR FROM THE LEAM, WHETHER IT WAS PREVIOUSLY IN THE OPERATE MODE OR THE STANDBY MODE. THE EXPERIMENT RELAYS ARE PRESET TO BE IN THE OFF MODE AT INITIAL LUNAR ACTIVATION. REPEATED APPLICATION OF CMD 044 HAS NO FURTHER EFFECT.

EXPERIMENT POWER SWITCHING (CONT'D)

OCTAL CMD NUMBERS

- 045 EXPER 3 OPER (HFE)

  THIS CMD ACTUATES LATCHING RELAYS, IN BOTH PDU'S, TO THE POSITION THAT APPLIES +29 VDC TO THE OPERATING LINE OF THE HFE. REPEATED APPLICATION OF CMD 045 HAS NO FURTHER EFFECT.

- 046 EXPER 3 STBY (HFE)

  THIS CMD ACTUATES LATCHING RELAYS, IN BOTH PDU'S, TO THE POSITION THAT REMOVES +29 VDC OPERATIONAL POWER FROM THE HFE, IF IT WAS IN THE OPERATE MODE, AND APPLIES +29 VDC TO THE STANDBY LINE. IN THE OFF MODE, CMD 046 DOES NOT CONTROL PWR AND THE EXPERIMENT REMAINS OFF. REPEATED APPLICATION OF CMD 046 HAS NO FURTHER EFFECT.

- 050 EXPER 3 OFF (HFE)

  THIS CMD ACTUATES LATCHING RELAYS, IN BOTH PDU'S, TO THE POSITION THAT REMOVES ALL +29 VDC PWR FROM THE HFE, WHETHER IT WAS PREVIOUSLY IN THE OPERATE MODE OR THE STANDBY MODE. THE EXPERIMENT RELAYS ARE PRESET TO BE IN THE OFF MODE AT INITIAL LUNAR ACTIVATION. REPEATED APPLICATION OF CMD 050 HAS NO FURTHER EFFECT.

EXPERIMENT POWER SWITCHING (CONT'D)

OCTAL CMD NUMBERS

- 052 EXPER 4 OPER (LSG)

  THIS CMD ACTUATES LATCHING RELAYS, IN BOTH PDU'S, TO THE POSITION THAT APPLIES +29 VDC TO THE OPERATING LINE OF THE LSG. REPEATED APPLICATION OF CMD 052 HAS NO FURTHER EFFECT.

- 053 EXPER 4 STBY (LSG)

  THIS CMD ACTUATES LATCHING RELAYS, IN BOTH PDU'S, TO THE POSITION THAT REMOVES +29 VDC OPERATIONAL POWER FROM THE LSG, IF IT WAS IN THE OPERATE MODE, AND APPLIES +29 VDC TO THE STANDBY LINE. IN THE OFF MODE, CMD 053 DOES NOT CONTROL PWR AND THE EXPERIMENT REMAINS OFF. REPEATED APPLICATION OF CMD 053 HAS NO FURTHER EFFECT.

- 054 EXPER 4 OFF (LSG)

  THIS CMD ACTUATES LATCHING RELAYS, IN BOTH PDU'S, TO THE POSITION THAT REMOVES ALL +29 VDC PWR FROM THE LSG, WHETHER IT WAS PREVIOUSLY IN THE OPERATE MODE OR THE STANDBY MODE. THE EXPERIMENT RELAYS ARE PRESET TO BE IN THE OFF MODE AT INITIAL LUNAR ACTIVATION. REPEATED APPLICATION OF CMD 054 HAS NO FURTHER EFFECT.

EXPERIMENT POWER SWITCHING (CONT'D)

OCTAL CMD NUMBERS

- 055 EXPER 5 OPER (LSP)

  THIS CMD ACTUATES LATCHING RELAYS, IN BOTH PDU'S, TO THE POSITION THAT APPLIES +29 VDC TO THE OPERATING LINE OF THE LSP. ASTRO SW 2 IS ALSO IN THIS LINE AND TM WILL SHOW OPER MODE REGARDLESS OF THE STATE OF ASTRO SW 2. REPEATED APPLICATION OF CMD 055 HAS NO FURTHER EFFECT.

- 056 EXPER 5 STBY (LSP)

  THIS CMD ACTUATES LATCHING RELAYS, IN BOTH PDU'S, TO THE POSITION THAT REMOVES +29 VDC OPERATIONAL POWER FROM THE LSP, IF IT WAS IN THE OPERATE MODE, AND APPLIES +29 VDC TO THE STANDBY LINE. THE LSP HAS NO STANDBY MODE. IN THE OFF MODE, CMD 056 DOES NOT CONTROL PWR AND THE EXPERIMENT REMAINS OFF. THE EXPERIMENT RELAYS ARE PRESET TO BE IN THE STBY MODE AT INITIAL LUNAR ACTIVATION. REPEATED APPLICATION OF CMD 056 HAS NO FURTHER EFFECT.

- 057 EXPER 5 OFF (LSP)

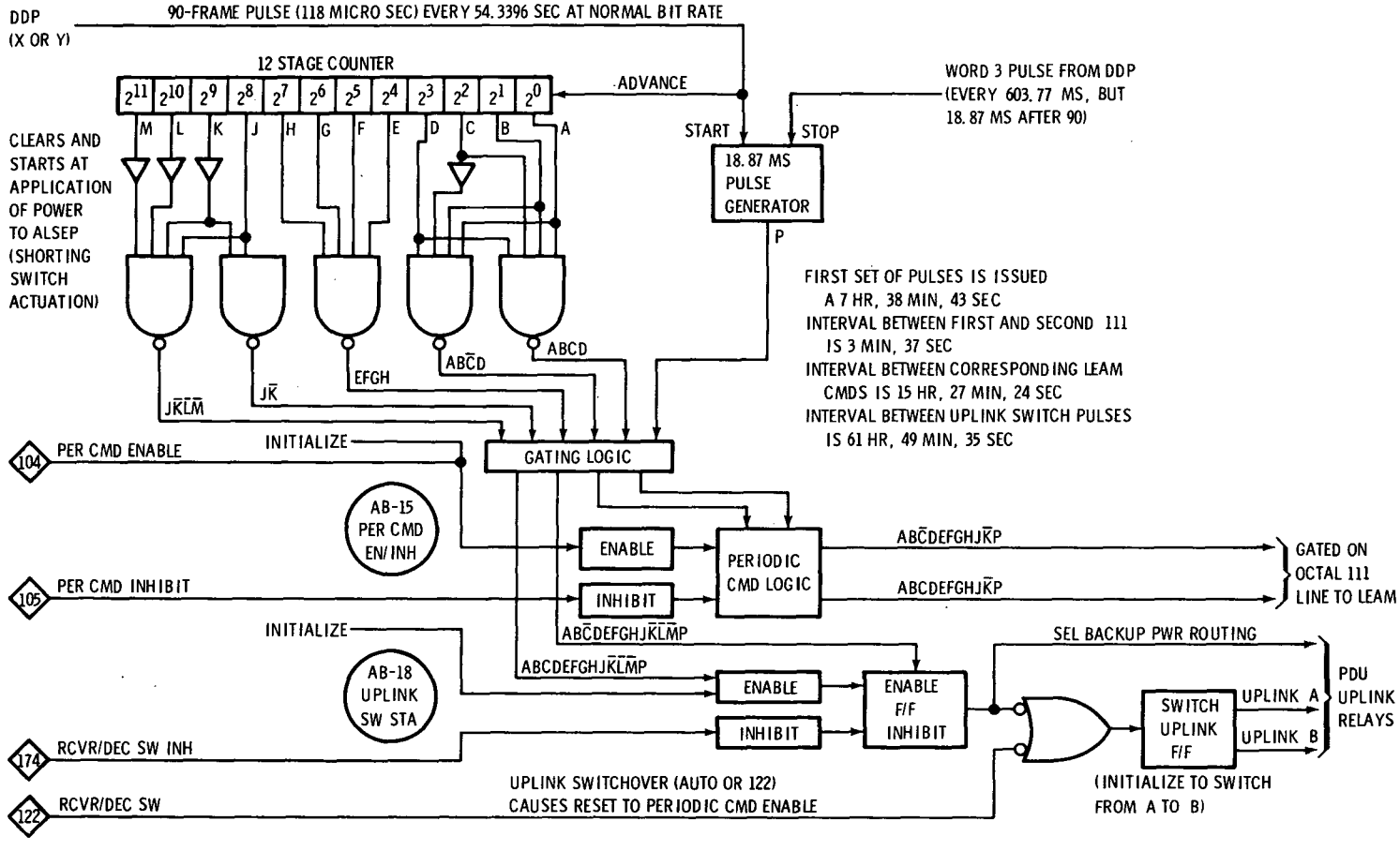
  THIS CMD ACTUATES LATCHING RELAYS, IN BOTH PDU'S, TO THE POSITION THAT REMOVES ALL +29 VDC PWR FROM THE LSP, WHETHER IT WAS PREVIOUSLY IN THE OPERATE MODE OR THE STANDBY MODE. REPEATED APPLICATION OF CMD 057 HAS NO FURTHER EFFECT.

EXPERIMENT POWER TELEMETRY

THE FOLLOWING STATUS PARAMETERS ARE GENERATED IN THE EXPERIMENT POWER CIRCUITS:

AB-04	EXPER 1/2 STATUS	(INDICATES THE OPER, STANDBY, OR OFF STATUS OF EXPERIMENT #1, LMS, AND EXPERIMENT #2, LEAM. IF THE STANDBY FUSE IS BLOWN, WILL INDICATE OFF WHEN COMMANDED TO STANDBY)
AB-05	EXPER 3/4 STATUS	(INDICATES THE OPER, STANDBY, OR OFF STATUS OF EXPERIMENT #3, HFE, AND EXPERIMENT #4, LSG. IF THE STANDBY FUSE IS BLOWN, WILL INDICATE OFF WHEN COMMANDED TO STANDBY)
AB-11	EXPER 5 STATUS	(INDICATES OPER, STANDBY, OR OFF FOR EXPERIMENT #5, LSP. THE STANDBY POWER CIRCUIT IS NOT CONNECTED TO THE LSP; FUNCTIONALLY, THE LSP IS OFF FOR BOTH OF THESE RELAY SETTINGS. FOR THE LSP TO RECEIVE OPERATIONAL POWER, THE RELAYS MUST BE IN THE OPERATE SETTING AS INDICATED BY AB-11, AND ASTRO SWITCH 2 MUST BE IN THE CW, CLOSED, POSITION)

UPLINK AND PERIODIC CMD FUNCTIONS
(NOT REDUNDANT)



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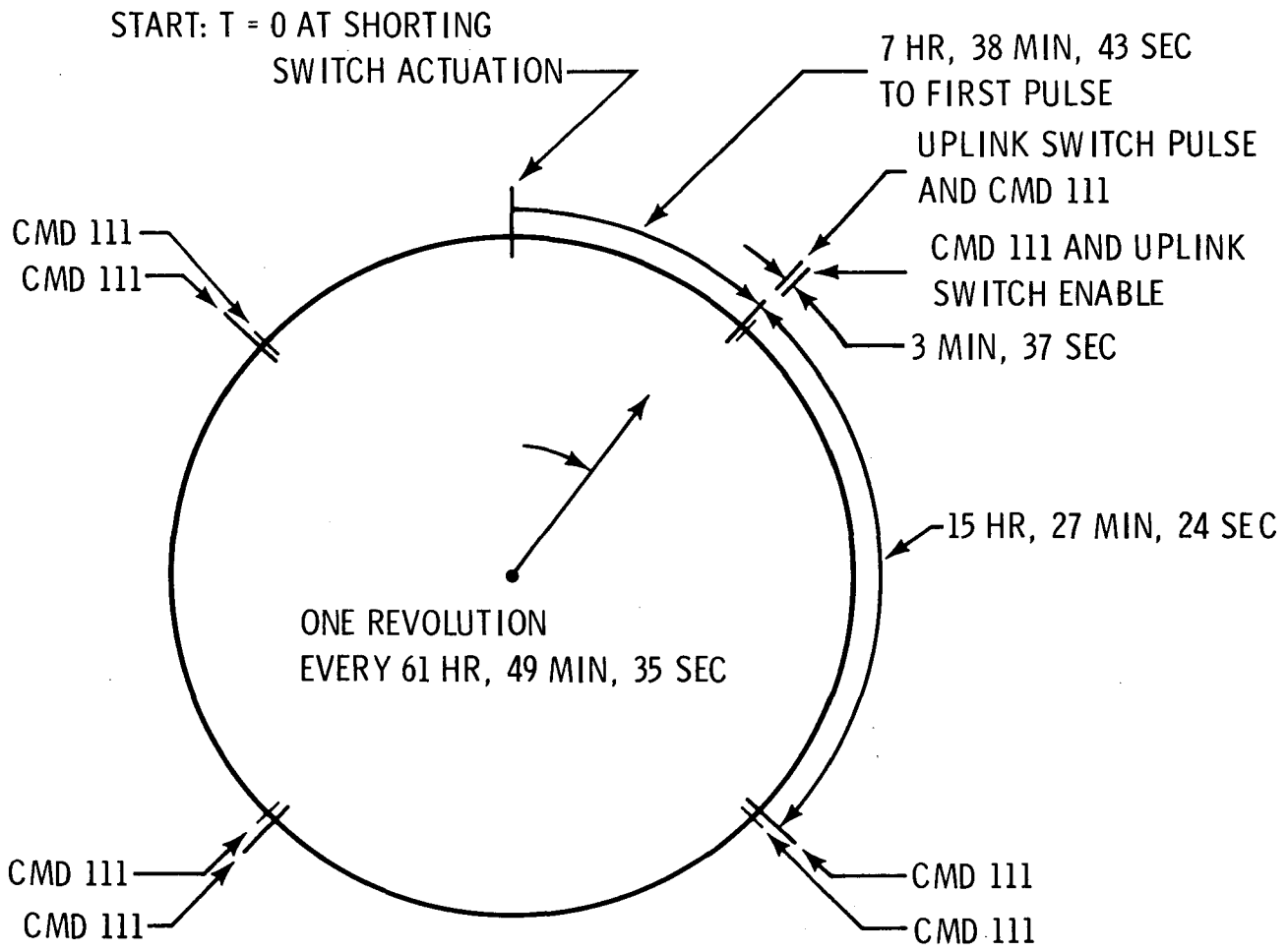
UPLINK AND PERIODIC CMD TIMING



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PERIODIC CMD ENABLE AND INHIBIT

OCTAL CMD NUMBER

- 104 PER CMD ENABLE

  THIS CMD ACTUATES CIRCUITRY IN THECMD DECODER TO ENABLE OUTPUT OF PERIODIC CMDS EVERY 15.46 HR EXCEPT FOR THE FIRST OUTPUT WHICH IS AT 7.65 HR. TWO OUTPUTS OCCUR WITH A 3.55-MINUTE INTERVAL, THE FIRST BEING BOTH CMD 065 (NOT USED) AND CMD 111, THE SECOND BEING COMMAND 111. THE APPLICATION OF PWR TO ALSEP CAUSES INITIALIZATION IN THE ENABLE CONFIGURATION. REPEATED APPLICATION OF CMD 104 HAS NO FURTHER EFFECT.

- 105 PER CMD INHIBIT

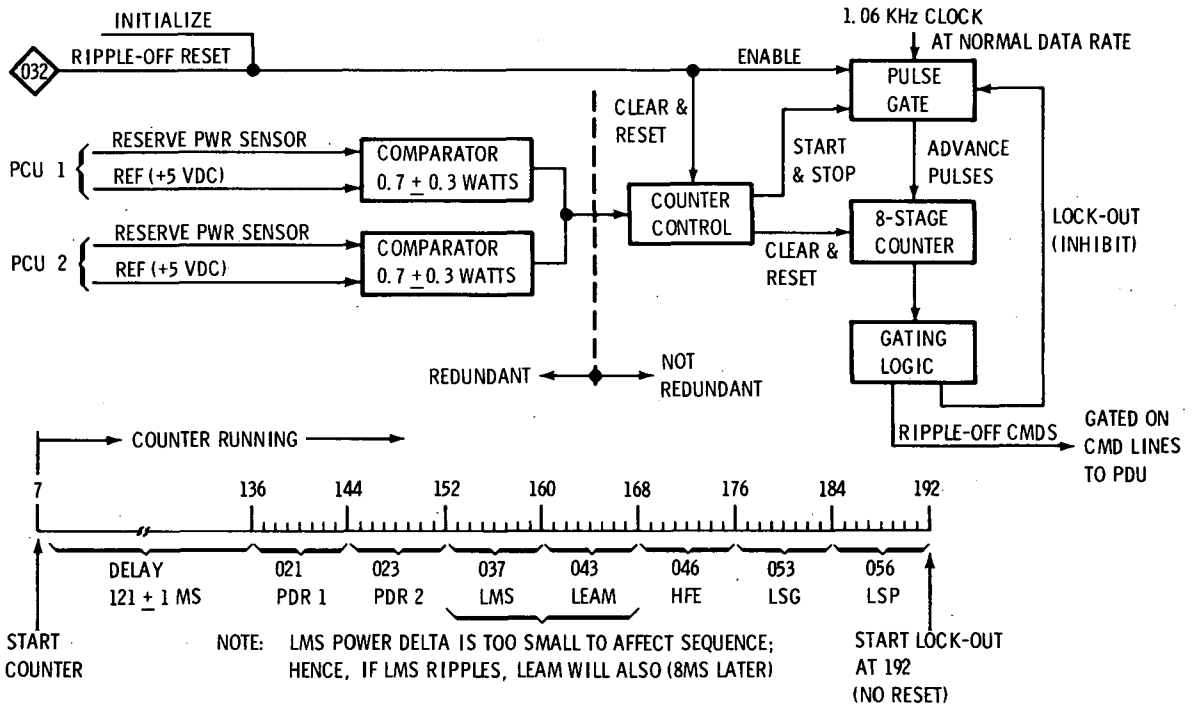
  THIS CMD ACTUATES CIRCUITRY IN THE CMD DECODER TO INHIBIT OUTPUT OF PERIODIC CMDS. REPEATED APPLICATION OF CMD 105 HAS NO FURTHER EFFECT. A SEQUENCE OF COMMANDS 104 AND 105, ALTERNATING ENABLE/INHIBIT, DOES NOT PRODUCE SPURIOUS PER CMD PULSES.

TELEMETRY

THE FOLLOWING STATUS PARAMETER IS GENERATED IN THE PERIODIC COMMAND CIRCUIT:

AB-15 PER CMD EN/INH (INDICATES WHETHER OUTPUT PULSES FROM THE 12-STAGE COUNTER WILL BE APPLIED TO THE COMMAND LINE GATES)

RIPPLE-OFF SEQUENCER FUNCTION



- IF OVERLOAD EXISTS FOR 121 ± 1 MS, THEN PDR OFF AND EXPER STBY CMDS ARE ISSUED SEQUENTIALLY FOR 8 COUNTS EACH UNTIL OVERLOAD NO LONGER EXISTS
- WHEN OVERLOAD IS CLEARED, THE COUNTER IS RESET TO 7 AUTOMATICALLY AND NO FURTHER RIPPLE-OFF CMDS ARE ISSUED
- NOTE THAT EXPERIMENTS CAN NOT SWITCH FROM OFF TO STBY; IF THEY ARE OFF, THEY REMAIN OFF
- IF COUNTER RUNS TO 192, IT MAY BE A RIPPLE-OFF MALFUNCTION; THEREFORE, A LOCK-OUT FEATURE IS PROVIDED TO INHIBIT FURTHER COUNTER ACTION. EXPER/PDR SHOULD BE RESET BY CMD AND THEN ISSUE CMD 032 TO CHECK PERFORMANCE.
- PCU SWITCHOVER MAY CAUSE INITIALIZATION AND CLEAR LOCK-OUT IF IT EXISTS

RIPPLE-OFF RESET COMMAND

OCTAL CMD NUMBER

- 032 RIPPLE-OFF RESET
  THIS CMD RESETS THE COUNTER IN THE RIPPLE-OFF SEQUENCER, THUS RESTORING THE RIPPLE-OFF CAPABILITY AFTER THE COUNTER HAS RUN TO THE END AND LOCKED ITSELF OUT. THE LOCK-OUT FEATURE IS PROVIDED IN CASE A MALFUNCTION IN THE RIPPLE-OFF CIRCUITRY CAUSES ERRONEOUS RIPPLE-OFF. IF A RESET BY CMD 032 IS FOLLOWED BY A SECOND (ERRONEOUS) RIPPLE-OFF, CMD 032 SHOULD BE FLAGGED AS CRITICAL. WHEN NO MALFUNCTION EXISTS IN THE RIPPLE-OFF CIRCUITRY, REPEATED APPLICATION OF CMD 032 HAS NO FURTHER EFFECT. IN NORMAL ALSEP START-UP, THE RIPPLE-OFF COUNTER IS RESET BY THE TURN-ON PWR TRANSIENT.

ASTRONAUT SWITCH FUNCTIONS

ASTRO SW-1 (FOR CONTINGENCY USE ONLY)

- NORMALLY IN CCW POSITION, AT LAUNCH
- DOUBLE-POLE, DOUBLE-THROW SWITCH (REDUNDANT CONTACTS)
- IF ALSEP FAILS TO START UP NORMALLY, ASTRONAUT ROTATES SW-1 BACK AND FORTH (FROM CCW TO CW AND BACK TO CCW) AS FAST AS HE WANTS TO. IT IS SPRING-LOADED CCW, BUT DELIBERATE ROTATION IS RECOMMENDED.
- CW ROTATION OPENS RTG LINE TO PCU AND SIMULTANEOUSLY APPLIES RTG POWER TO PCU 2 SEL RELAY COIL CAUSING TRANSFER TO PCU 2 SETTING
- CCW ROTATION REMOVES RTG POWER FROM RELAY COIL AND APPLIES RTG TO PCU 2

ASTRO SW-2 (USED OPERATIONALLY)

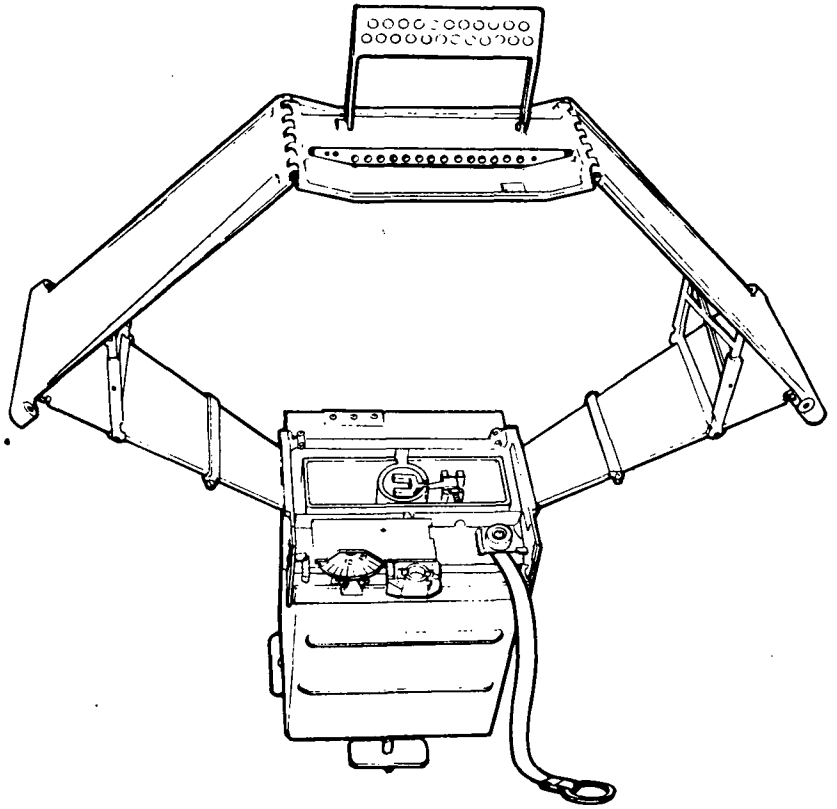
- NORMALLY IN CCW POSITION, AT LAUNCH, WHICH OPENS LINE AND PREVENTS +29 VDC FROM BEING APPLIED TO LSP DURING DEPLOYMENT
- AFTER DEPLOYMENT OF LSP EXPLOSIVE PACKAGES, ASTRONAUT ROTATES SW-2 CW TO ENABLE COMMAND APPLICATION OF +29 VDC OPERATIONAL POWER TO THE LSP

NOTE: DIRECTION OF ROTATION FOR ENABLE/INHIBIT IS THE REVERSE OF SW-5 ON EARLIER ALSEP's WITH ASE

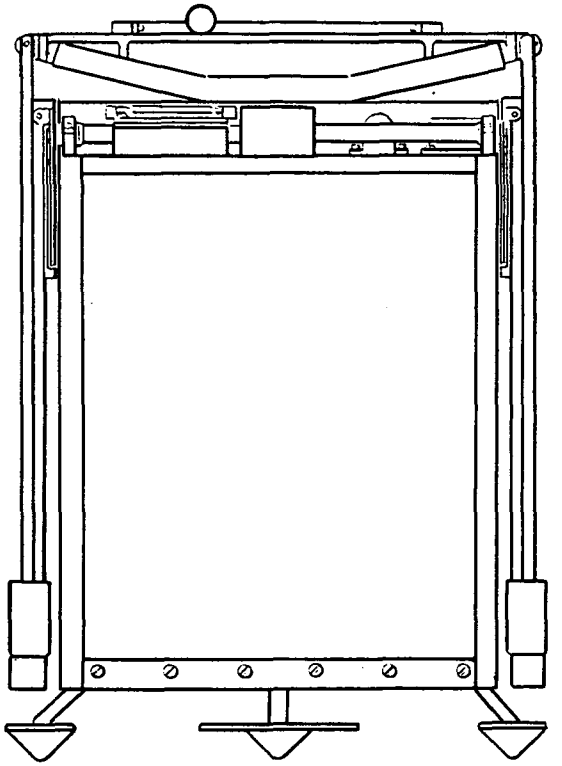
LUNAR SURFACE GRAVIMETER (LSG)

LSG EXTERNAL CONFIGURATION

LSG EXTERNAL CONFIGURATION



DEPLOYED



STOWED

JUNE 72 3270.3.2

LSG OBJECTIVES AND MEASUREMENTS

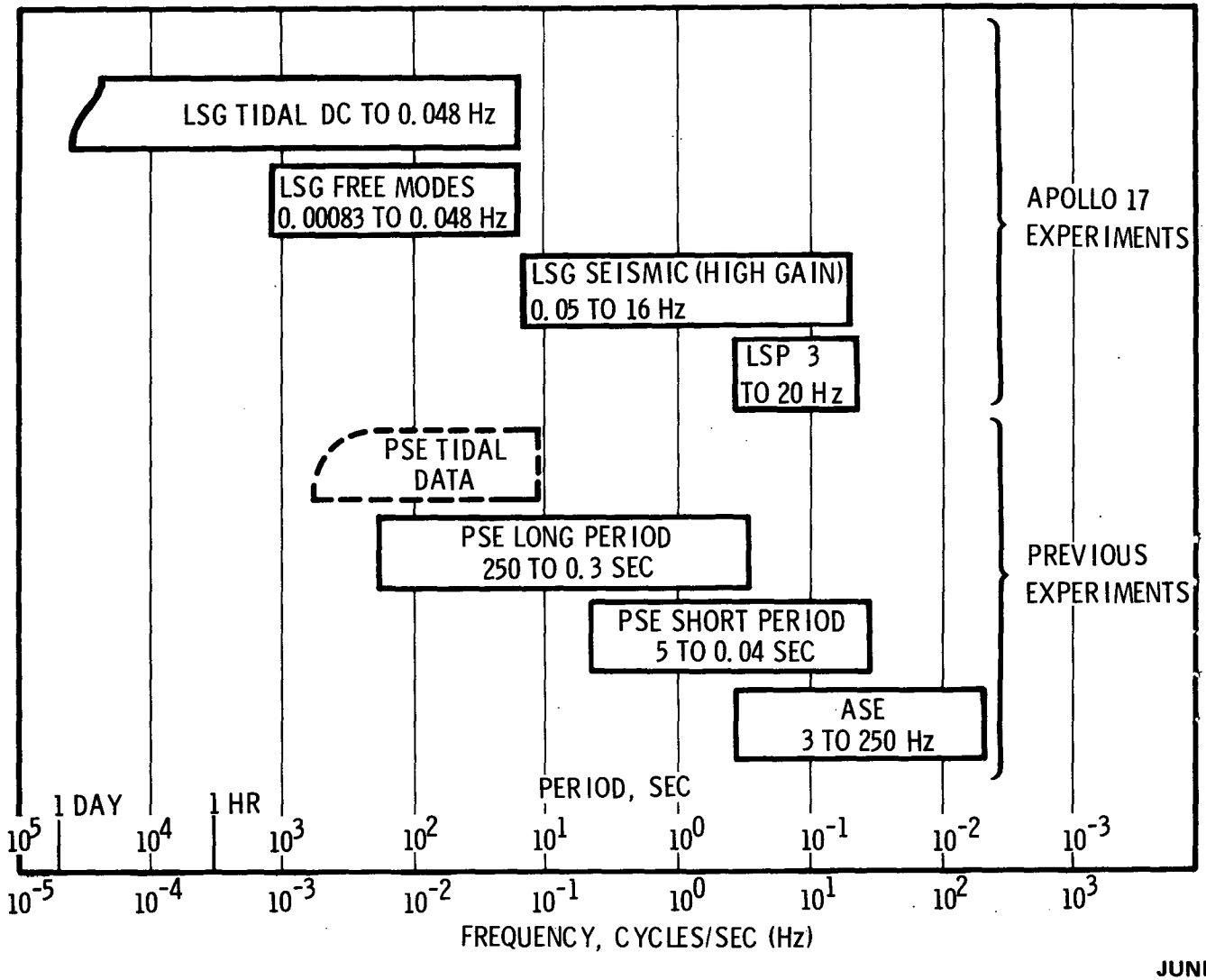
OBJECTIVES:

- SEARCH FOR GRAVITATIONAL RADIATION FROM COSMIC SOURCES, WHICH MAY EXCITE LOW-FREQUENCY FREE OSCILLATIONS OF THE MOON, IN THE FREQUENCY RANGE UPWARD FROM ONE CYCLE EVERY 15 MINUTES
- OBTAIN INFORMATION ON THE INTERNAL STRUCTURE OF THE MOON BY OBSERVATION OF LUNAR TIDES
- OBTAIN VERTICAL AXIS SEISMIC DATA UP TO FREQUENCIES OF 16 HZ
- DETERMINE THE RATIO OF LUNAR GRAVITATIONAL FORCE TO EARTH GRAVITY WITH A PRECISION OF 1 PART IN 10^5

MEASUREMENTS:

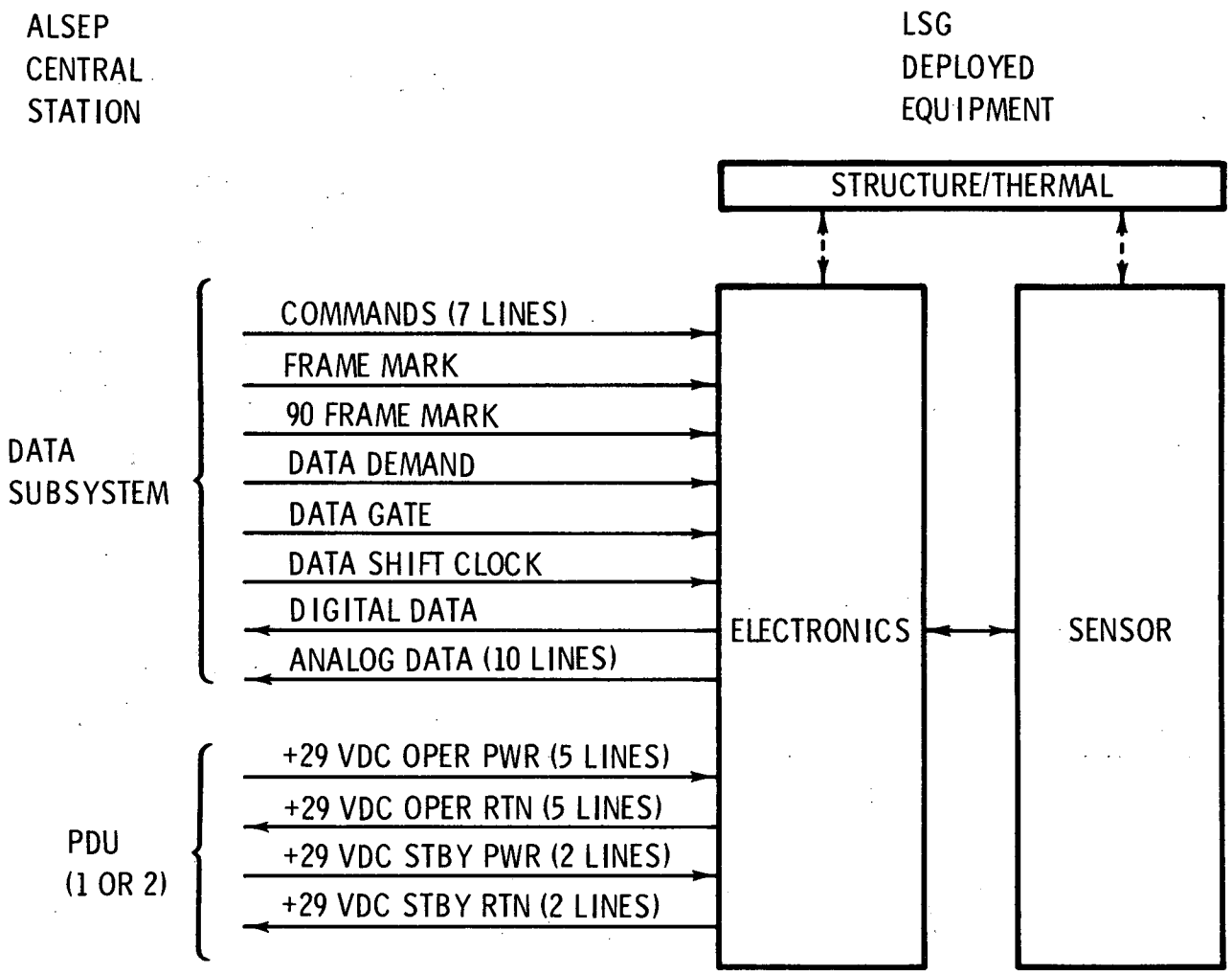
- USE THE LACOSTE-ROMBERG TYPE OF SPRING-MASS SUSPENSION TO SENSE CHANGES IN THE VERTICAL COMPONENT OF LOCAL GRAVITY
- BASIC INSTRUMENT SENSITIVITY TO CHANGES IN THE LUNAR GRAVITATIONAL FORCE IS 1 PART IN 10^{10}
- SHORT-PERIOD CHANGES (FREQUENCIES UP TO 16 HZ) ARE RECORDED AS SEISMIC DATA WHILE LONG-PERIOD CHANGES MEASURE TIDAL EFFECTS
- THE LOWEST FREQUENCIES (LONGEST PERIODS) ARE ASSOCIATED WITH FREE OSCILLATIONS OF THE MOON

SEISMIC/TIDAL RESPONSE SPECTRUM



JUNE 72 3270.3.4

LSG COMPONENTS AND ELECTRICAL INTERFACE



JUNE 72 3270.3.5

LSG OPERATIONS SUMMARY

DEPLOYMENT

- LOCATE 25 FT FROM CENTRAL STATION
- RAISE AND TILT SUNSHADE
- SET INSTRUMENT ON FIRM SURFACE WITH APPROXIMATE ORIENTATION
- LEVEL $\pm 3^0$ WRT BUBBLE AND ALIGN $\pm 3^0$ WRT SHADOW
- PERFORM INITIAL UNCAGING
- REPORT LEVEL AND ALIGNMENT

APPROX TIME, 3 MIN

POST DEPLOYMENT

- UNCAGE AND ACTIVATE BY CMD
- PERFORM INITIAL SET-UP/CHECK-OUT CMD SEQUENCE
- MAKE SUBSEQUENT ADJUSTMENTS BY CMD AS REQUIRED

LSG COMMUNICATIONS SUMMARY

COMMANDS

- POWER OPER/STBY/OFF
- 7 SPECIAL CMDS FOR:

  INSTRUMENT HOUSING HEATER ON/OFF (2)
  LSG CMD DECODER ON/OFF (2)
  LSG CMD REGISTER UP/DOWN (2)
  LSG CMD REGISTER EXECUTE (1)

- THE LSG CMD REGISTER PROVIDES FOR 30 ENCODED CMDS WHICH PERFORM VARIOUS INTERNAL ADJUSTMENTS AND FUNCTIONAL CHANGES IN LSG OPERATION

DATA

- 36 TEN-BIT DIGITAL WORDS IN EACH 64-WORD ALSEP DATA FRAME, WITH TWO DIFFERENT WORD ASSIGNMENTS SELECTABLE BY CMD:
  -NORMAL SCIENTIFIC DATA
  -SHAFT ENCODER DATA
- DIGITAL DATA RATE, 60 BITS PER SEC (AVERAGE AT NORMAL BIT RATE)
- ONE COMPLETE UPDATE OF SCIENTIFIC DATA IN EACH ALSEP FRAME (0.6-SEC REP RATE AT ALSEP NORMAL BIT RATE)
- SHAFT ENCODER DATA ARE READ OUT AS OFTEN AS 12 TIMES IN EACH ALSEP FRAME AND REPEATED FOR 90 FRAMES (NO CHANGE IN READINGS)
- 10 ANALOG ENGINEERING PARAMETERS EACH SAMPLED ONCE EVERY 90 ALSEP DATA FRAMES (54 SEC AT NORMAL BIT RATE)

LSG DESIGN PARAMETERS

MECHANICAL

SENSITIVITY: DEVIATIONS IN LUNAR SURFACE ACCELERATION OF ONE PART IN 10^{10} OR BETTER

ACCURACY: LUNAR TIDES, 0.1% OR BETTER
RESOLUTION FOR INDIVIDUAL MEASUREMENTS, 2 MICROGALS
RATIO OF LUNAR G TO EARTH G, 1 PART IN 10^5

THERMAL

SHORT TERM STABILITY: $\pm$ 0.001°C (FOR PERIODS UP TO 30 MIN.) AT AN INVERSION TEMPERATURE NEAR 50°C

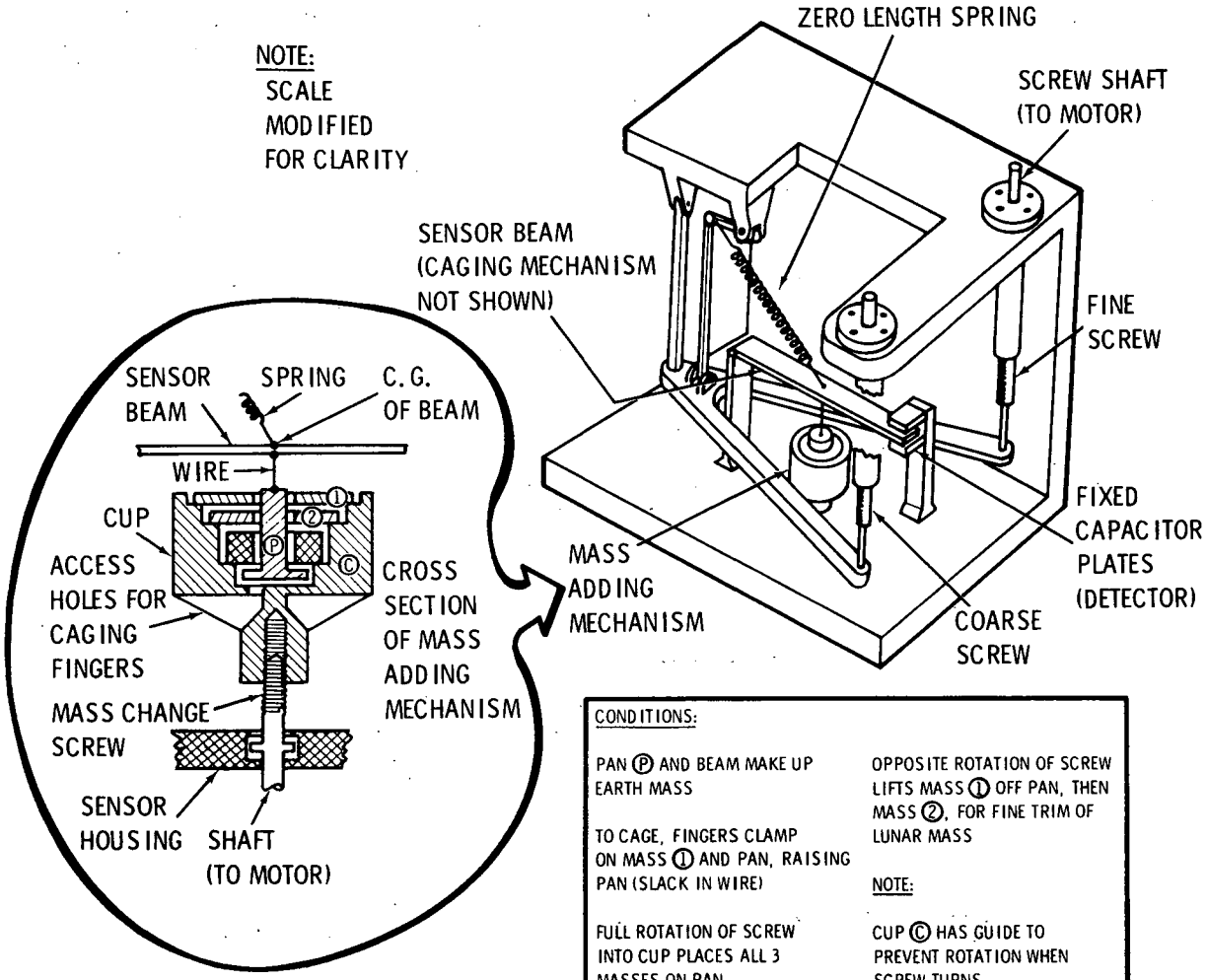
LONG TERM DRIFT: 0.1°C PER MONTH

ABSOLUTE TEMPERATURE: 0.001°C

ELECTRICAL

PREAMP GAIN: 40
POSTAMP GAIN: 1 TO 90 IN STEPS OF 6
SEISMIC AMPLIFIER GAIN WITH SOFT LIMITING: 500
FREE MODES AMP GAIN: 500
INTEGRATOR TIME CONSTANT: 50 SEC
BIAS VOLTAGE: 13V $\pm$ 1V
ANALOG STATUS DATA: 0 TO 5V TO CENTRAL STATION
SCIENCE DATA: 10 BINARY BITES PER WORD

LSG SENSOR DETAILS



CONDITIONS:

PAN Ⓟ AND BEAM MAKE UP EARTH MASS

TO CAGE, FINGERS CLAMP ON MASS ① AND PAN, RAISING PAN (SLACK IN WIRE)

FULL ROTATION OF SCREW INTO CUP PLACES ALL 3 MASSES ON PAN

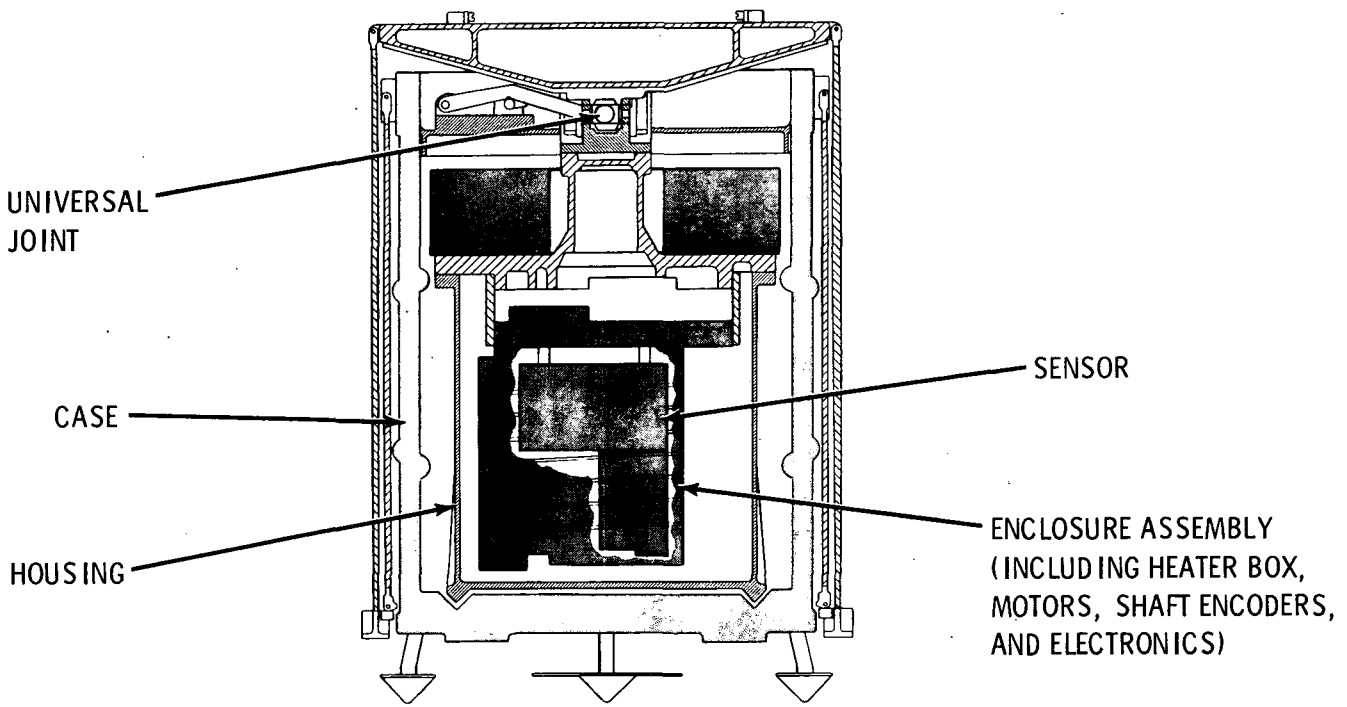
OPPOSITE ROTATION OF SCREW LIFTS MASS ① OFF PAN, THEN MASS ②, FOR FINE TRIM OF LUNAR MASS

NOTE:

CUP Ⓒ HAS GUIDE TO PREVENT ROTATION WHEN SCREW TURNS

JUNE 72 3270.3.9

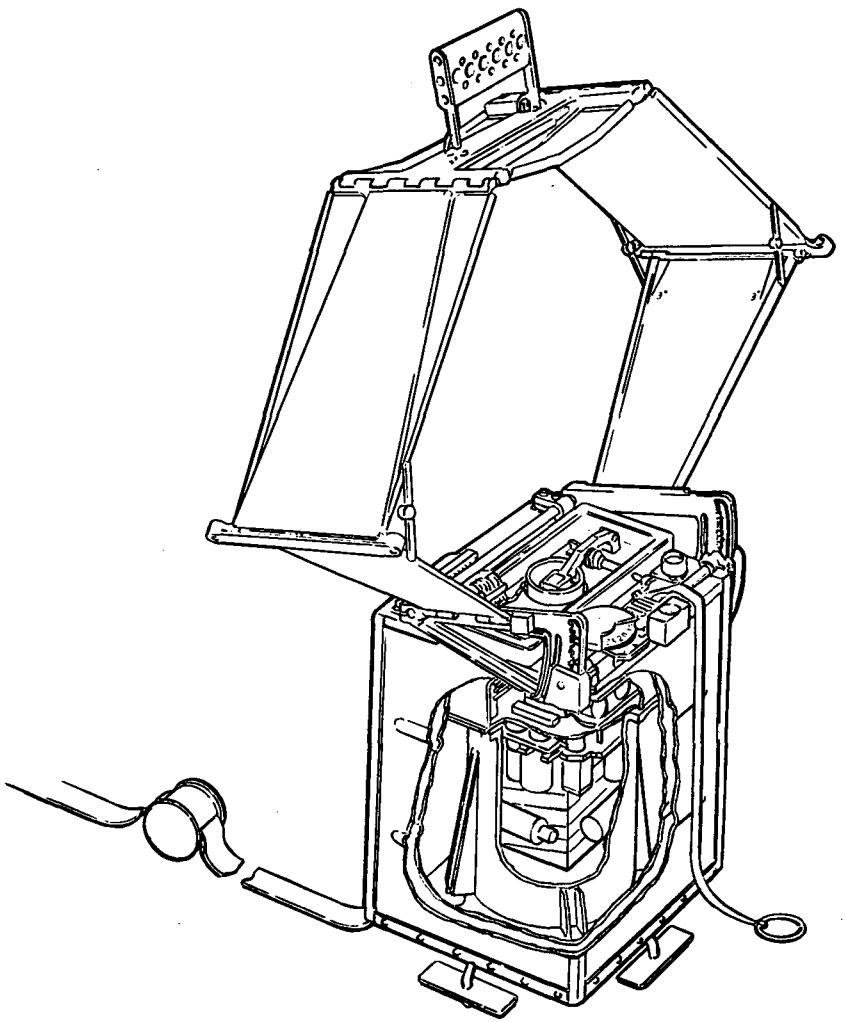
LSG STOWED CROSS SECTION



CAGING FEATURES:

1. HOUSING, HANGING ON UNIVERSAL JOINT, IS CAGED BY DOWNWARD RESTRAINT AND RELEASED BY ASTRONAUT (LANYARD). DIFFICULT TO RECAGE.
2. MASS CHANGING MECHANISM IS CAGED BY CALIPER-TYPE FINGERS CLAMPING ON MASS 1 AND PAN, RAISING PAN. RELEASED AND RECAGED BY COMMAND.
3. SENSOR BEAM IS CAGED BY CLAMPING BEAM AGAINST STOP. RELEASED AND RECAGED BY COMMAND.

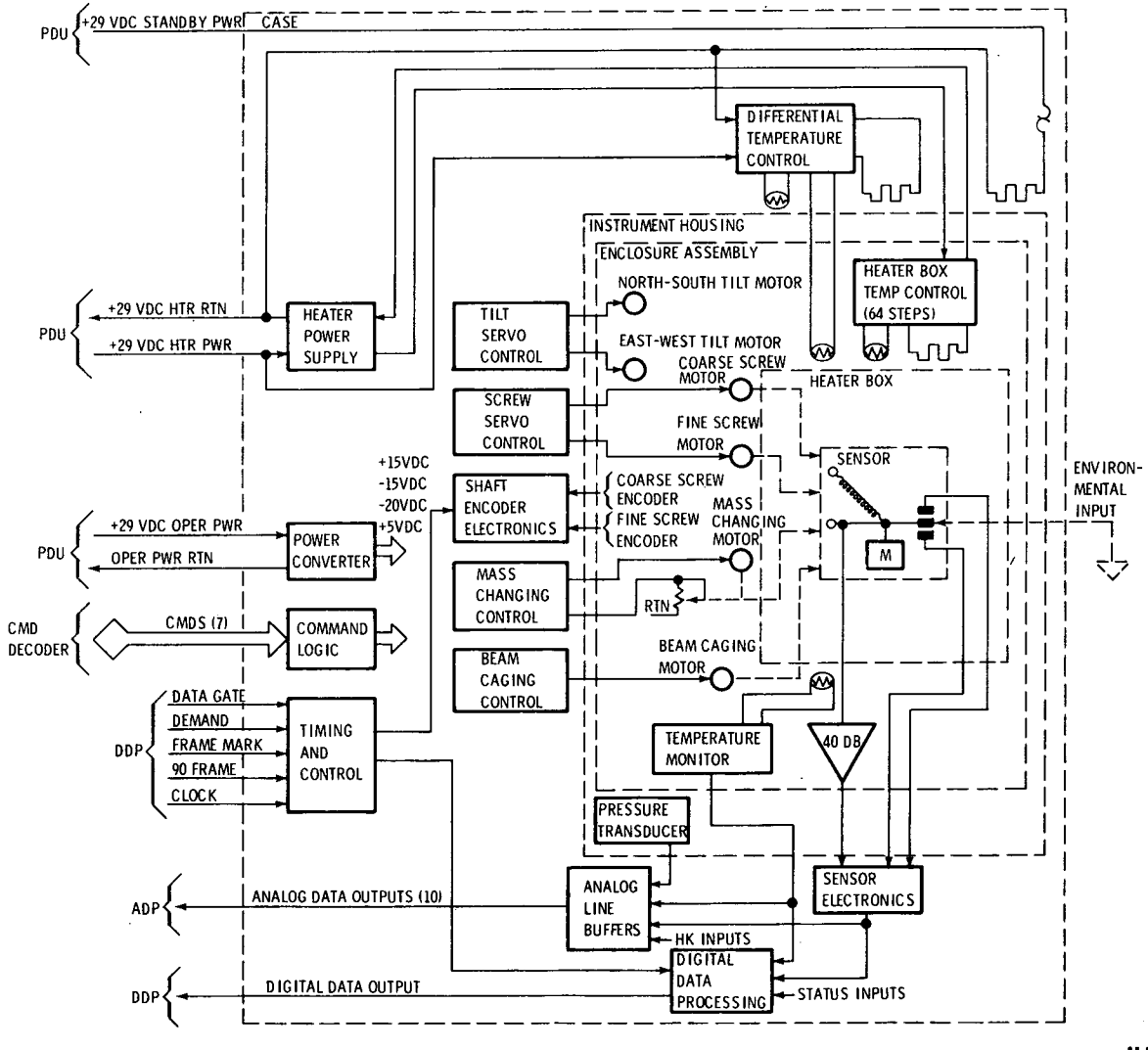
LSG PHYSICAL PARAMETERS



SIZE, WEIGHT, AND POWER	
STOWED SIZE, IN.	10.9 LENGTH 10.0 WIDTH 15.1 HEIGHT PLUS 3 X 3 (DIAM) CABLE REEL
EARTH WT, LB: 28	
POWER, W: 9.3 (APPROX, MAX)	

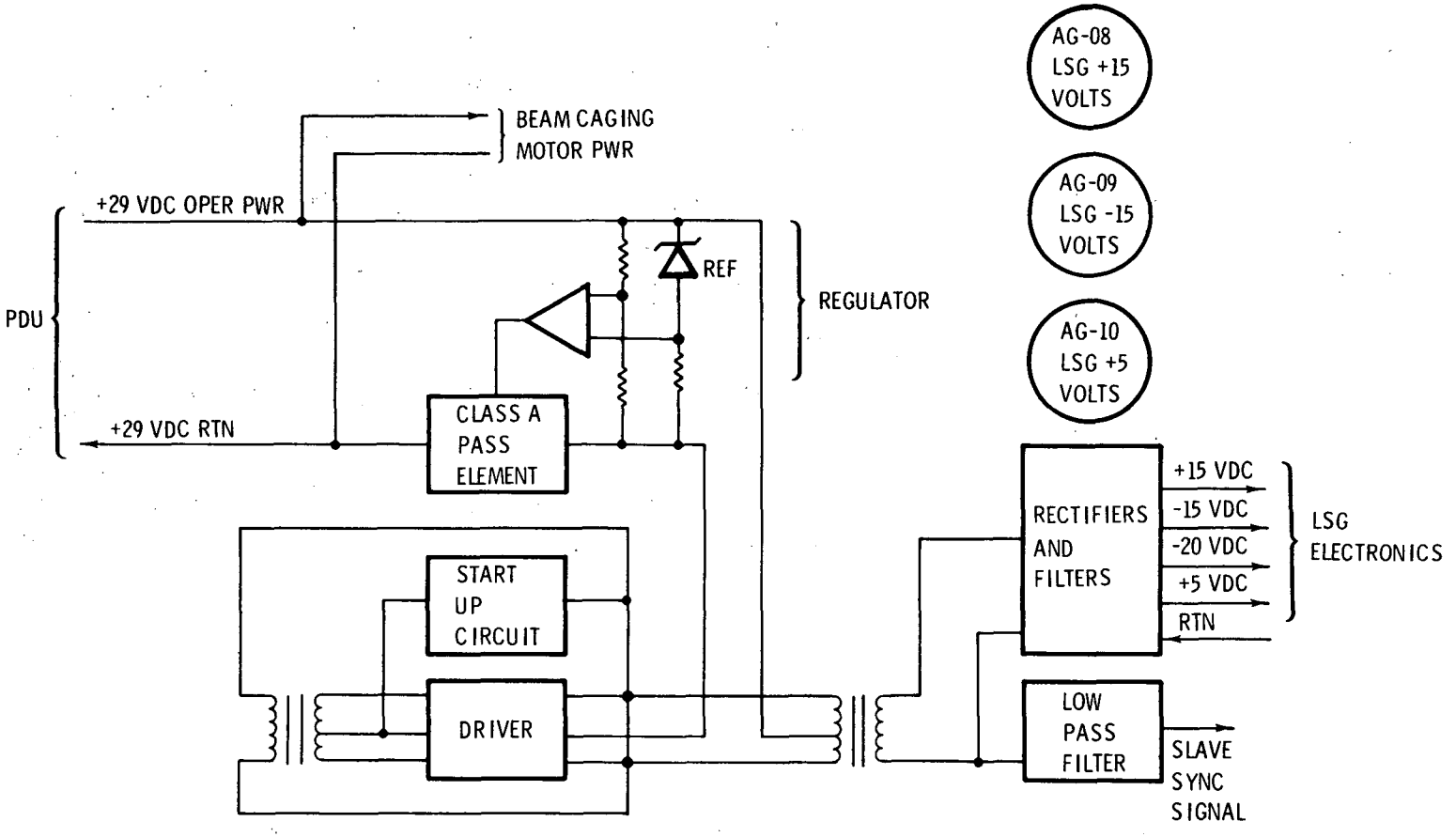
JUNE 72 3270.3.11

LSG ELECTRICAL FUNCTIONS



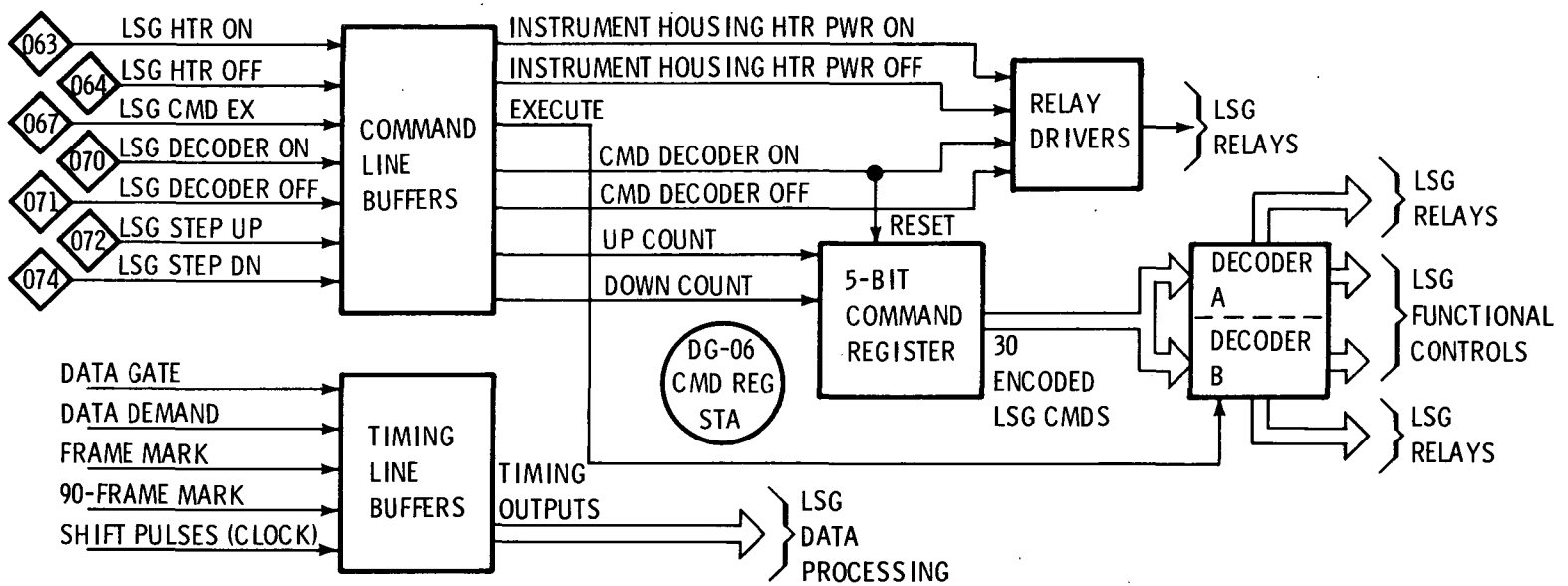
JUNE 72 3270.3.12

LSG POWER CONVERTER

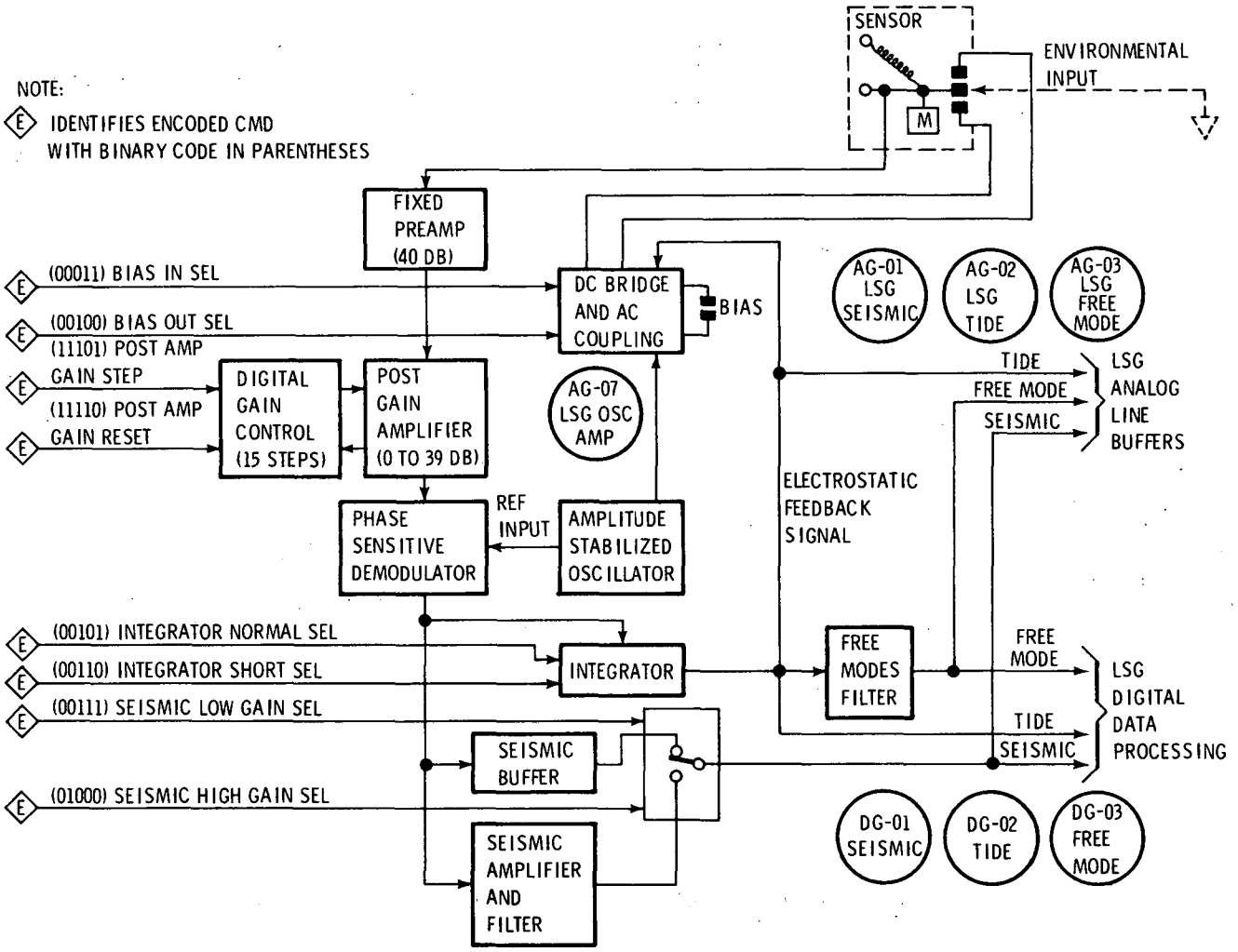


JUNE 72 3270.3.13

LSG CMD LOGIC, TIMING AND CONTROL

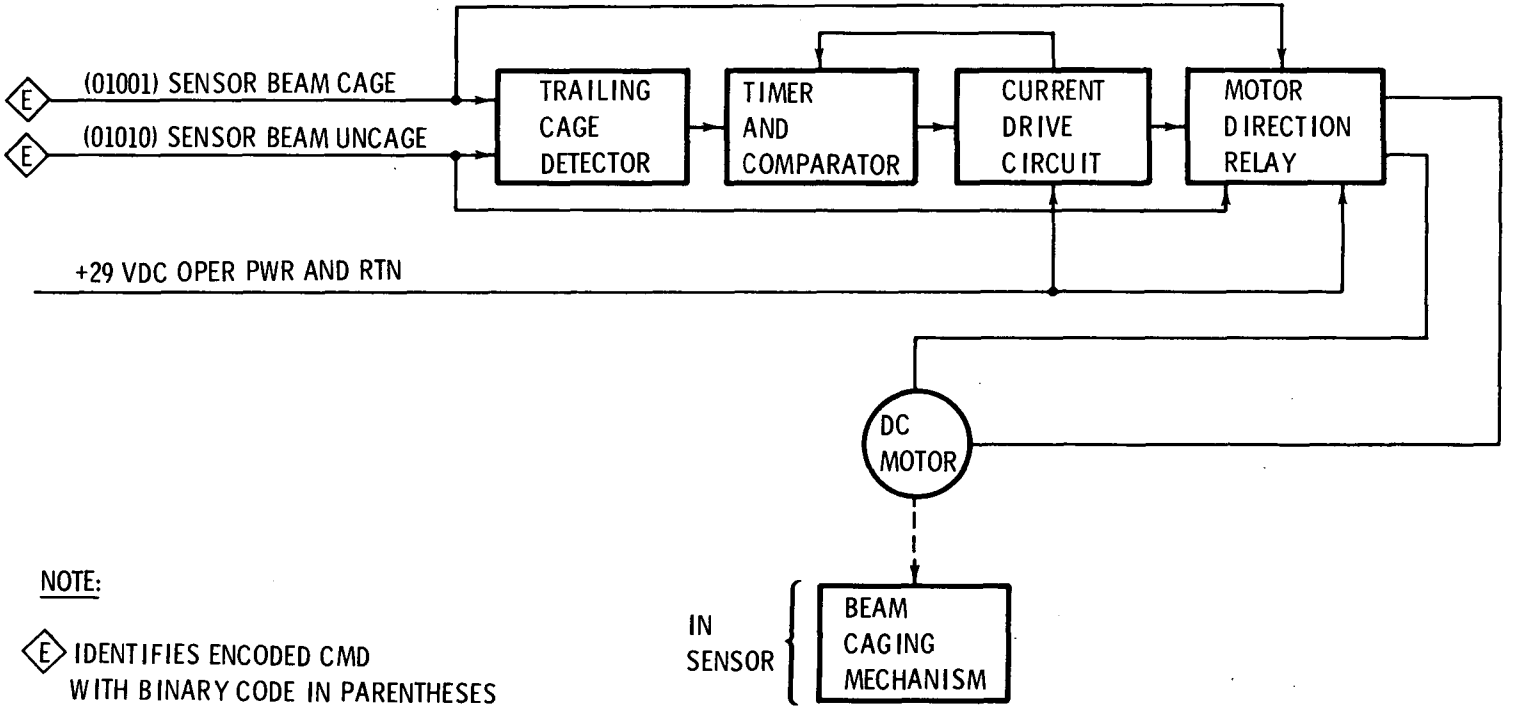


LSG SENSOR ELECTRONICS



JUNE 72 3270.3.15

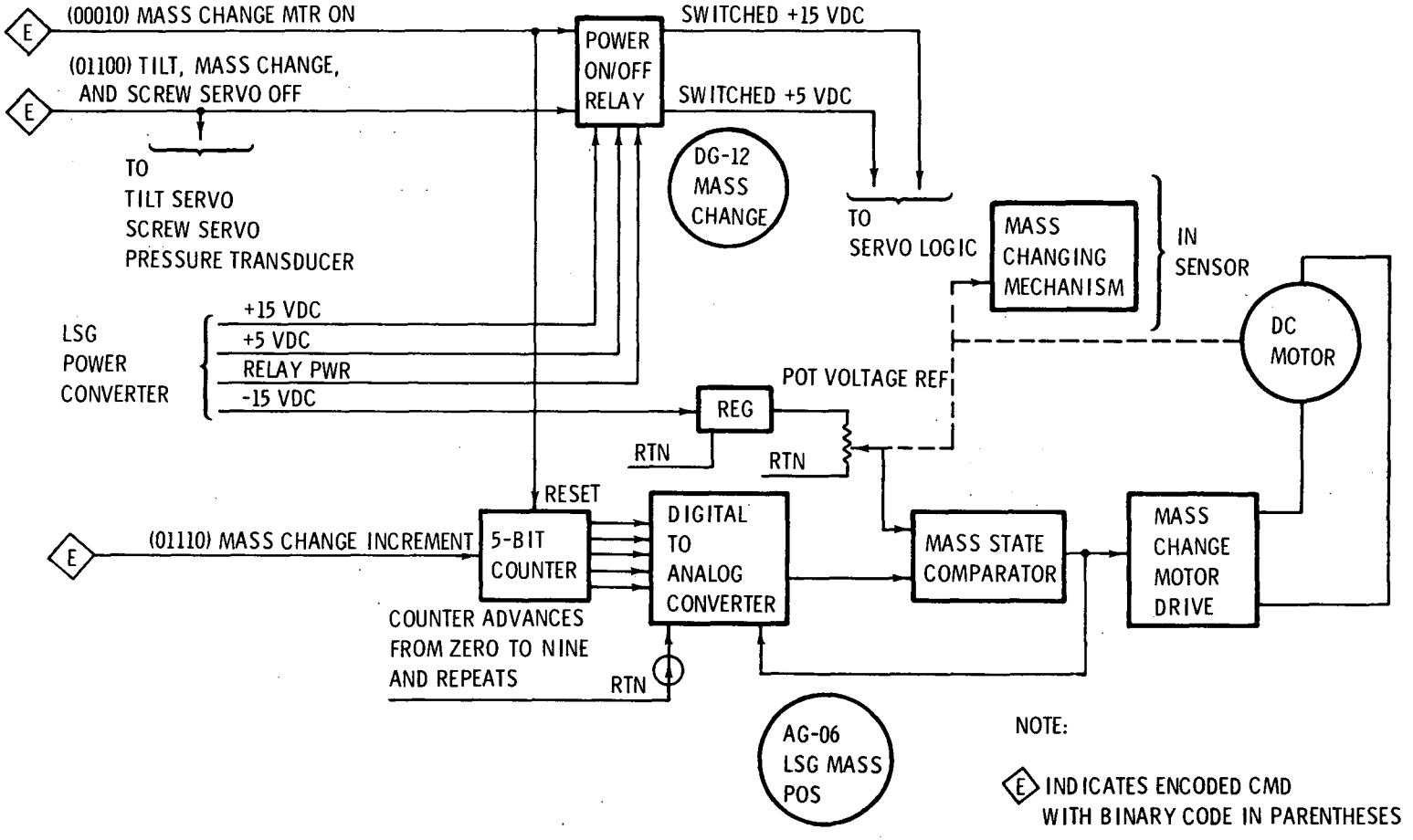
LSG BEAM CAGING CONTROL



NOTE:

E IDENTIFIES ENCODED CMD WITH BINARY CODE IN PARENTHESES

LSG MASS CHANGING CONTROL



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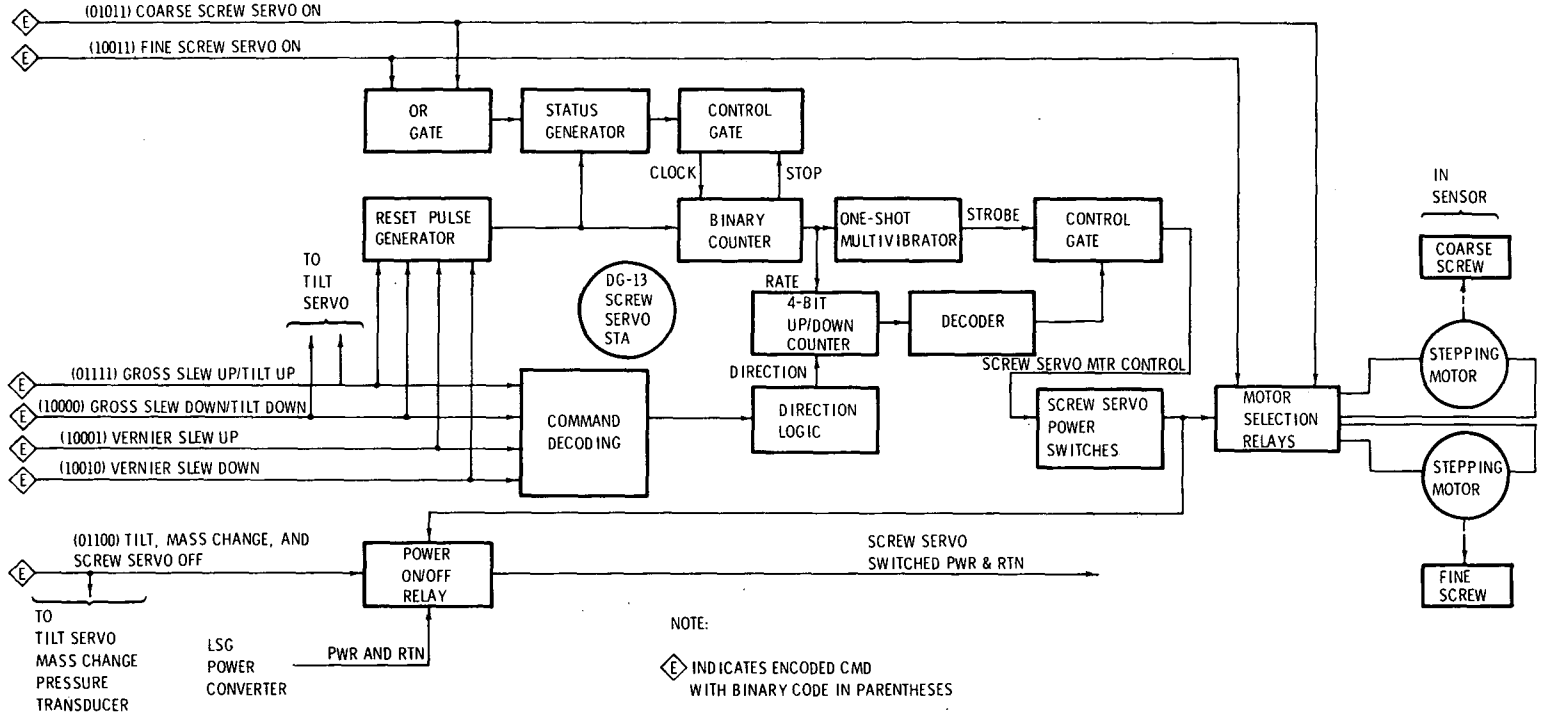
LSG SCREW SERVO CONTROL



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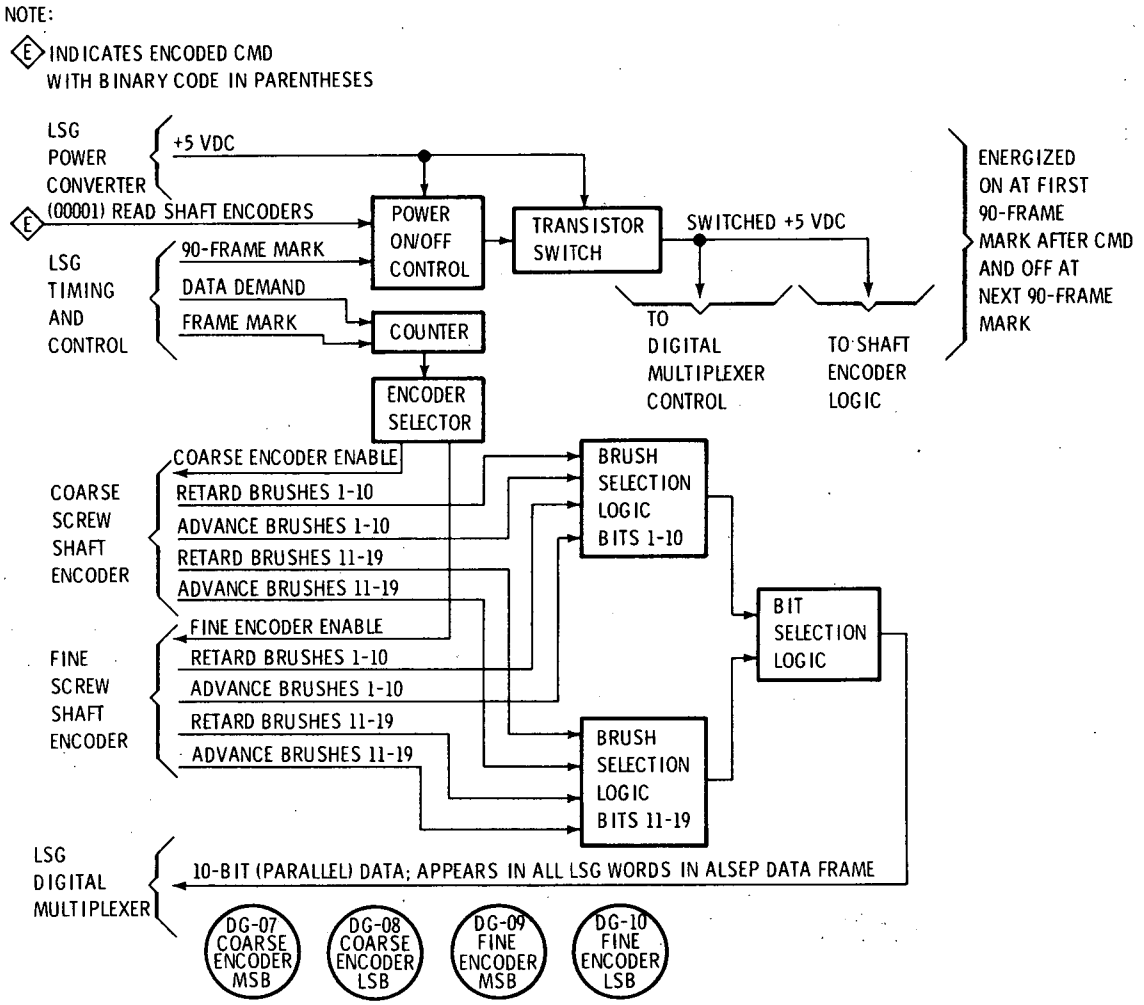
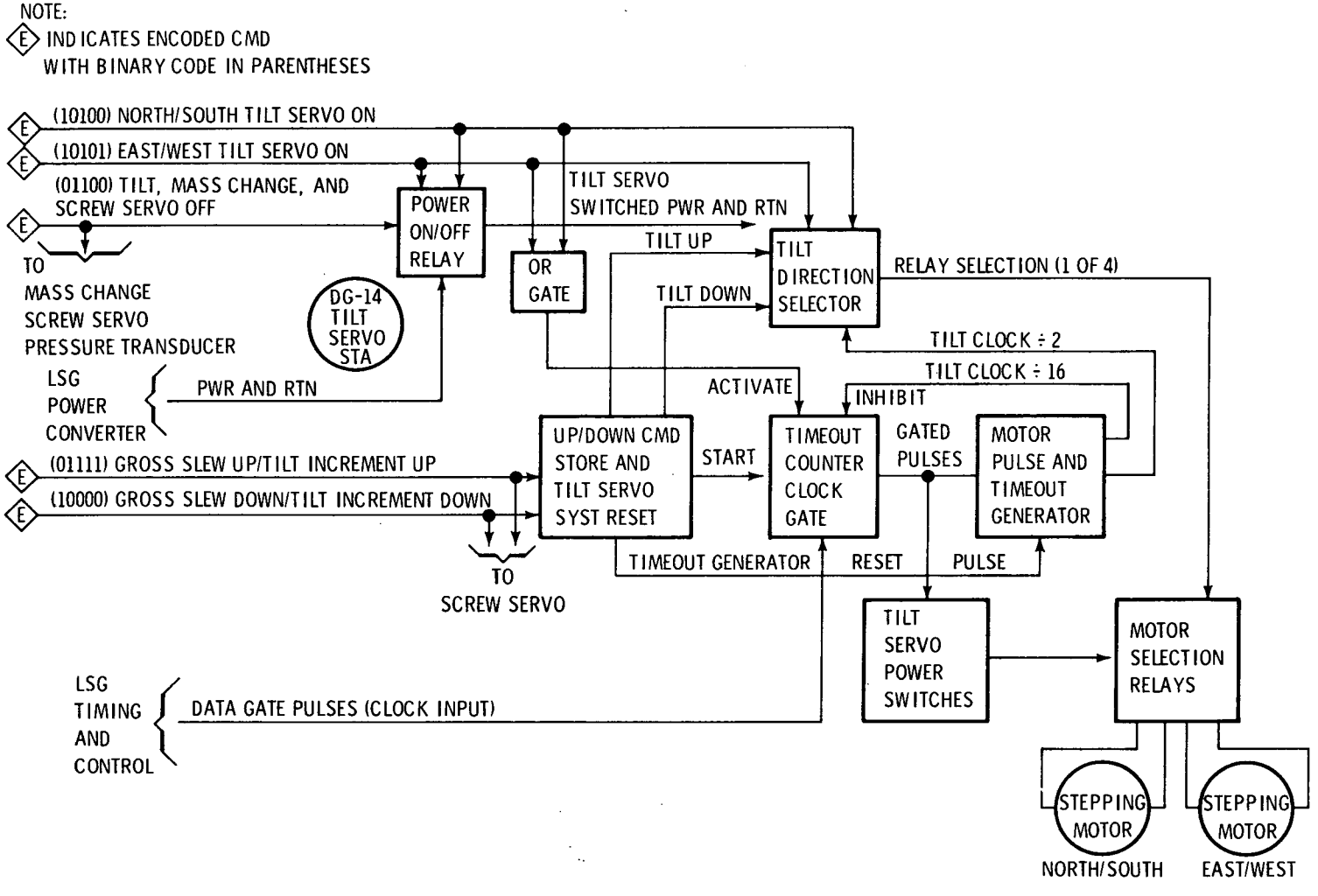
LSG SHAFT ENCODERS

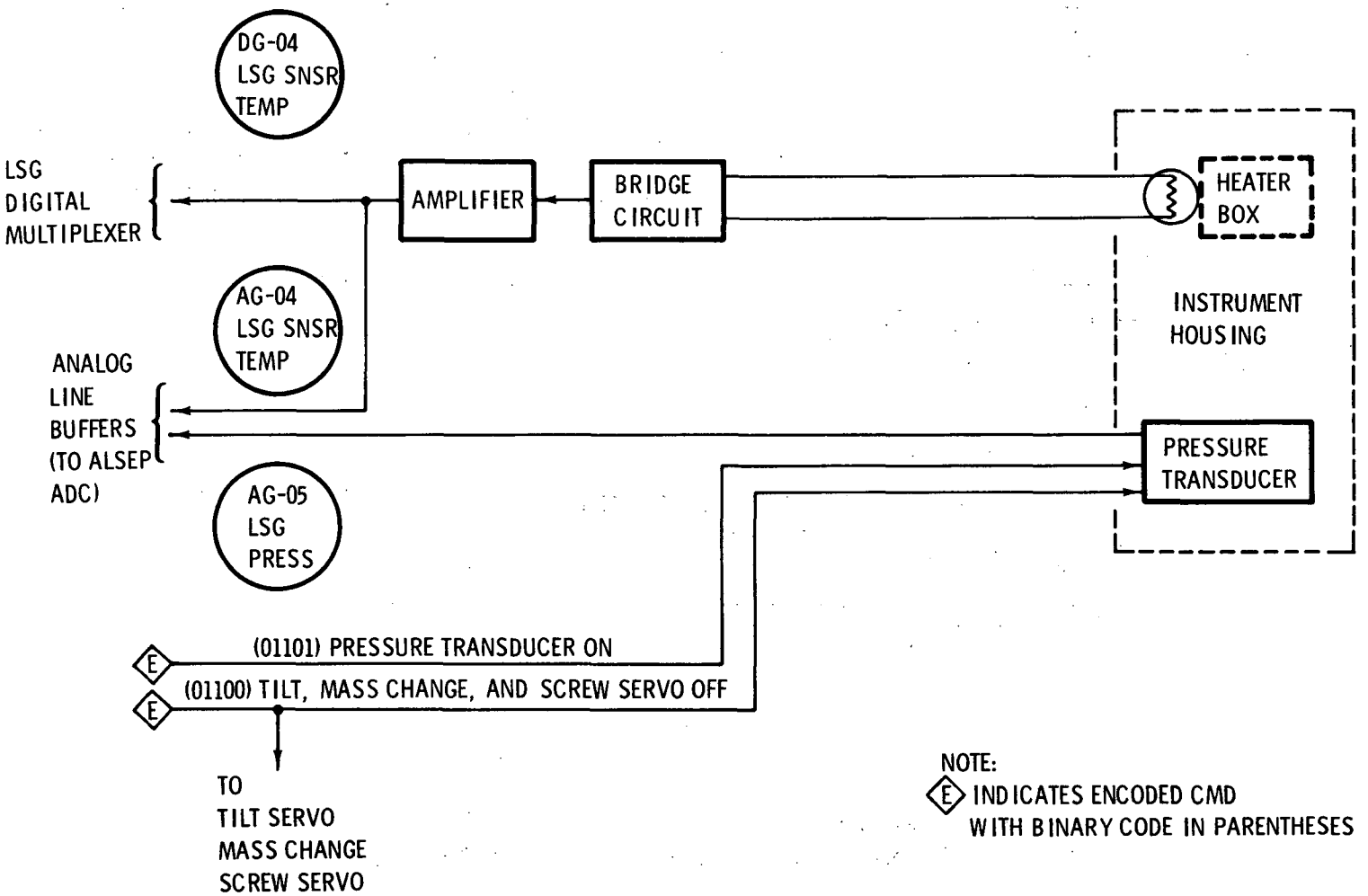


LSG TILT SERVO CONTROL



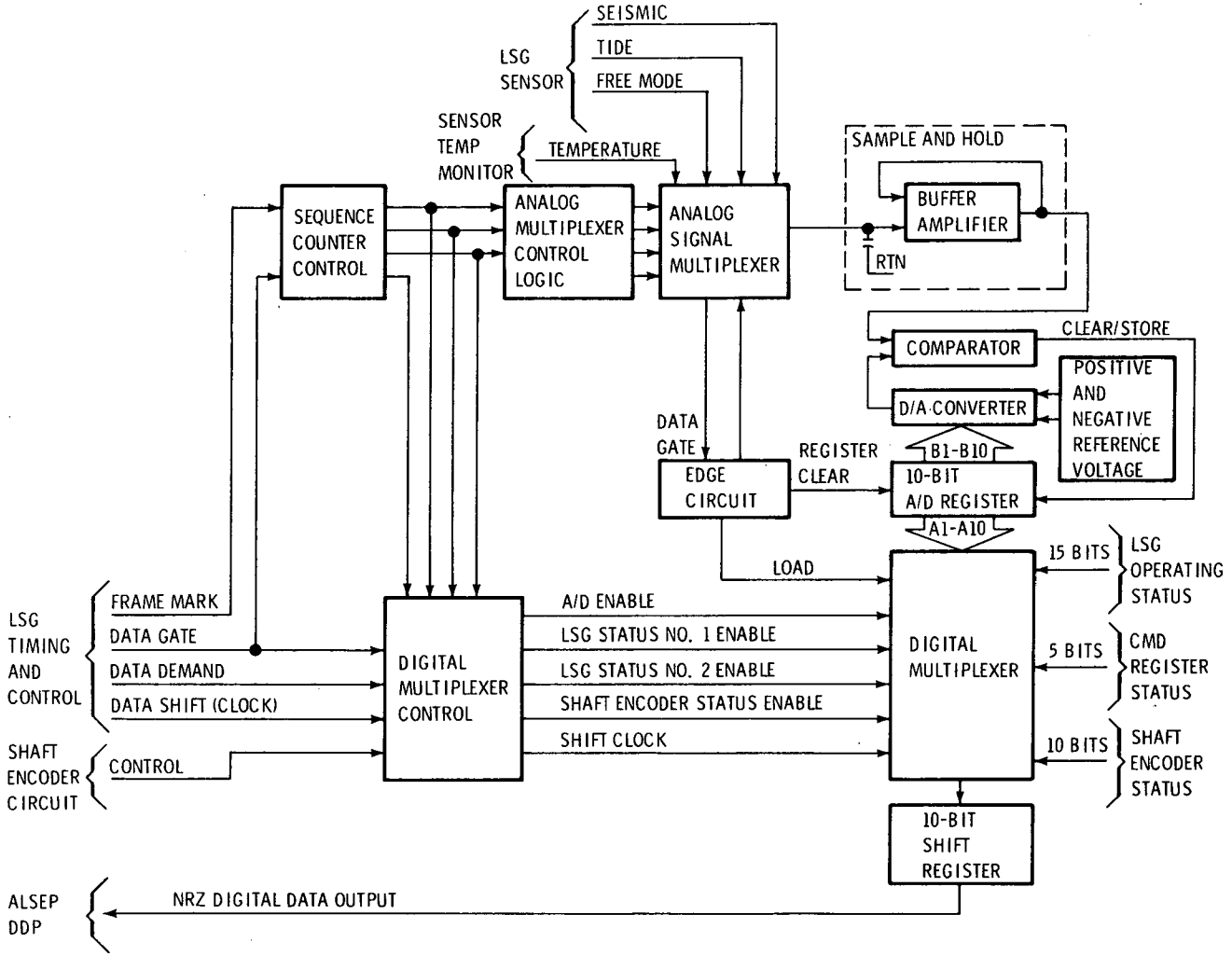
JUNE 72 3270.3.20

LSG TEMPERATURE AND PRESSURE MONITOR



JUNE 72 3270.3.21

LSG DIGITAL DATA PROCESSING



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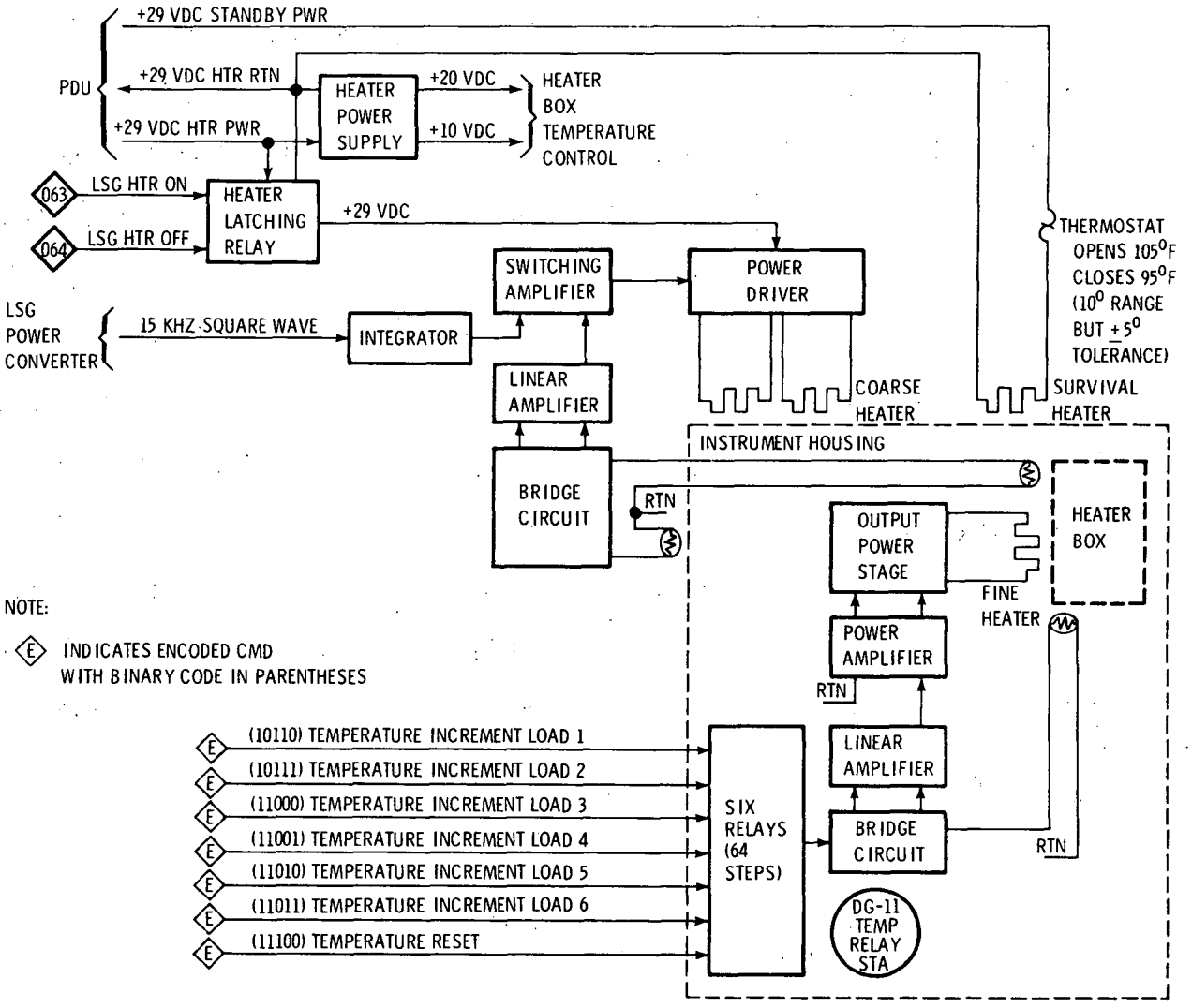
LSG TEMPERATURE CONTROL



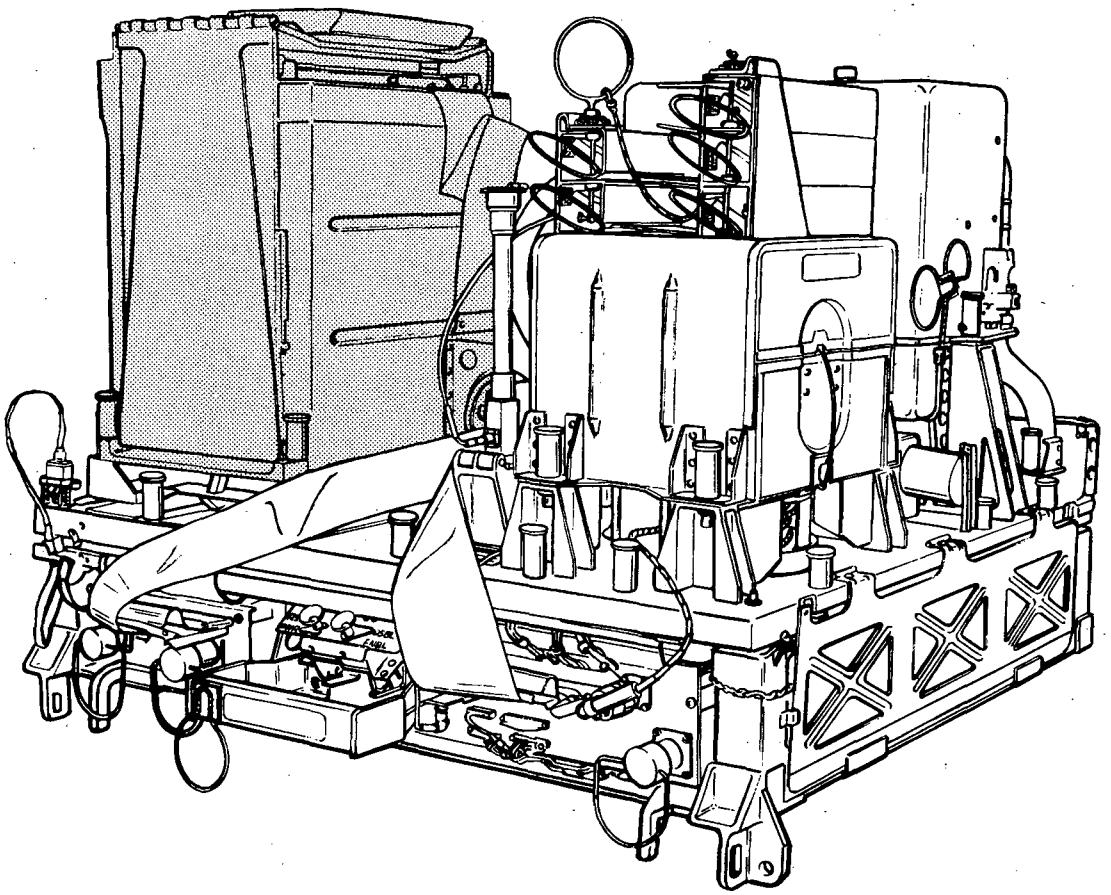
JUNE 72 3270.3.23

LSG POWER SUMMARY

ITEM	POWER, WATTS		COMMENTS
	INCREMENT	TOTAL	
BASIC SYSTEM	2.09	2.09	INCLUDES 0.5 W HEATER BOX HTR
COMMAND DECODER	0.41	2.50	
TILT SERVO ELECTRONICS	0.09	2.59	
TILT MOTOR	1.00	3.59	WITH MOTOR RUNNING
SCREW SERVO ELECTRONICS	0.15	2.65	
SCREW MOTOR	1.00	3.65	WITH MOTOR RUNNING
MASS CHANGE MOTOR			
MAXIMUM	4.00	6.50	
MINIMUM	1.70	4.20	
SHAFT ENCODER ELECTRONICS	0.21	2.30	CMD DECODER NOT ON
UNCAGE/RECAGE MOTOR	2.00	4.50	WITH MOTOR RUNNING
INSTRUMENT HOUSING HEATER	6.70	8.79	CMD DECODER NOT ON
MAXIMUM			

SURVIVAL HEATER (STANDBY PWR) IS 4.20 WATTS WITH ON/OFF THERMOSTAT CONTROL

LSG INSTALLATION ON ALSEP

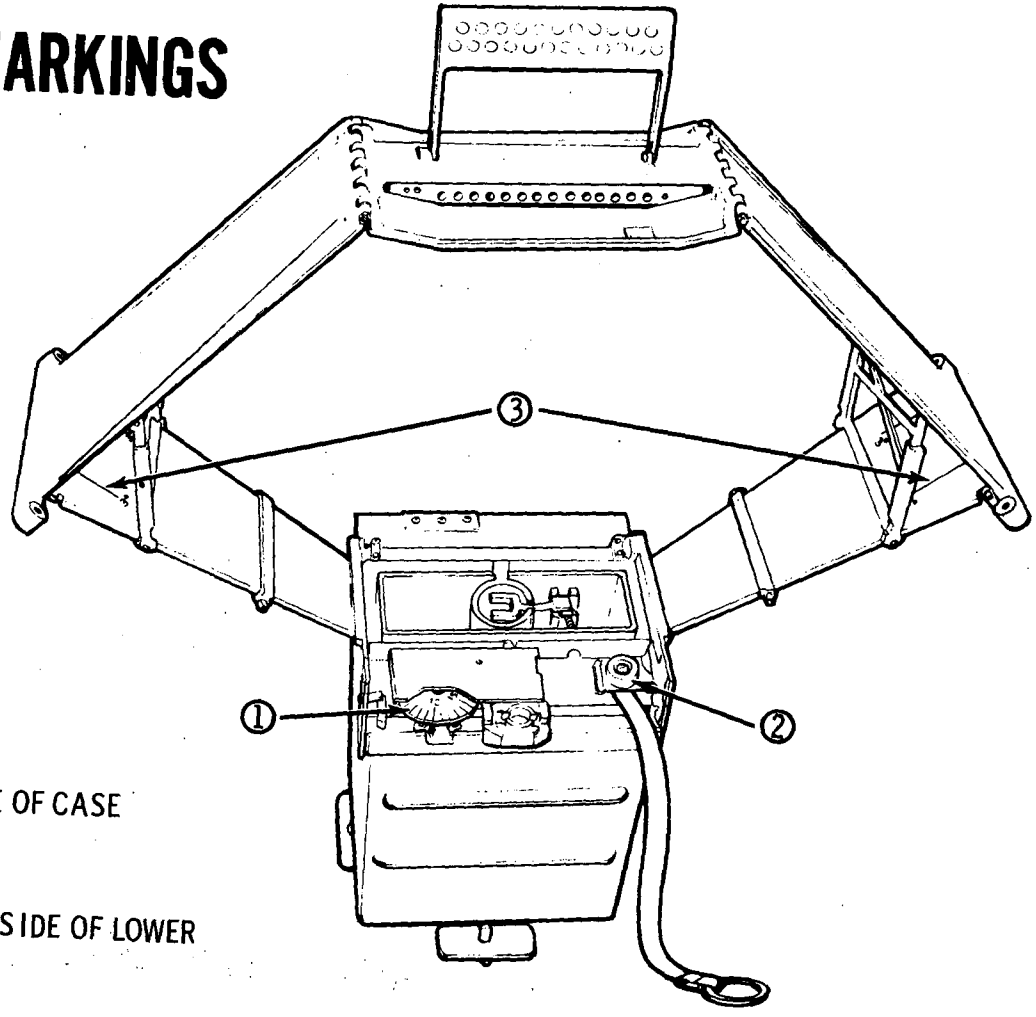


JUNE 72 3270.3.25

LSG EMPLACEMENT CRITERIA

PARAMETER	REQUIREMENT	PRIORITY	INDICATOR	COMMENTS
DISTANCE FROM CENTRAL STATION	25 ± 5 FT		PACING AND CABLE LENGTH	CABLE LENGTH 30 ± 1 FT
DIRECTION FROM CENTRAL STATION	WEST		VISUAL	
SITE SELECTION	LEVEL, WITH A FIRM SURFACE		VISUAL	SLOPE LESS THAN 5^0, AVOID CRATERS & RUBBLE
ROUGH ALIGNMENT	SUNSHADE MUST TILT TOWARD EQUATOR			
SUNSHADE TILT SETTING	LATITUDE ANGLE		CIRCULAR DIAL	DIAL MARKED IN DEGREES OF LATITUDE
LEVEL, WRT INDICATOR	WITHIN ± 3^0		BUBBLE LEVEL	OFF-LEVEL CONDITION DEGRADES ALIGNMENT ACCURACY
ALIGN, WRT SHADOW	WITHIN ± 3^0		MARKING ON SUNSHADE PANEL	SHADOW OF UPPER EAST PANEL ON INSIDE OF LOWER WEST PANEL
NOTES	• STABLE ON 15^0 SLOPE WITH SUNSHADE DEPLOYED AND FULLY TILTED • RECHECK LEVEL AND ALIGNMENT AFTER LANYARD RELEASE OF INSTRUMENT HOUSING CAGING RESTRAINT			

LSG ALIGNMENT MARKINGS



① SUNSHADE TILT DIAL
-MARKED IN DEGREES OF LATITUDE

② BUBBLE LEVEL
-WITHIN $\pm 3^0$ WHEN BUBBLE IS FREE OF CASE

③ SHADOW ALIGNMENT
-LIMITS OF $\pm 3^0$ ARE MARKED ON INSIDE OF LOWER SUNSHADE PANELS

LSG COMMAND SUMMARY

OCTAL COMMANDS

063	LSG HTR ON
064	LSG HTR OFF
067	LSG CMD EX
070	LSG DECODER ON
071	LSG DECODER OFF
072	LSG STEP UP
074	LSG STEP DN

ENCODED COMMANDS (BINARY)

00001	READ SHAFT ENCODERS
00010	MASS CHANGE MOTOR ON
00011	BIAS IN SELECT
00100	BIAS OUT SELECT
00101	INTEGRATOR NORMAL MODE SELECT
00110	INTEGRATOR SHORT MODE SELECT
00111	SEISMIC LOW GAIN SELECT
01000	SEISMIC HIGH GAIN SELECT
01001	SENSOR BEAM CAGE
01010	SENSOR BEAM UNCAGE
01011	COARSE SCREW SERVO ON
01100	TILT, MASS CHANGE, AND SCREW SERVO OFF
01101	PRESSURE TRANSDUCER ON
01110	MASS CHANGE INCREMENT
01111	GROSS SLEW UP/TILT INCREMENT UP
10000	GROSS SCREW DOWN/TILT INCREMENT DOWN
10001	VERNIER SLEW UP
10010	VERNIER SLEW DOWN
10011	FINE SCREW SERVO ON
10100	NORTH/SOUTH TILT SERVO ON
10101	EAST/WEST TILT SERVO ON
10110	TEMPERATURE INCREMENT LOAD 1
10111	TEMPERATURE INCREMENT LOAD 2
11000	TEMPERATURE INCREMENT LOAD 3
11001	TEMPERATURE INCREMENT LOAD 4
11010	TEMPERATURE INCREMENT LOAD 5
11011	TEMPERATURE INCREMENT LOAD 6
11100	TEMPERATURE RESET
11101	POST AMP GAIN STEP
11110	POST AMP GAIN RESET

LSG COMMANDS

OCTAL CMD NUMBER

- 063 LSG HTR ON

THIS CMD ACTUATES A LATCHING RELAY IN THE LSG TO THE POSITION THAT APPLIES +29 VDC SLAVE HEATER POWER TO THE LSG INSTRUMENT HOUSING. THIS HEATER IS SLAVED TO THE TEMPERATURE OF THE HEATER BOX BY TWO SENSORS, ONE ON THE INSTRUMENT HOUSING, USING A DIFFERENTIAL OUTPUT BY MEANS OF A BRIDGE CIRCUIT. REPEATED APPLICATION OF CMD 063 HAS NO FURTHER EFFECT. THE SLAVE HEATER IS PRESET TO BE IN THE (TBD) CONDITION AT INITIAL LUNAR ACTIVATION.

- 064 LSG HTR OFF

THIS CMD ACTIVATES A LATCHING RELAY IN THE LSG TO THE POSITION THAT REMOVES +29 VDC SLAVE HEATER POWER FROM THE LSG INSTRUMENT HOUSING. REPEATED APPLICATION OF CMD 064 HAS NO FURTHER EFFECT. THE SLAVE HEATER IS PRESET TO BE IN THE (TBD) CONDITION AT INITIAL LUNAR ACTIVATION.

- 067 LSG CMD EX

THIS CMD CAUSES EXECUTION OF ONE OF THE 30 ENCODED LSG CMDS AS CONTAINED IN ITS 5-STAGE CMD REGISTER WHICH IS SHIFTED UP/DOWN BY OCTAL CMDS 072/074. EXECUTION DOES NOT CLEAR THE REGISTER. REPEATED APPLICATION OF CMD 067 WILL CAUSE REPEATED EXECUTION OF THE SELECTED ENCODED CMD.

- 070 LSG DECODER ON

THIS CMD ACTUATES A LATCHING RELAY IN THE LSG TO THE POSITION THAT APPLIES +5 VDC POWER TO THE CMD COUNTER AND THE ASSOCIATED CMD DECODING CIRCUITRY WITHIN THE LSG, ALLOWING THE 5-STAGE CMD REGISTER COUNTER TO BE STEPPED UP/DOWN AND ENABLING THE LSG ENCODED CMD EXECUTION FUNCTION. APPLICATION OF CMD 070 ALWAYS RESETS THE REGISTER COUNTER TO 00000. REPEATED APPLICATION OF CMD 070 HAS NO FURTHER EFFECT. THE COMMAND DECODER IS PRESET TO BE IN THE OFF CONDITION AT INITIAL LUNAR ACTIVATION.

- 071 LSG DECODER OFF

THIS CMD ACTUATES A LATCHING RELAY IN THE LSG TO THE POSITION THAT REMOVES +5 VDC POWER FROM THE CMD DECODER WITHIN THE LSG. REPEATED APPLICATIONS OF CMD 071 HAS NO FURTHER EFFECT. THE CMD DECODER IS PRESET TO BE IN THE OFF CONDITION AT INITIAL LUNAR ACTIVATION.

- 072 LSG STEP UP

THIS CMD ADVANCES THE 5-STAGE CMD REGISTER COUNTER OF THE LSG TO THE NEXT HIGHER BINARY VALUE, THUS REPRESENTING A NEW ENCODED CMD FUNCTION, IF EXECUTED. OF THE 32 POSSIBLE STATES, 30 ARE USED (EXCLUDING 00000 AND 11111), AND THE REGISTER STATE IS READ OUT IN THE TM. REPEATED APPLICATION OF CMD 072 ADVANCES THE COUNTER SETTING UNTIL IT REACHES 11111, AFTER WHICH CMD 072 SETS THE COUNTER TO 00000, ETC.

- 074 LSG STEP DN

THIS CMD REDUCES THE VALUE IN THE 5-STAGE CMD REGISTER COUNTER OF THE LSG TO THE NEXT LOWER BINARY VALUE, THUS REPRESENTING A NEW ENCODED CMD FUNCTION, IF EXECUTED. OF THE 32 POSSIBLE STATES, 30 ARE USED (EXCLUDING 00000 AND 11111), AND THE REGISTER STATE IS READ OUT IN THE TM. REPEATED APPLICATION OF CMD 074 REDUCES THE COUNTER SETTING UNTIL IT REACHES 00000, AFTER WHICH CMD 074 SETS THE COUNTER TO 11111, ETC.

LSG ENCODED COMMANDS

BINARY COUNT

00000 AND 11111 HAVE NO FUNCTIONAL EFFECT

00001 READ SHAFT ENCODERS

THIS CMD INHIBITS ALL OTHER SIGNALS TO THE LSG DIGITAL MULTIPLEXER AND ACTIVATES CONTINUOUS READOUT OF THE SHAFT ENCODERS ON THE COARSE AND FINE SCREW SERVO SHAFTS. THESE TWO ENCODERS ARE READ OUT IN THE ALSEP DATA WORDS ASSIGNED TO LSG AS 19-BIT READINGS, ALTERNATING IN THE FOLLOWING MANNER, STARTING AT THE ALSEP FRAME MARK:

1ST WORD	COARSE ENCODER	LAST 10 BITS (LSB)
2ND WORD	COARSE ENCODER	FIRST 9 BITS (MSB)
3RD WORD	FINE ENCODER	LAST 10 BITS (LSB)
4TH WORD	FINE ENCODER	FIRST 9 BITS (MSB)
5TH WORD	COARSE ENCODER	LAST 10 BITS (LSB)
ETC.		

IN THE MSB WORDS A FILLER BIT (BINARY ONE) IS INSERTED AS THE FIRST BIT OF THE 10-BIT ALSEP WORD. THERE ARE TWO BRUSHES (ADVANCE/RETARD) ON EACH ENCODER. THESE BRUSHES ALSO ALTERNATE IN THE DATA READOUT. THE SHAFT ENCODER DATA READOUT STARTS AT THE FIRST ALSEP 90-FRAME MARK FOLLOWING RECEIPT OF CMD 00001 (BINARY) AND CONTINUES UNITL THE NEXT ALSEP 90-FRAME MARK AFTER WHICH NORMAL LSG SCIENTIFIC DATA READOUT IS REACTIVATED. REPEATED APPLICATIONS OF CMD 00001 (BINARY) WILL CAUSE SHAFT ENCODER DATA READOUT FOR ADDITIONAL BLOCKS OF 90 FRAMES PROVIDED THAT THE SEQUENTIAL CMD APPLICATIONS OCCUR BEFORE AND AFTER AN ALSEP 90-FRAME MARK. APPLICATION OF OPERATIONAL POWER TO THE LSG CAUSES INITIALIZATION IN THE NORMAL DATA MODE.

00010 MASS CHANGE MOTOR ON

THIS CMD ACTIVATES THE LSG MASS CHANGING SERVO CONTROL AND, AT TURN-ON, RESETS THE 5-BIT MASS CHANGE INCREMENT COUNTER TO ZERO SO THAT SUBSEQUENT INCREMENT CMDS CAN STEP THE COUNTER UP TO THE DESIRED FUNCTIONAL STATE. ADDITIONAL MASS CHANGE FEATURES ARE:

- MASS CHANGING IS INHIBITED WHEN THE INSTRUMENT HOUSING HEATER IS ON BUT THE STATUS TM RESPONDS TO EXECUTION OF CMD 00010 (BINARY), INDICATING SERVO CONTROL ON WHEN IT IS NOT ON.

00010 MASS CHANGE MOTOR ON (CONT'D)

- THERE ARE 10 FUNCTIONAL STATES CONTROLLED BY THE INCREMENT CMD, 01110 (BINARY).
- THE COUNTER STATUS IS READ OUT IN THE TM AS AN ANALOG VOLTAGE VALUE AND THE ZERO COUNTER SETTING IS DEFINED AS STATE 1.
- AT TURN-ON, THE MECHANISM ALWAYS DRIVES TO STATE 1 WHICH IS AGAINST THE STOP.
- STATE 2 OF THE INCREMENT COUNTER IS PROVIDED TO CAGE THE MASS CHANGING MECHANISM DURING TRANSPORTATION AND STATE 10 IS USED ON EARTH FOR CALIBRATION.
- THE MASS CHANGE MOTOR USES SERVO FEEDBACK AND, WHEN ACTIVATED, ONLY OPERATES UNTIL THE STATE CALLED FOR BY THE COUNTER IS ACHIEVED.
- TURN-OFF OF THE CONTROL, BY CMD 01100 (BINARY) CAUSES THE MECHANISM STATE TO BE RETAINED UNTIL THE NEXT TURN-ON.
- SINCE TURN-ON CLEARS THE REGISTER, REPEATED APPLICATION OF CMD 00010 (BINARY) CAUSES NO FURTHER CHANGE PROVIDED THAT NO INCREMENT CMDS ARE EXECUTED BETWEEN TURN-ON CMDS.

00011 BIAS IN SEL

THIS CMD ACTUATES A LATCHING RELAY TO THE POSITION THAT APPLIES +13 VDC FIXED BIAS TO THE SENSOR BRIDGE DRIVE CIRCUIT OF THE LSG SENSOR ELECTRONICS. REPEATED APPLICATION OF CMD 00011 (BINARY) HAS NO FURTHER EFFECT. THE BIAS RELAY IS PRESET TO BE IN THE (TBD) CONDITION AT INITIAL LUNAR ACTIVATION.

00100 BIAS OUT SEL

THIS CMD ACTUATES A LATCHING RELAY TO THE POSITION THAT REMOVES THE +13 VDC FIXED BIAS FROM THE SENSOR BRIDGE DRIVE CIRCUIT OF THE LSG SENSOR ELECTRONICS. REPEATED APPLICATION OF CMD 00100 (BINARY) HAS NO FURTHER EFFECT. THE BIAS RELAY IS PRESET TO BE IN THE (TBD) CONDITION AT INITIAL LUNAR ACTIVATION.

LSG ENCODED COMMANDS (CONT'D)

BINARY COUNT

00101 INTEGRATOR NORMAL MODE SEL

THIS CMD CAUSES CLOSED-LOOP OPERATION OF THE LSG SENSOR ELECTROSTATIC SYSTEM IN WHICH THE OUTPUT OF THE INTEGRATOR IS FED BACK TO CONTROL THE PLATE DRIVE TO THE SENSOR. REPEATED APPLICATION OF CMD 00101 (BINARY) HAS NO FURTHER EFFECT. THE INTEGRATOR IS PRESET TO BE IN THE (TBD) MODE AT INITIAL LUNAR ACTIVATION.

00110 INTEGRATOR SHORT MODE SEL

THIS CMD CAUSES THE LSG INTEGRATOR OUTPUT TO BE SHORT CIRCUITED WHICH PUTS THE ELECTROSTATIC SYSTEM IN AN OPEN LOOP CONFIGURATION. REPEATED APPLICATION OF CMD 00110 (BINARY) HAS NO FURTHER EFFECT. THE INTEGRATOR IS PRESET TO BE IN THE (TBD) MODE AT INITIAL LUNAR ACTIVATION.

00111 SEISMIC LOW GAIN SEL

THIS CMD SELECTS THE LOW GAIN CONFIGURATION OF THE SEISMIC OUTPUT CIRCUIT OF THE LSG SENSOR. REPEATED APPLICATION OF CMD 00111 (BINARY) HAS NO FURTHER EFFECT. THE SEISMIC GAIN IS PRESET TO BE IN THE (TBD) CONDITION AT INITIAL LUNAR ACTIVATION.

01000 SEISMIC HIGH GAIN SEL

THIS CMD SELECTS THE HIGH GAIN CONFIGURATION OF THE SEISMIC OUTPUT CIRCUIT OF THE LSG SENSOR WHICH INSERTS AN ADDITIONAL AMPLIFIER AND FILTER INTO THE CIRCUIT. REPEATED APPLICATION OF CMD 01000 (BINARY) HAS NO FURTHER EFFECT. THE SEISMIC GAIN IS PRESET TO BE IN THE (TBD) CONDITION AT INITIAL LUNAR ACTIVATION.

01001 SENSOR BEAM CAGE

THIS CMD ACTIVATES A CIRCUIT TO PERFORM THE LSG SENSOR BEAM CAGING OPERATION. INITIATION OF THE CMD CAUSES CHARGING OF A CAPACITOR WHICH TURNS ON AN FET WHICH SUPPLIES DRIVE CURRENT TO THE CAGING MOTOR UNTIL THE RC TIME CONSTANT TURNS OFF THE FET. THIS TIME CONSTANT IS APPROXIMATELY 7.5 SEC. THE INITIATION OF CMD 01001 (BINARY) ALSO SELECTS THE STATE OF A DOUBLE-POLE RELAY WHICH CONTROLS THE DIRECTION OF MOTOR DRIVE, CAUSING THE RELAY TO MOVE TO THE POSITION WHERE THE MOTOR OPERATES IN THE DIRECTION TO CAGE THE SENSOR BEAM. REPEATED APPLICATION OF CMD 01001 (BINARY) RESULTS IN CLUTCH ACTION TO PREVENT FURTHER DRIVING OF THE GEARS IN THE CAGED DIRECTION.

01010 SENSOR BEAM UNCAGE

THIS CMD ACTIVATES A CIRCUIT TO PERFORM THE LSG SENSOR BEAM UNCAGING OPERATION. INITIATION OF THE CMD CAUSES CHARGING OF A CAPACITOR WHICH TURNS ON AN FET WHICH SUPPLIES DRIVE CURRENT TO THE CAGING MOTOR UNTIL THE RC TIME CONSTANT TURNS OFF THE FET. THIS TIME CONSTANT IS APPROXIMATELY 7.5 SEC. THE INITIATION OF CMD 01010 (BINARY) ALSO SELECTS THE STATE OF A DOUBLE-POLE RELAY WHICH CONTROLS THE DIRECTION OF MOTOR DRIVE, CAUSING THE RELAY TO MOVE TO THE POSITION WHERE THE MOTOR OPERATES IN THE DIRECTION TO UNCAGE THE SENSOR BEAM. REPEATED APPLICATION OF CMD 01010 (BINARY) RESULTS IN CLUTCH ACTION TO PREVENT FURTHER DRIVING OF THE GEARS IN THE UNCAGED DIRECTION.

01011 COARSE SCREW SERVO ON

THIS CMD ACTIVATES LSG SCREW SERVO CIRCUITS TO ENABLE ACCEPTANCE OF UP AND DOWN SLEW CMDS, EITHER GROSS OR VERNIER. SCREW SERVO ACTIVATION IS INHIBITED IF THE TILT SERVO CONTROL IS ON, AND VICE VERSA. INITIATION OF CMD 01011 (BINARY) ALSO SELECTS A RELAY POSITION SUCH THAT THE DRIVE POWER, WHEN APPLIED, WILL BE FED TO THE MOTOR OF THE COARSE SCREW OF THE LSG SENSOR. REPEATED APPLICATION OF CMD 01011 (BINARY) HAS NO FURTHER EFFECT. TURN-OFF OF THE SCREW SERVO CIRCUITS IS ACCOMPLISHED BY CMD 01100 (BINARY). THE SERVO POWER CONTROL IS PRESET TO BE IN THE OFF CONDITION AT INITIAL LUNAR ACTIVATION.

01100 TILT, MASS CHANGE, AND SCREW SERVO OFF

THIS CMD DEACTIVATES LSG CIRCUITS WHICH ARE ACTIVATED BY INDIVIDUAL BINARY CMDS AS FOLLOWS:

TILT:	10100 OR 10101
MASS CHANGE:	00010
SCREW SERVO:	01011 OR 10011
PRESSURE TRANSDUCER:	01101

REPEATED APPLICATION OF CMD 01100 (BINARY) HAS NO FURTHER EFFECT. THE POWER CONTROLS ARE PRESET TO BE IN THE OFF CONDITION AT INITIAL LUNAR ACTIVATION.

LSG ENCODED COMMANDS (CONT'D)

BINARY COUNT

01101 PRESSURE TRANSDUCER ON

THIS CMD ACTIVATES A THERMAL CONDUCTIVITY TYPE OF PRESSURE TRANSDUCER TO MEASURE THE LSG INSTRUMENT HOUSING INTERNAL PRESSURE VIA THE ALSEP HOUSKEEPING, AG-05. REPEATED APPLICATION OF CMD 01101 (BINARY) HAS NO FURTHER EFFECT. TURN-OFF OF THE PRESSURE TRANSDUCER IS ACCOMPLISHED BY CMD 01100 (BINARY). THE PRESSURE TRANSDUCER IS PRESET TO BE IN THE OFF CONDITION AT INITIAL LUNAR ACTIVATION.

01110 MASS CHANGE INCREMENT

THIS CMD STEPS THE 5-BIT COUNTER OF THE LSG MASS CHANGING SERVO CONTROL CIRCUITRY, WHEN THE CIRCUIT HAS BEEN ACTIVATED BY CMD 00010 (BINARY). WHEN THE CIRCUIT IS ACTIVATED, THE COUNTER AUTOMATICALLY RESETS TO ZERO (STATE 1) AND EACH INCREMENT CMD STEPS IT ONE STEP UP (TO THE NEXT HIGHER STATE). STATES 1 THROUGH 10 ARE FUNCTIONAL STATES OF THE COUNTER AND CONTROL THE MASS CHANGING SERVO. STATE 2 IS PROVIDED TO CAGE THE MASS CHANGING SYSTEM DURING TRANSPORTATION AND STATE 10 IS USED ON EARTH FOR CALIBRATION. REPEATED APPLICATION OF CMD 01110 (BINARY) CAUSES REPEATED STEPS AND THE TENTH INCREMENT CMD WILL SELECT STATE 1 AGAIN.

01111 GROSS SLEW UP/TILT INCREMENT UP

THIS CMD CAUSES OPERATION IN THE UP DIRECTION OF ONE OF THE TWO LSG SCREW SERVO MOTORS OR ONE OF THE TWO TILT MOTORS, IF THEY HAVE BEEN PREVIOUSLY ENABLED BY ONE OF THE INDIVIDUAL BINARY CMDS AS FOLLOWS:

COARSE SCREW SERVO ON:	01011
FINE SCREW SERVO ON:	10011
NORTH/SOUTH TILT SERVO ON:	10100
EAST/WEST TILT SERVO ON:	10101

FOR THE SCREW SERVOS, EXECUTION OF CMD 01111 (BINARY) SETS A 15-BIT COUNTER TO A COUNT OF 32,768 AFTER WHICH DATA GATE PULSES STEP THE COUNTER DOWN TO ZERO; A PERIOD OF 308 SECONDS CORRESPONDING TO 16,384 STEPS OF THE STEPPING MOTOR, IN THE UP DIRECTION. A RELAY WHICH CONTROLS THE DIRECTION OF MOTOR DRIVE IS ACTUATED TO THE PROPER SETTING BY EXECUTION OF THE CMD.

01111 GROSS SLEW UP/TILT INCREMENT UP (CONT.)

FOR THE TILT SERVOS, EXECUTION OF CMD 01111 (BINARY) ENABLES DATA GATE PULSES TO STEP A TIMEOUT COUNTER CLOCK WHICH WAS ALSO RESET BY THE CMD. THE TIMEOUT OF THE CLOCK CORRESPONDS TO 2 REVOLUTIONS OF THE TILT MOTOR, IN THE UP DIRECTION.

REPEATED APPLICATION OF CMD 01111 (BINARY) CAUSES REPEATED INCREMENTS OF GROSS SLEW UP OR TILT UP; HOWEVER, THE PROPER TIME INTERVAL BETWEEN CMDS MUST BE OBSERVED.

10000 GROSS SLEW DOWN/TILT INCREMENT DOWN

THIS CMD CAUSES OPERATION IN THE DOWN DIRECTION OF ONE OF THE TWO LSG SCREW SERVO MOTORS OR ONE OF THE TWO TILT MOTORS, IF THEY HAVE BEEN PREVIOUSLY ENABLED BY ONE OF THE INDIVIDUAL BINARY CMDS AS FOLLOWS:

COARSE SCREW SERVO ON:	01011
FINE SCREW SERVO ON:	10011
NORTH/SOUTH TILT SERVO ON:	10100
EAST/WEST TILT SERVO ON:	10101

FOR THE SCREW SERVOS, EXECUTION OF CMD 10000 (BINARY) SETS A 15-BIT COUNTER TO A COUNT OF 32,768 AFTER WHICH DATA GATE PULSES STEP THE COUNTER DOWN TO ZERO; A PERIOD OF 308 SECONDS CORRESPONDING TO 16,384 STEPS OF THE STEPPING MOTOR, IN THE DOWN DIRECTION. A RELAY WHICH CONTROLS THE DIRECTION OF MOTOR DRIVE IS ACTUATED BY EXECUTION OF THE CMD.

FOR THE TILT SERVOS, EXECUTION OF CMD 10000 (BINARY) ENABLES DATA GATE PULSES TO STEP A TIMEOUT COUNTER CLOCK WHICH WAS ALSO RESET BY THE CMD. THE TIMEOUT OF THE CLOCK CORRESPONDS TO 2 REVOLUTIONS OF THE TILT MOTOR, IN THE DOWN DIRECTION.

REPEATED APPLICATION OF CMD 10000 (BINARY) CAUSES REPEATED INCREMENTS OF GROSS SLEW DOWN OR TILT DOWN; HOWEVER, THE PROPER TIME INTERVAL BETWEEN CMDS MUST BE OBSERVED.

LSG ENCODED COMMANDS (CONT'D)

BINARY COUNT

10001 VERNIER SLEW UP

THIS CMD CAUSES OPERATION IN THE UP DIRECTION OF ONE OF THE TWO LSG SCREW SERVO MOTORS, IF THEY HAVE BEEN PREVIOUSLY ENABLED BY ONE OF THE INDIVIDUAL BINARY CMDS AS FOLLOWS:

COARSE SCREW SERVO ON:	01011
FINE SCREW SERVO ON:	10011

EXECUTION OF CMD 10001 (BINARY) SETS A 15-BIT COUNTER TO 256 AFTER WHICH DATA GATE PULSES STEP THE COUNTER DOWN TO ZERO; A PERIOD OF 2.5 SECONDS CORRESPONDING TO 128 STEPS OF THE STEPPER MOTOR, IN THE UP DIRECTION. A RELAY WHICH CONTROLS THE DIRECTION OF MOTOR DRIVE IS ACTUATED BY EXECUTION OF THE CMD.

REPEATED APPLICATION OF CMD 10001 (BINARY) CAUSES REPEATED VERNIER SLEW UP OF WHICHEVER SCREW SERVO MOTOR HAS BEEN ENABLED.

10010 VERNIER SLEW DOWN

THIS CMD CAUSES OPERATION IN THE DOWN DIRECTION OF ONE OF THE TWO LSG SCREW SERVO MOTORS, IF THEY HAVE BEEN PREVIOUSLY ENABLED BY ONE OF THE INDIVIDUAL BINARY CMDS AS FOLLOWS:

COARSE SCREW SERVO ON:	01011
FINE SCREW SERVO ON:	10011

EXECUTION OF CMD 10010 (BINARY) SETS A 15-BIT COUNTER TO 256 AFTER WHICH DATA GATE PULSES STEP THE COUNTER DOWN TO ZERO; A PERIOD OF 2.5 SECONDS CORRESPONDING TO 128 STEPS OF THE STEPPER MOTOR, IN THE DOWN DIRECTION. A RELAY WHICH CONTROLS THE DIRECTION OF MOTOR DRIVE IS ACTUATED BY EXECUTION OF THE CMD.

REPEATED APPLICATION OF CMD 10010 (BINARY) CAUSES REPEATED VERNIER SLEW DOWN OF WHICHEVER SCREW SERVO MOTOR HAS BEEN ENABLED.

10011 FINE SCREW SERVO ON

THIS CMD ACTIVATES LSG SCREW SERVO CIRCUITS TO ENABLE ACCEPTANCE OF UP AND DOWN SLEW COMMANDS, EITHER GROSS OR VERNIER. SCREW SERVO ACTIVATION IS INHIBITED WHEN THE TILT SERVO CONTROL IS ON AND VICE VERSA. INITIATION OF CMD 10011 (BINARY) ALSO SELECTS A RELAY POSITION SUCH THAT THE DRIVE POWER, WHEN APPLIED, WILL BE FED TO THE FINE SCREW OF THE LSG SENSOR. REPEATED APPLICATION OF CMD 10011 (BINARY) HAS NO FURTHER EFFECT. TURN-OFF OF THE SCREW SERVO CIRCUITS IS ACCOMPLISHED BY CMD 01100 (BINARY). THE SERVO POWER CONTROL IS PRESET TO BE IN THE OFF CONDITION AT INITIAL LUNAR ACTIVATION.

10100 NORTH/SOUTH TILT SERVO ON

THIS CMD ACTIVATES LSG TILT SERVO CIRCUITS TO ENABLE ACCEPTANCE OF AN UP OR DOWN TILT INCREMENT COMMAND. TILT SERVO ACTIVATION IS INHIBITED WHEN THE SCREW SERVO CONTROL IS ON AND VICE VERSA. INITIATION OF CMD 10100 (BINARY) ALSO SELECTS A RELAY POSITION SUCH THAT THE DRIVE POWER, WHEN APPLIED, WILL BE FED TO NORTH/SOUTH TILT MOTOR. REPEATED APPLICATION OF CMD 10100 (BINARY) HAS NO FURTHER EFFECT. TURN-OFF OF THE TILT SERVO CIRCUITS IS ACCOMPLISHED BY CMD 01100 (BINARY). THE SERVO POWER CONTROL IS PRESET TO BE IN THE OFF CONDITION AT INITIAL LUNAR ACTIVATION.

10101 EAST/WEST TILT SERVO ON

THIS CMD ACTIVATES LSG TILT SERVO CIRCUITS TO ENABLE ACCEPTANCE OF AN UP OR DOWN TILT INCREMENT COMMAND. TILT SERVO ACTIVATION IS INHIBITED WHEN THE SCREW SERVO IS ON AND VICE VERSA. INITIATION OF CMD 10101 (BINARY) ALSO SELECTS A RELAY POSITION SUCH THAT THE DRIVE POWER, WHEN APPLIED, WILL BE FED TO THE EAST/WEST TILT MOTOR. REPEATED APPLICATION OF CMD 10101 (BINARY) HAS NO FURTHER EFFECT. TURN-OFF OF THE TILT SERVO CIRCUITS IS ACCOMPLISHED BY CMD 01100 (BINARY). THE SERVO POWER CONTROL IS PRESET TO BE IN THE OFF CONDITION AT INITIAL LUNAR ACTIVATION.

LSG ENCODED COMMANDS (CONT'D)

BINARY COUNT

10110 TEMPERATURE INCREMENT LOAD 1

THIS CMD IS ONE OF SIX USED BY THE LSG TO LOAD A REGISTER CONSISTING OF SIX RELAYS. THE STATE OF THE REGISTER IS READ OUT IN THE TM AND EACH OF THE 64 STATES, THROUGH A THERMISTOR BRIDGE CIRCUIT, CONTROLS THE TEMPERATURE OF THE HEATER BOX AROUND THE LSG SENSOR THROUGH 64 STEPS OF 0.05°C. THUS, THE TEMPERATURE CAN BE ADJUSTED WITHIN A RANGE OF ± 1.6°C AROUND THE NOMINAL OPERATING POINT TO FIND THE SENSOR INVERSION POINT ON THE LUNAR SURFACE AND MAINTAIN OPERATION AT THIS POINT. REPEATED APPLICATION OF CMD 10110 (BINARY) HAS NO FURTHER EFFECT UNTIL THE REGISTER IS CLEARED BY THE RESET CMD 11100 (BINARY). THE TEMPERATURE REGISTER RELAYS ARE PRESET TO BE IN THE (TBD) CONDITION AT INITIAL LUNAR ACTIVATION. THESE RELAYS MAY RESET WHEN LSG OPERATIONAL POWER IS REMOVED AND REAPPLIED.

10111 TEMPERATURE INCREMENT LOAD 2

THIS CMD IS ONE OF SIX USED BY THE LSG TO LOAD A REGISTER CONSISTING OF SIX RELAYS. THE STATE OF THE REGISTER IS READ OUT IN THE TM AND EACH OF THE 64 STATES, THROUGH A THERMISTOR BRIDGE CIRCUIT, CONTROLS THE TEMPERATURE OF THE HEATER BOX AROUND THE LSG SENSOR THROUGH 64 STEPS OF 0.05°C. THUS, THE TEMPERATURE CAN BE ADJUSTED WITHIN A RANGE OF ± 1.6°C AROUND THE NOMINAL OPERATING POINT TO FIND THE SENSOR INVERSION POINT ON THE LUNAR SURFACE AND MAINTAIN OPERATION AT THIS POINT. REPEATED APPLICATION OF CMD 10111 (BINARY) HAS NO FURTHER EFFECT UNTIL THE REGISTER IS CLEARED BY THE RESET CMD 11100 (BINARY). THE TEMPERATURE REGISTER RELAYS ARE PRESET TO BE IN THE (TBD) CONDITION AT INITIAL LUNAR ACTIVATION. THESE RELAYS MAY RESET WHEN LSG OPERATIONAL POWER IS REMOVED AND REAPPLIED.

11000 TEMPERATURE INCREMENT LOAD 3

THIS CMD IS ONE OF SIX USED BY THE LSG TO LOAD A REGISTER CONSISTING OF SIX RELAYS. THE STATE OF THE REGISTER IS READ OUT IN THE TM AND EACH OF THE 64 STATES, THROUGH A THERMISTOR BRIDGE CIRCUIT, CONTROLS THE TEMPERATURE OF THE HEATER BOX AROUND THE LSG SENSOR THROUGH 64 STEPS OF 0.05°C. THUS, THE TEMPERATURE CAN BE ADJUSTED WITHIN A RANGE OF ± 1.6°C AROUND THE NOMINAL OPERATING POINT TO FIND THE SENSOR INVERSION POINT ON THE LUNAR SURFACE AND MAINTAIN OPERATION AT THIS POINT. REPEATED APPLICATION OF CMD 11000 (BINARY) HAS NO FURTHER EFFECT UNTIL THE REGISTER IS CLEARED BY THE RESET CMD 11100 (BINARY). THE TEMPERATURE REGISTER RELAYS ARE PRESET TO BE IN THE (TBD) CONDITION AT INITIAL LUNAR ACTIVATION. THESE RELAYS MAY RESET WHEN LSG OPERATIONAL POWER IS REMOVED AND REAPPLIED.

11001 TEMPERATURE INCREMENT LOAD 4

THIS CMD IS ONE OF SIX USED BY THE LSG TO LOAD A REGISTER CONSISTING OF SIX RELAYS. THE STATE OF THE REGISTER IS READ OUT IN THE TM AND EACH OF THE 64 STATES, THROUGH A THERMISTOR BRIDGE CIRCUIT, CONTROLS THE TEMPERATURE OF THE HEATER BOX AROUND THE LSG SENSOR THROUGH 64 STEPS OF 0.05°C. THUS, THE TEMPERATURE CAN BE ADJUSTED WITHIN A RANGE OF ± 1.6°C AROUND THE NOMINAL OPERATING POINT TO FIND THE SENSOR INVERSION POINT ON THE LUNAR SURFACE AND MAINTAIN OPERATION AT THIS POINT. REPEATED APPLICATION OF CMD 11001 (BINARY) HAS NO FURTHER EFFECT UNTIL THE REGISTER IS CLEARED BY THE RESET CMD 11100 (BINARY). THE TEMPERATURE REGISTER RELAYS ARE PRESET TO BE IN THE (TBD) CONDITION AT INITIAL LUNAR ACTIVATION. THESE RELAYS MAY RESET WHEN LSG OPERATIONAL POWER IS REMOVED AND REAPPLIED.

11010 TEMPERATURE INCREMENT LOAD 5

THIS CMD IS ONE OF SIX USED BY THE LSG TO LOAD A REGISTER CONSISTING OF SIX RELAYS. THE STATE OF THE REGISTER IS READ OUT IN THE TM AND EACH OF THE 64 STATES, THROUGH A THERMISTOR BRIDGE CIRCUIT, CONTROLS THE TEMPERATURE OF THE HEATER BOX AROUND THE LSG SENSOR THROUGH 64 STEPS OF 0.05°C. THUS, THE TEMPERATURE CAN BE ADJUSTED WITHIN A RANGE OF ± 1.6°C AROUND THE NOMINAL OPERATING POINT TO FIND THE SENSOR INVERSION POINT ON THE LUNAR SURFACE AND MAINTAIN OPERATION AT THIS POINT. REPEATED APPLICATION OF CMD 11010 (BINARY) HAS NO FURTHER EFFECT UNTIL THE REGISTER IS CLEARED BY THE RESET CMD 11100 (BINARY). THE TEMPERATURE REGISTER RELAYS ARE PRESET TO BE IN THE (TBD) CONDITION AT INITIAL LUNAR ACTIVATION. THESE RELAYS MAY RESET WHEN LSG OPERATIONAL POWER IS REMOVED AND REAPPLIED.

11011 TEMPERATURE INCREMENT LOAD 6

THIS CMD IS ONE OF SIX USED BY THE LSG TO LOAD A REGISTER CONSISTING OF SIX RELAYS. THE STATE OF THE REGISTER IS READ OUT IN THE TM AND EACH OF THE 64 STATES, THROUGH A THERMISTOR BRIDGE CIRCUIT, CONTROLS THE TEMPERATURE OF THE HEATER BOX AROUND THE LSG SENSOR THROUGH 64 STEPS OF 0.05°C. THUS, THE TEMPERATURE CAN BE ADJUSTED WITHIN A RANGE OF ± 1.6°C AROUND THE NOMINAL OPERATING POINT TO FIND THE SENSOR INVERSION POINT ON THE LUNAR SURFACE AND MAINTAIN OPERATION AT THIS POINT. REPEATED APPLICATION OF CMD 11011 (BINARY) HAS NO FURTHER EFFECT UNTIL THE REGISTER IS CLEARED BY THE RESET CMD 11100 (BINARY). THE TEMPERATURE REGISTER RELAYS ARE PRESET TO BE IN THE (TBD) CONDITION AT INITIAL LUNAR ACTIVATION THESE RELAYS MAY RESET WHEN LSG OPERATIONAL POWER IS REMOVED AND REAPPLIED.

LSG ENCODED COMMANDS (CONT'D)

BINARY COUNT

11100 TEMPERATURE RESET

THIS CMD RESETS THE SIX RELAYS USED IN THE REGISTER OF THE LSG HEATER BOX TEMPERATURE CONTROL CIRCUIT. REPEATED APPLICATION OF CMD 11100 HAS NO FURTHER EFFECT. THE TEMPERATURE REGISTER RELAYS ARE PRESET TO BE IN THE (TBD) CONDITION AT INITIAL LUNAR ACTIVATION. THESE RELAYS MAY RESET WHEN LSG OPERATIONAL POWER IS REMOVED AND REAPPLIED.

11101 POST AMP GAIN INCREMENT

THIS CMD ADVANCES THE COUNT OF A 4-STAGE REGISTER CONTROLLING THE GAIN OF THE POST-AMPLIFIER OF THE LSG SENSOR. THE STATUS OF THIS REGISTER IS NOT READ OUT IN THE TM. REPEATED APPLICATION OF CMD 11101 (BINARY) CAUSES THE COUNTER SETTING TO ADVANCE IN REPEATED INCREMENTS UNTIL IT REACHES 15, AFTER WHICH IT RESETS TO ZERO AND CONTINUES IN THE SAME SEQUENCE. WHEN OPERATIONAL POWER IS APPLIED TO THE LSG, THE INITIAL GAIN SETTING IS UNPREDICTABLE.

11110 POST AMP GAIN RESET

THIS CMD RESETS THE COUNTER OF THE 4-STAGE REGISTER CONTROLLING THE GAIN OF THE POST-AMPLIFIER OF THE LSG SENSOR, RESULTING IN THE LOWEST GAIN SETTING. REPEATED APPLICATION OF CMD 11110 (BINARY) HAS NO FURTHER EFFECT.

LSG DIGITAL DATA FORMATS

NORMAL MODE

1 C	2 C	3 C	4 G	5	6 G	7	8 G
9	10 G	11	12 G	13	14 G	15	16 G
17	18 G	19	20 G	21	22 G	23	24 G
25 TIDE	26 G	27 FREE MODE	28 G	29 TEMP	30 G	31	32 G
33 H. K.	34 G	35 STATUS 1	36 G	37 STATUS 2	38 G	39	40 G
41	42 G	43	44 G	45	46 G	47	48 G
49	50 G	51	52 G	53	54 G	55	G
57	58 G	59	60 G	61	62 G	63	64 G

SHAFT ENCODER MODE

C	C	C	COARSE ENCODER MSB		COARSE ENCODER LSB		FINE ENCODER MSB
	FINE ENCODER LSB		COARSE ENCODER MSB		COARSE ENCODER LSB		FINE ENCODER MSB
	FINE ENCODER LSB		COARSE ENCODER MSB		COARSE ENCODER LSB		FINE ENCODER MSB
FINE ENCODER LSB	FINE ENCODER LSB	FINE ENCODER LSB	FINE ENCODER LSB	FINE ENCODER LSB	FINE ENCODER LSB		FINE ENCODER LSB
H. K.	COARSE ENCODER MSB	COARSE ENCODER LSB	COARSE ENCODER LSB	COARSE ENCODER LSB	COARSE ENCODER LSB		COARSE ENCODER LSB
	FINE ENCODER MSB		FINE ENCODER LSB		COARSE ENCODER MSB		COARSE ENCODER LSB
	FINE ENCODER MSB		FINE ENCODER LSB		COARSE ENCODER MSB		COARSE ENCODER LSB
	FINE ENCODER MSB		FINE ENCODER LSB		COARSE ENCODER MSB		COARSE ENCODER LSB

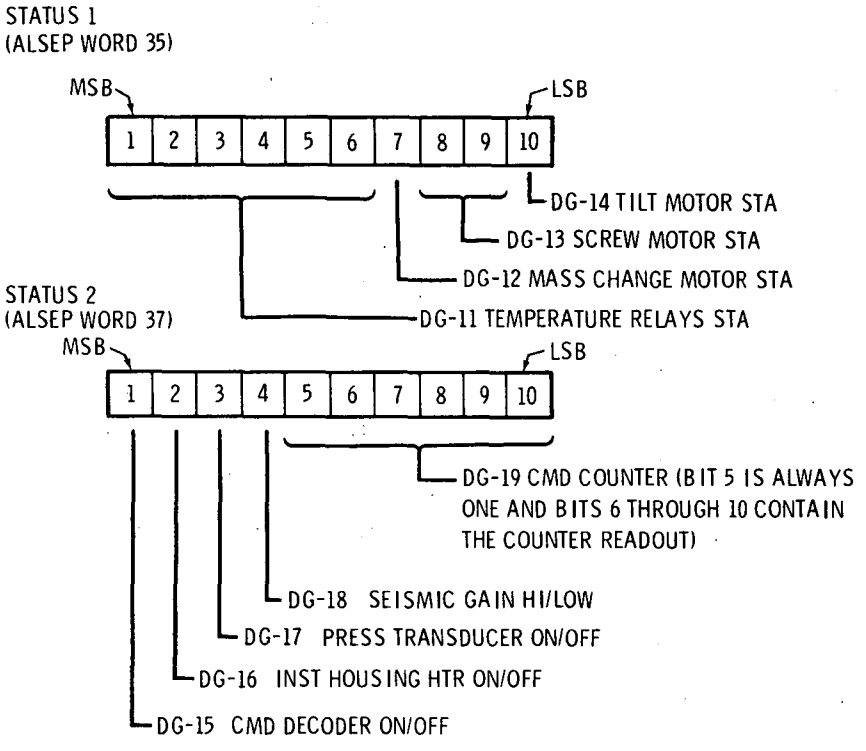
ALSEP DATA FRAME CONTAINS 64 10-BIT DATA WORDS

C = ALSEP CONTROL WORDS (3 PER FRAME)

G = LSG SEISMIC DATA (31 WORDS PER FRAME)

H. K. = HOUSEKEEPING (INCLUDING 10 LSG PARAMETERS)
COMMUTATED ONCE EVERY 90 ALSEP FRAMES

LSG STATUS AND ENGINEERING DATA



HOUSEKEEPING (ALSEP WORD 33)

ALSEP FRAME NO.	CODE	PARAMETER
10	AG-02	LSG TIDE *
23	AG-03	LSG FREE MODE *
24	AG-07	LSG OSCILLATOR AMPLITUDE
38	AG-08	LSG +15 VOLTS
39	AG-01	LSG SEISMIC *
53	AG-09	LSG -15 VOLTS
54	AG-06	LSG MASS CHANGE POSITION
68	AG-04	LSG SENSOR TEMPERATURE
69	AG-10	LSG +5 VOLTS
89	AG-05	LSG PRESSURE
* SCIENCE DATA READ OUT IN ANALOG HOUSEKEEPING CHANNELS		

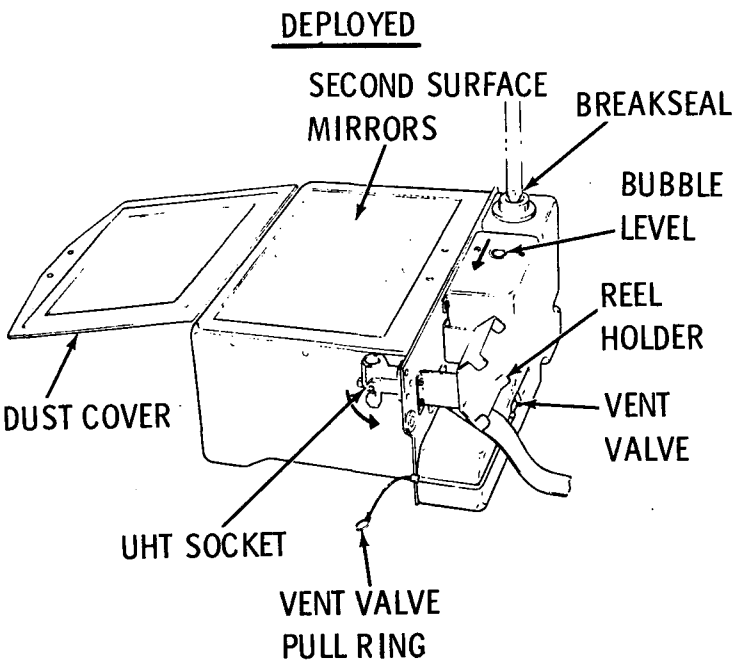
HOUSEKEEPING PARAMETERS ARE READ OUT ONCE EVERY 90 ALSEP FRAMES (ONCE EVERY 54 SECONDS AT NORMAL DATA RATE)

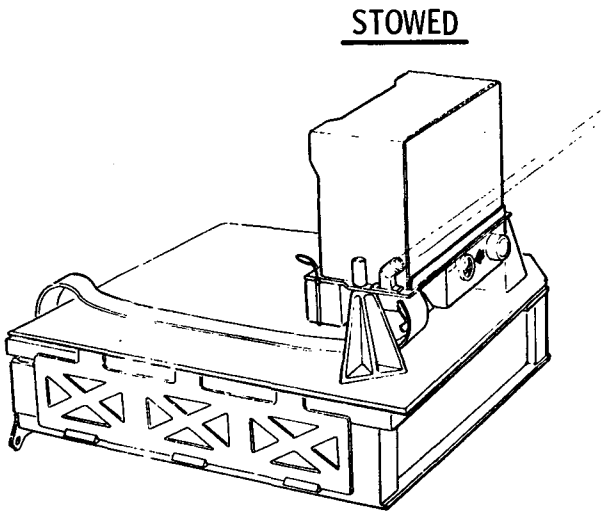
LSG INITIAL LUNAR OPERATIONS

FUNCTION	COMMENTS
1. INSTRUMENT TURN-ON	APPLICATION OF LSG OPERATIONAL POWER
2. INITIAL TEMPERATURE SET UP	RESET REGISTER TO LOWEST INCREMENT
3. PRESSURE TRANSDUCER CHECK	1.5 MINUTES FOR STABILIZATION, THEN TURN OFF
4. INITIALIZE ELECTROSTATIC LOOP	SET BIAS OUT, INTEGRATOR SHORT MODE, AND MINIMUM GAIN
5. UNCAGE MASS CHANGE MECHANISM	
6. UNCAGE SENSOR BEAM	
7. INITIAL MASS ADJUSTMENT	ACTUATE MASS CHANGE MOTOR
8. INITIAL BEAM ADJUSTMENT	OPERATE SCREW MOTORS, READ SHAFT ENCODERS
9. TEMPERATURE STABILIZATION	MAY TAKE SEVERAL HOURS
10. NULL SENSOR BEAM	ACTUATE SCREW MOTORS
11. ADJUST TILT	ACTUATE TILT MOTORS
12. OBTAIN SPRING INVERSION TEMP	ADJUST TEMP IN INCREMENTS, STABILIZING EACH TIME
13. RE-NULL SENSOR BEAM	ACTUATE SCREW MOTORS
14. ADJUST ELECTROSTATIC LOOP	SET BIAS IN, INTEGRATOR NORMAL, AND INCREASE GAIN
15. STABILITY CHECK	RE-ADJUST AS NECESSARY
16. OPERATIONAL MODE	FOLLOWS COMPLETION OF THE OPERATIONS ABOVE

LUNAR MASS SPECTROMETER (LMS)

LMS CONFIGURATION





JUNE 72 3270.4.2

LMS SCIENCE SUMMARY

OBJECTIVES

- TO IDENTIFY AND DETERMINE THE DENSITY OF CONSTITUENTS OF THE LUNAR ATMOSPHERE
- TO DETERMINE THE TEMPORAL VARIATIONS OF THE ATMOSPHERIC CONSTITUENTS

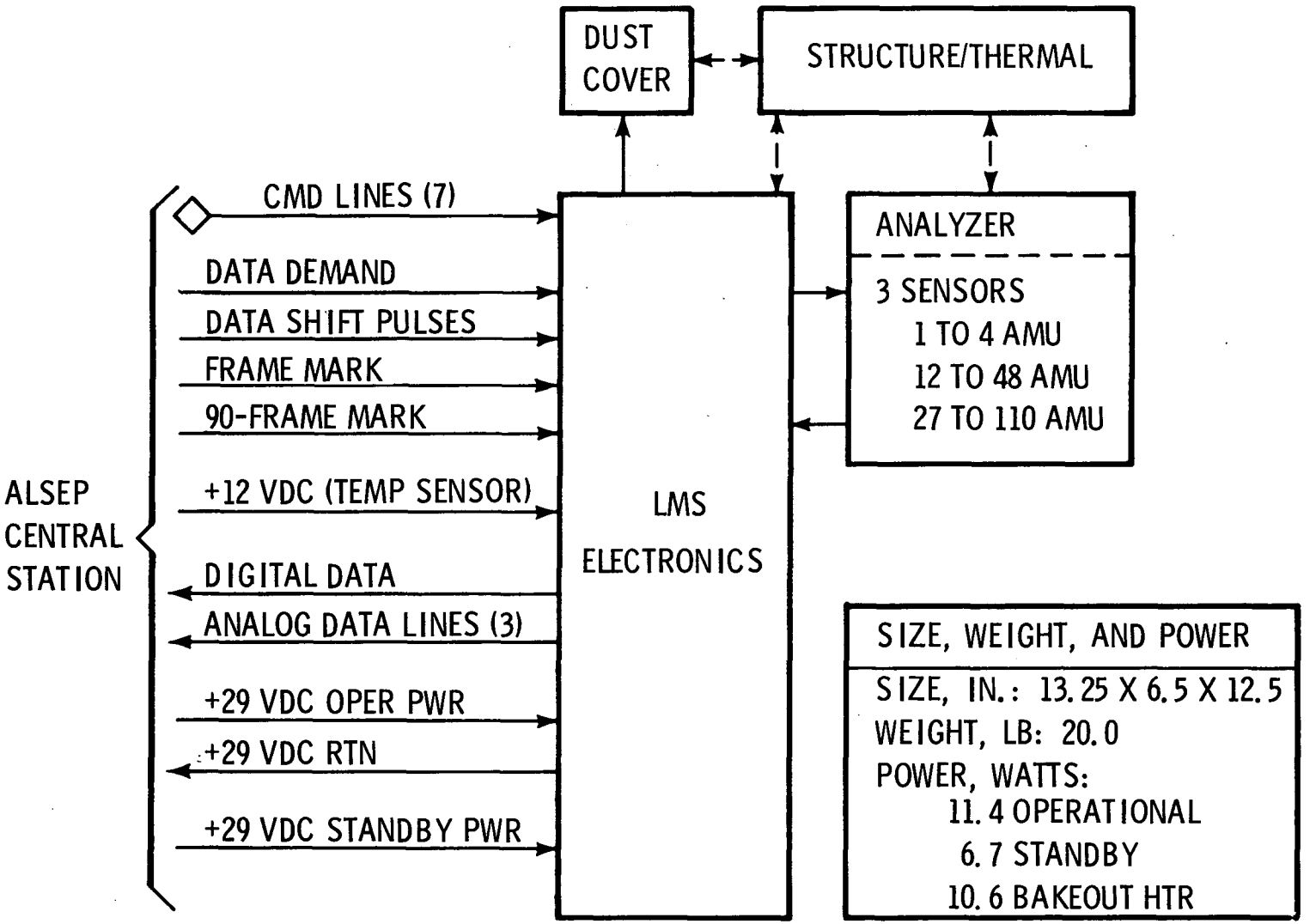
METHODS

- DETECT AND COLLECT IONS IN MASS RANGE 1 THROUGH 4 AMU AND 12 THROUGH 110 AMU

RESULTS

- STRUCTURE AND COMPOSITION OF LUNAR ATMOSPHERE
  - GLOBAL DISTRIBUTION
  - DIURNAL VARIATIONS
  - GAS RELEASE AT DAWN TERMINATOR
  - TEST THEORIES OF PLANETARY EXOSPHERE DYNAMICS
- ORIGIN OF ATMOSPHERE
  - SOLAR WIND ACCRETION
  - NEON DISTRIBUTION
  - VOLCANISM
- TRANSIENT PHENOMENA
  - LOCATION OF GAS VENTING
  - PHYSICAL PROCESSES CAUSING GAS RELEASE
- RESIDUAL CONTAMINATION
  - DIFFUSION RATES OF GAS CLOUDS
  - OUTGASSING RATE OF SURFACE

LMS COMPONENTS AND INTERFACE



JUNE 72 3270.4.4

LMS OPERATIONS SUMMARY

DEPLOYMENT

- OPEN VENT VALVE
- REMOVE 3 TIE-DOWN FASTENERS
- ROTATE 90^0 TO UPRIGHT POSITION
- PLACE 45 FT NORTHWEST OF CENTRAL STATION
- LEVEL
- BREAK HERMETIC SEAL ON SENSOR
- RECHECK LEVEL

POST DEPLOYMENT

- CMD OPERATIONAL POWER FOR LOW VOLTAGES
- REMOVE DUST COVER AFTER LM ASCENT
- PERFORM BAKEOUT
- TURN ON ION PUMP, READ PRESSURE
- APPLY HIGH VOLTAGES FOR FULL OPERATION

CONSIDERATIONS

- HERMETICALLY SEALED ON EARTH
- REQUIRES UNOBSTRUCTED UPWARD HEMISPHERE VIEW
- PLACE AS FAR AS POSSIBLE FROM EQUIPMENT THAT MIGHT OUTGAS
- CONTAINS PERMANENT MAGNETS
- USES HIGH VOLTAGES
- USES SECOND SURFACE MIRRORS ON TOP THERMAL CONTROL SURFACE

LMS COMMUNICATIONS SUMMARY

COMMANDS

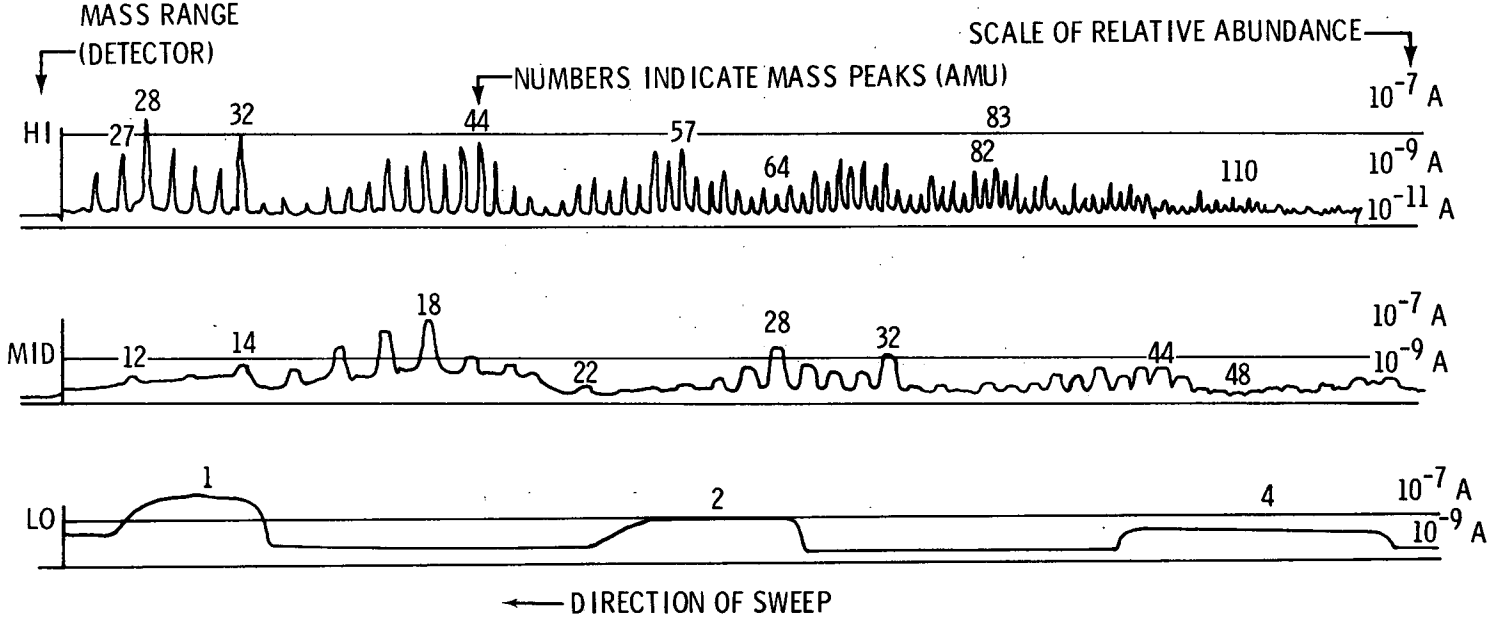
- POWER ON/STANDBY/OFF
- 7 CMD LINES TO PROVIDE 15 ENCODED CMDS
  (2 LOAD AND 1 EXECUTE, EACH) INCLUDING:
  -DUST COVER REMOVAL
  -HIGH VOLTAGES ON/OFF
  -ION PUMP ON/OFF
  -FILAMENT 1 OR 2 SELECT/OFF
  -HIGH VOLTAGE STEPS
  -SWEEP LOCK/STEP MODE SELECT
  -BAKEOUT MODE SELECT
  -ELECTRON MULTIPLIER VOLTAGE SELECT
  -DISCRIMINATOR LEVEL SELECT

DATA

- 4 DIGITAL 10-BIT WORDS PER ALSEP FRAME
  -1 INSTRUMENT/CMD STATUS DATA
  -3 SCIENCE DATA (3 SENSORS SAMPLED ONCE PER FRAME)
- 3 ANALOG CHANNELS IN ALSEP WORD 33,
  READ OUT ONCE EVERY 90 ALSEP FRAMES
  (ONCE EVERY 54 SECONDS AT NORMAL DATA RATE)
  -1 MULTIPLEXED 16-CHANNEL HOUSEKEEPING DATA
  -1 SWEEP VOLTAGE
  -1 ELECTRONICS TEMPERATURE
  (READS OUT IN OPERATIONAL, STANDBY, AND OFF CONDITIONS)

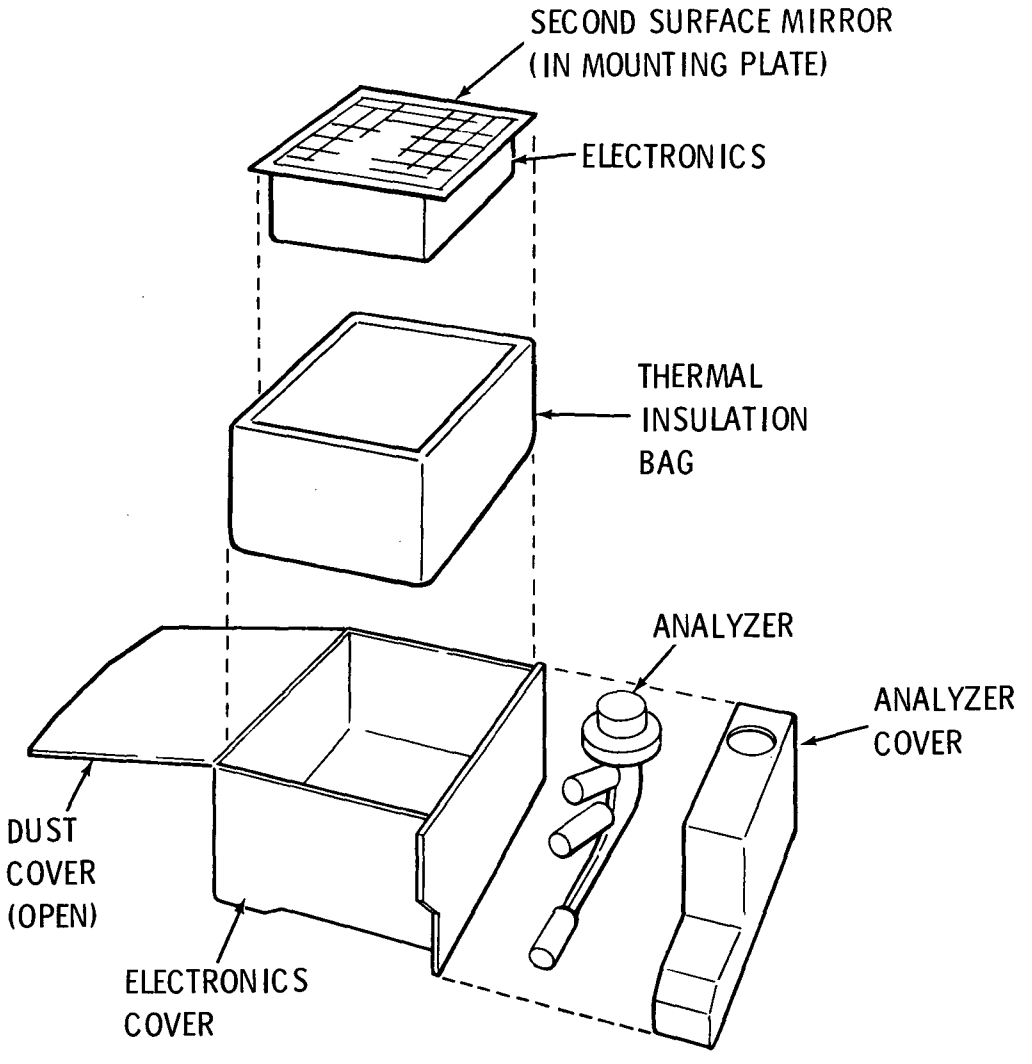
LMS PERFORMANCE CHARACTERISTICS

- MODE OF OPERATION: AUTOMATIC CONTINUOUS SWEEP WITH COMMANDABLE LOCK AT ANY AMU
- SCAN TECHNIQUE: VARY ACCELERATING VOLTAGE FROM 320 TO 1420 VOLTS IN A SERIES OF 1350 STEPS
- MEASUREMENT: THREE DETECTORS DETERMINE THE DENSITY (ABUNDANCE) OF EACH CONSTITUENT IN THE LUNAR ATMOSPHERE BY COUNTING PARTICLES AT EACH STEP FOR A PERIOD OF 0.6 SECONDS
- RESOLUTION: 10%
- SENSITIVITY: 1.0×10^{-5} TORR
- DYNAMIC RANGE: 1×10^{5}
- TYPICAL RECORD FOR ONE SWEEP IS SHOWN BELOW



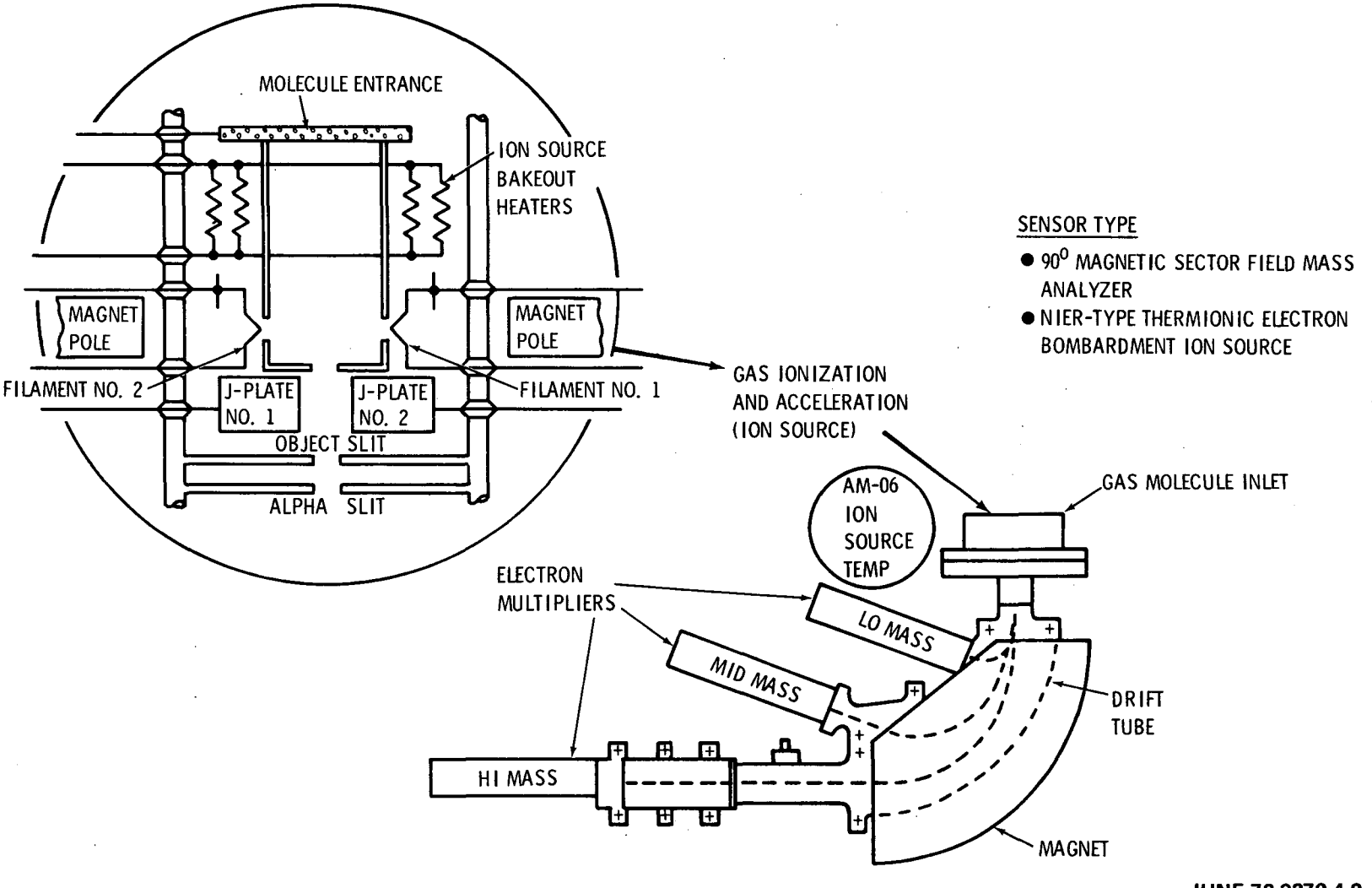
JUNE 72 3270.4.7

LMS EXPLODED ASSEMBLY



JUNE 72 3270.4.8

LMS DETECTION SYSTEM

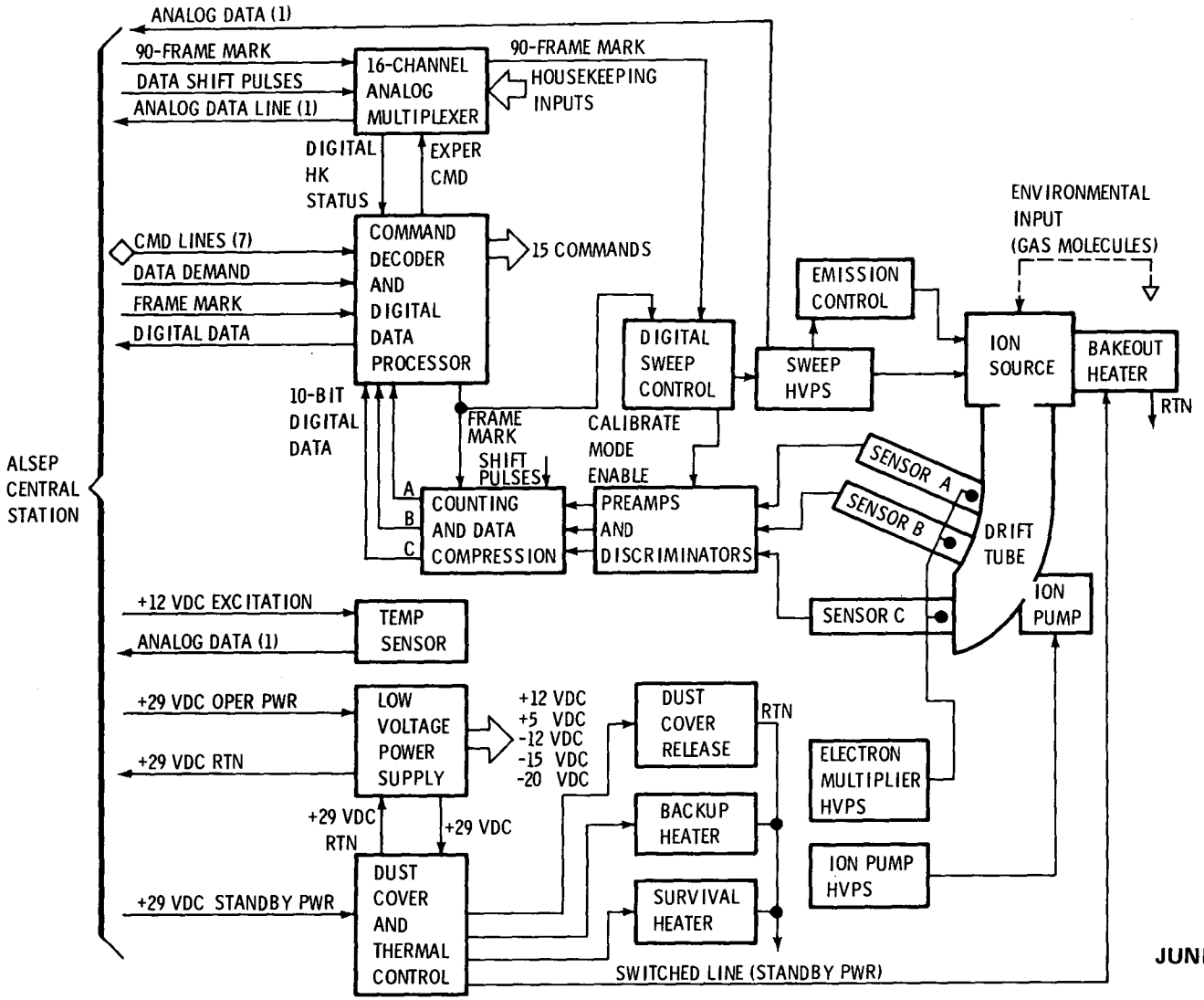


SENSOR TYPE

- 90^{0} MAGNETIC SECTOR FIELD MASS ANALYZER
- NIER-TYPE THERMIONIC ELECTRON BOMBARDMENT ION SOURCE

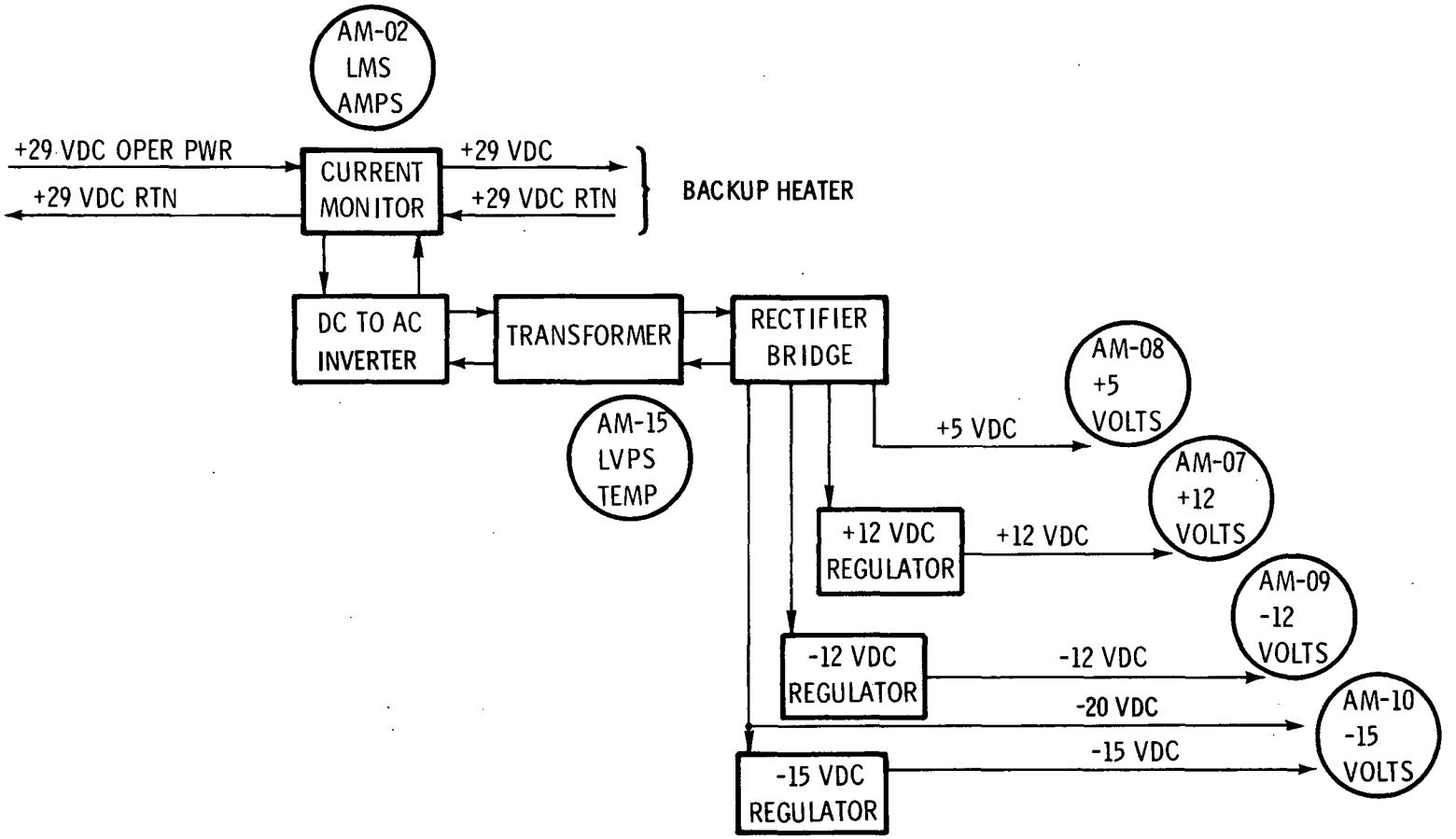
JUNE 72 3270.4.9

LMS FUNCTIONAL SUMMARY



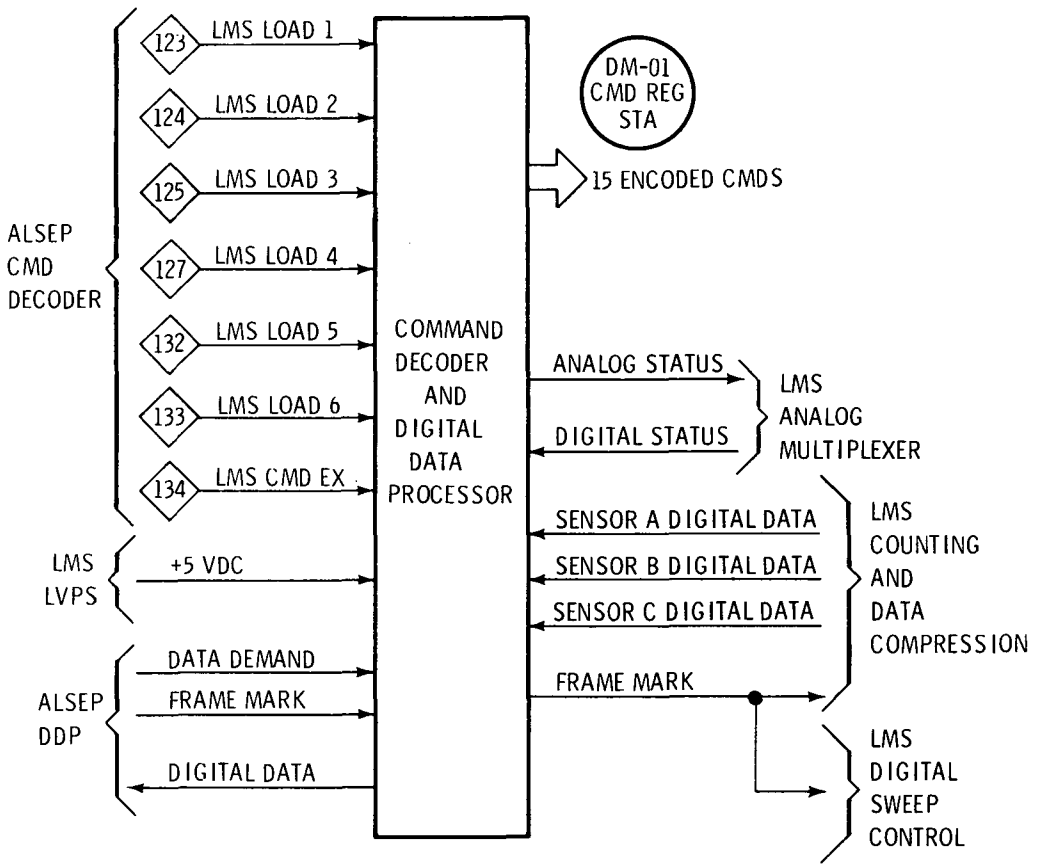
JUNE 72 3270.4.10

LMS LOW VOLTAGE POWER SUPPLY
(LVPS)



JUNE 72 3270.4.11

LMS DECODER AND DATA PROCESSOR



PURPOSE

- RECEIVES INDIVIDUAL CMDS FROM ALSEP, DECODES THE MULTIPLEXED COMBINATIONS, CONDITIONS THEM AND ROUTES THEM TO THE PROPER CIRCUITS
- PROVIDES TM ON CMDS RECEIVED FROM ALSEP
- GATES SCIENTIFIC DIGITAL DATA AND LMS OPERATING STATUS DIGITAL DATA TO ALSEP DDP IN THE PROPER SEQUENCE

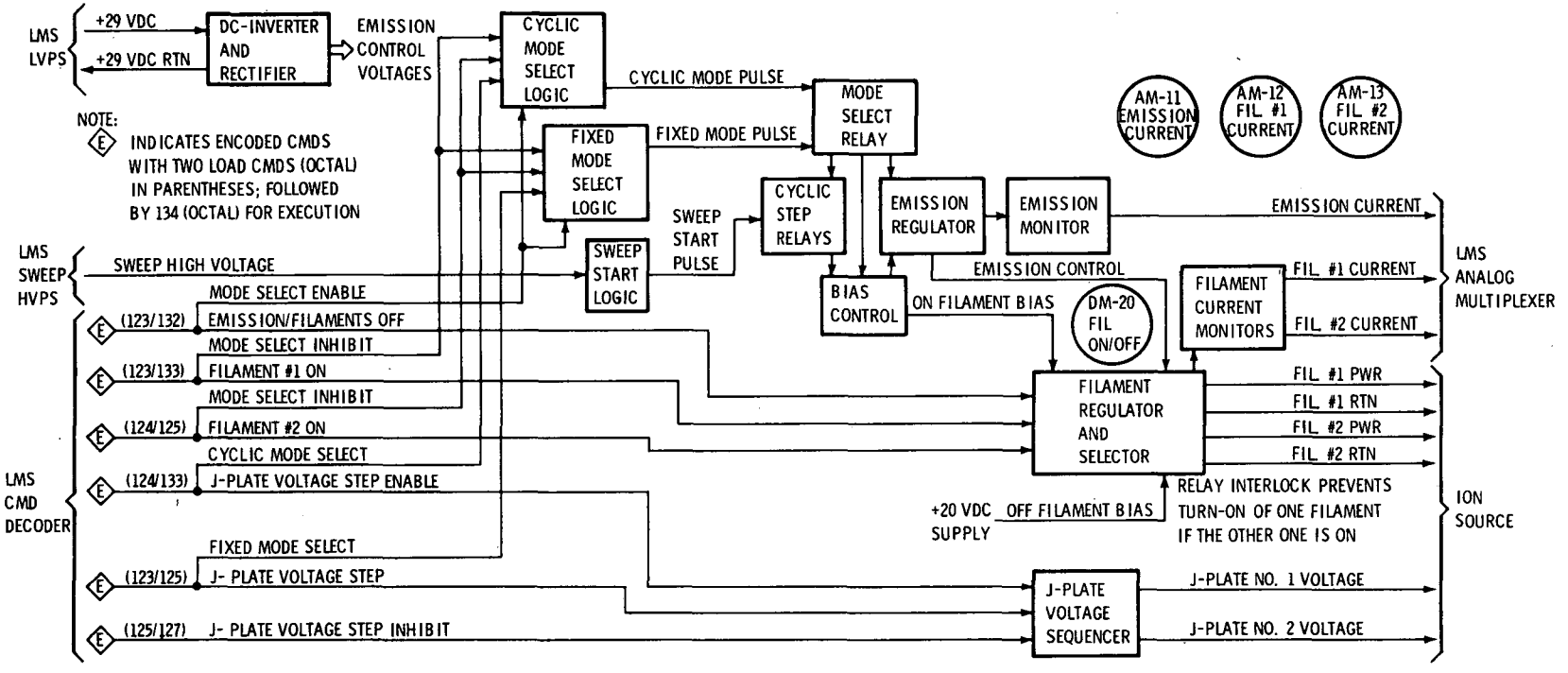
INPUTS

- DIGITAL CMD AND TIMING FROM ALSEP
- DIGITAL HOUSEKEEPING STATUS DATA FROM LMS ANALOG MULTIPLEXER
- DIGITAL SCIENTIFIC DATA FROM THE THREE SENSORS VIA THE LMS COUNTING AND DATA COMPRESSION

OUTPUTS

- CMDS TO LMS CIRCUITS
- TIMING TO LMS DATA AND SWEEP CONTROL
- DIGITAL SCIENTIFIC AND STATUS DATA TO THE ALSEP DIGITAL DATA PROCESSOR

LMS EMISSION CONTROL



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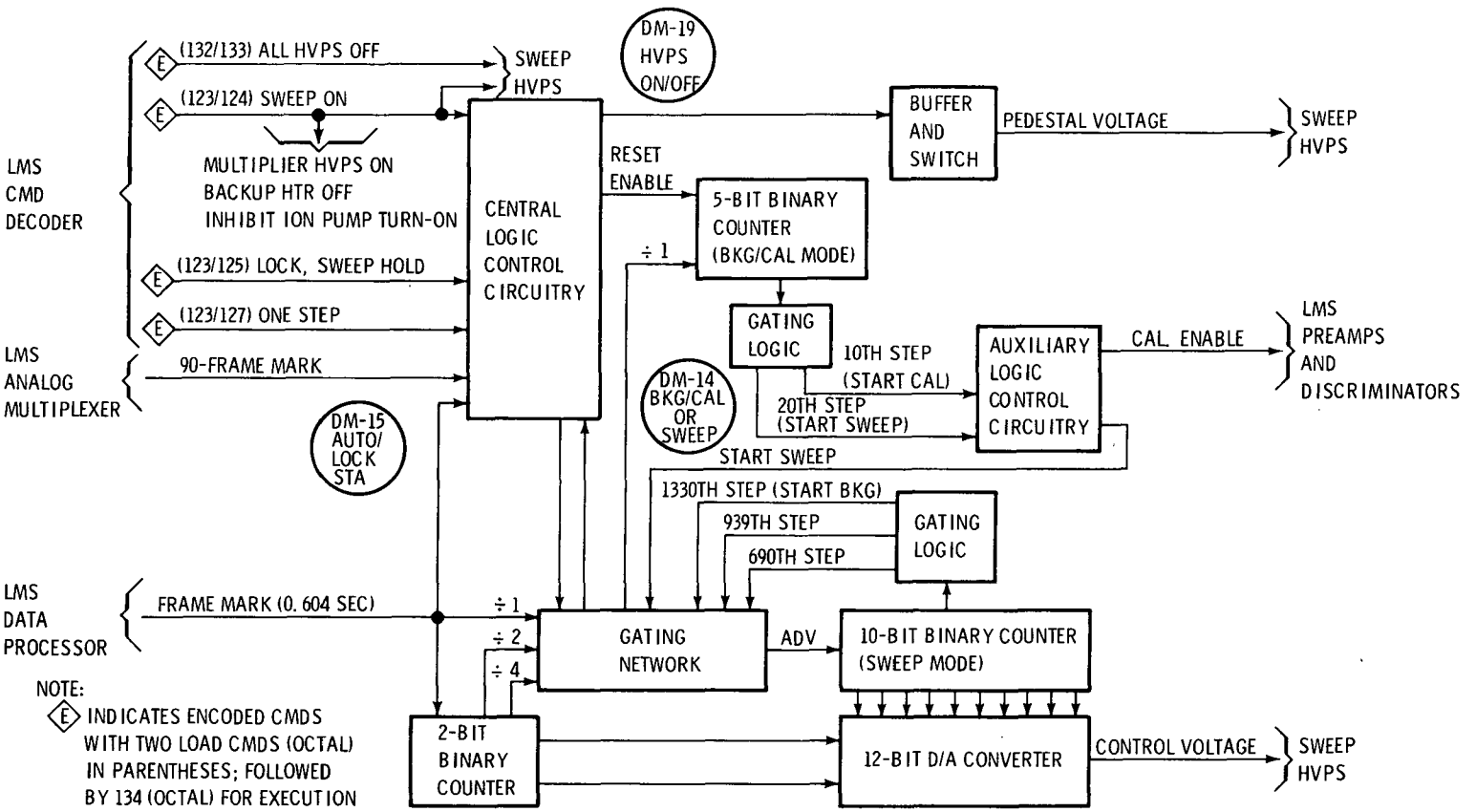
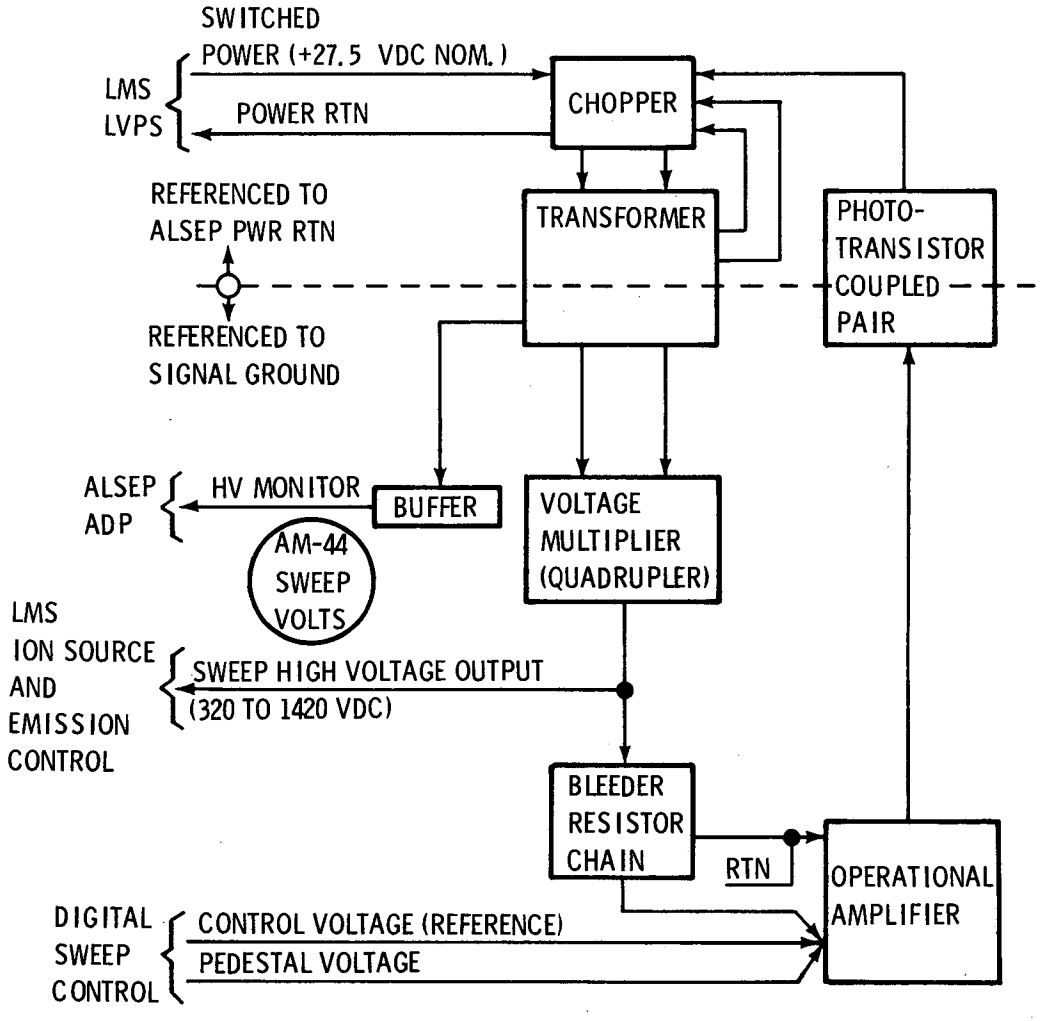
LMS DIGITAL SWEEP CONTROL



JUNE 72 3270.4.14

LMS SWEEP HVPS

(HIGH VOLTAGE POWER SUPPLY)



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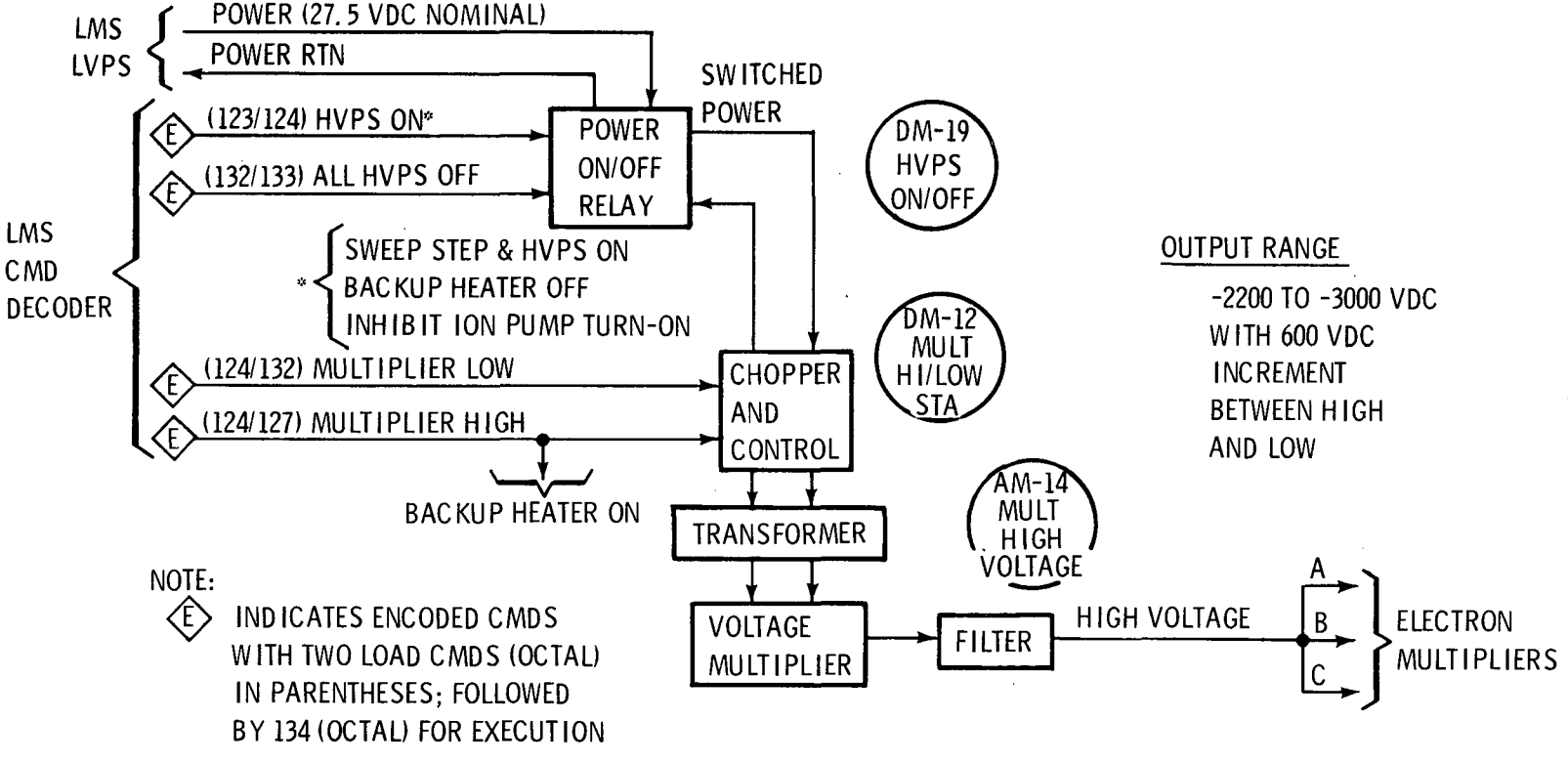
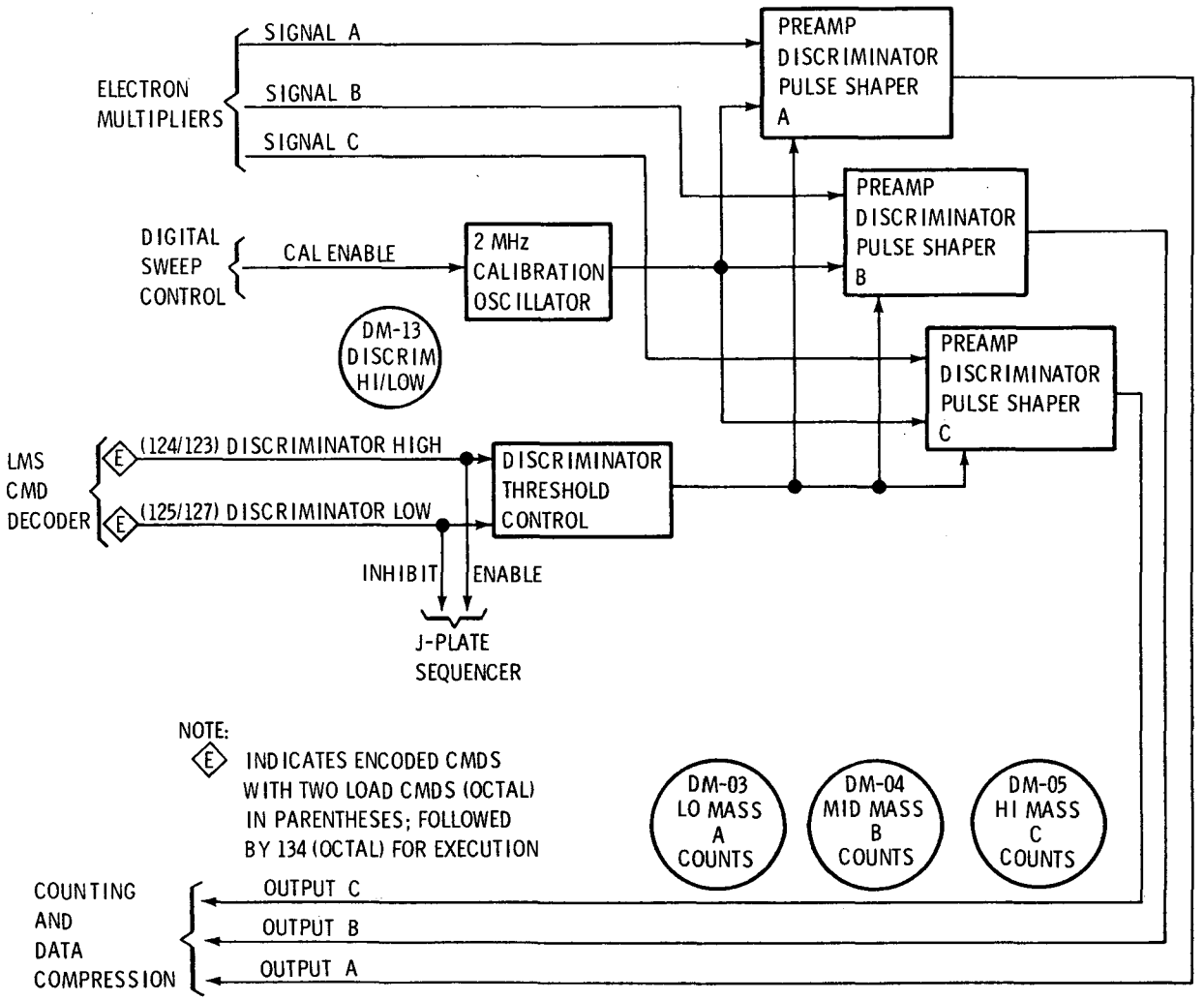
LMS ELECTRON MULTIPLIER HVPS

(HIGH VOLTAGE POWER SUPPLY)



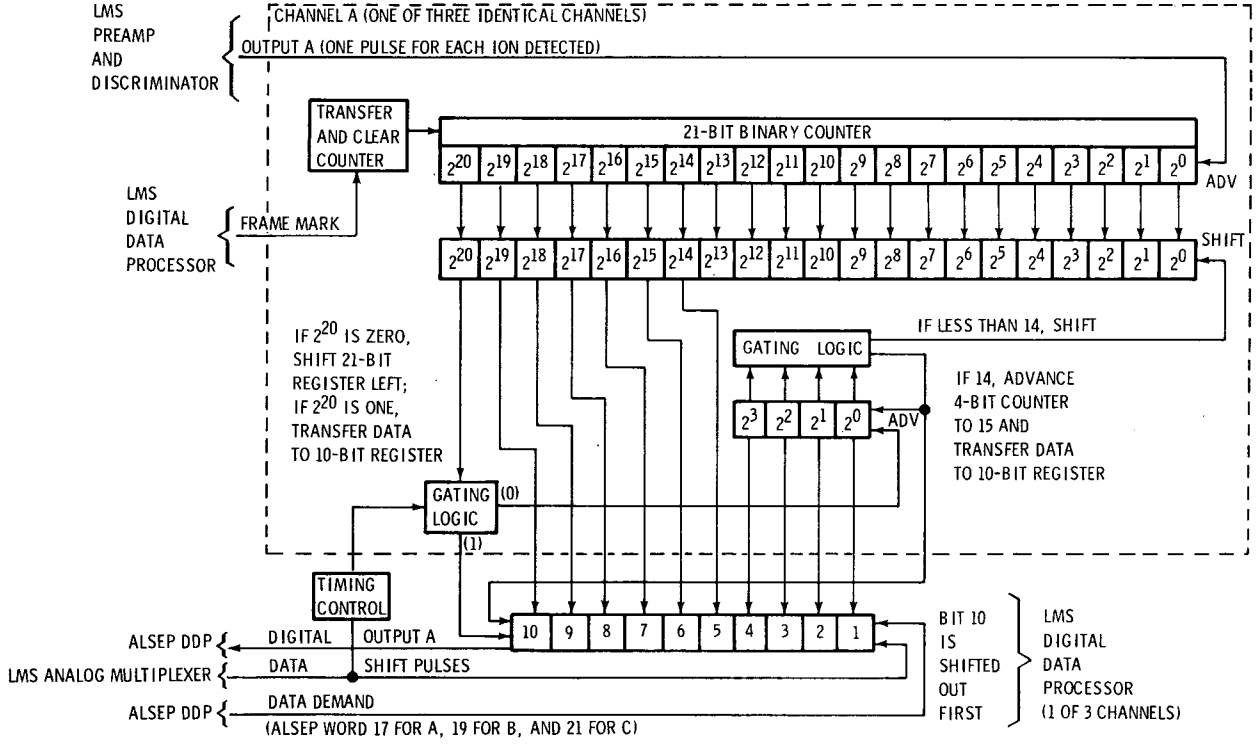
JUNE 72 3270.4.16

LMS PREAMPS AND DISCRIMINATORS



JUNE 72 3270.4.17

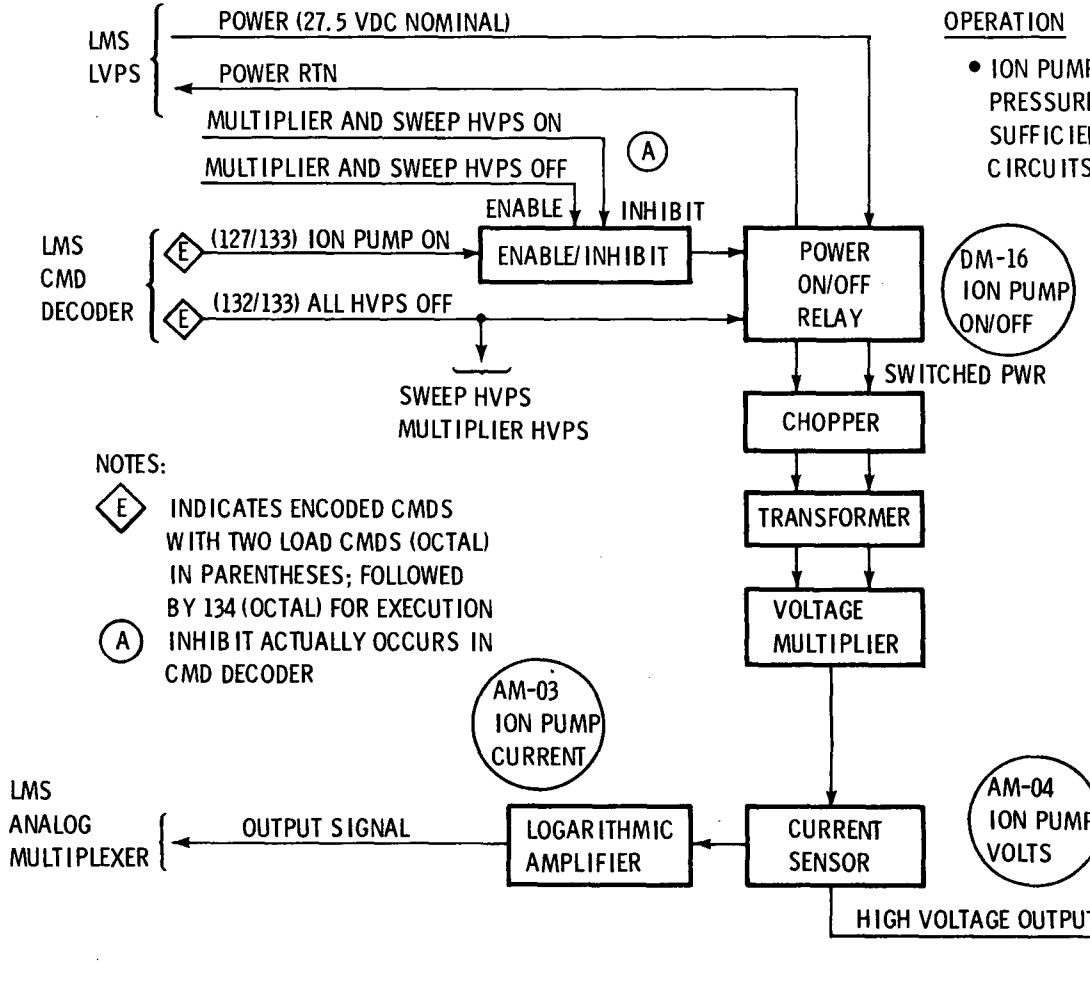
LMS COUNTING AND DATA COMPRESSION



OPERATION

- IONS ARE DETECTED IN EACH OF THE THREE ELECTRON MULTIPLIERS AND COUNTED IN A 21-BIT BINARY COUNTER (2,097,152 CAPACITY) FOR ONE FRAME MARK INTERVAL; 0.604 SEC AT NORMAL DATA RATE
- THE COUNTS ARE TRANSFERRED (AND COUNTER CLEARED) TO A 21-BIT SHIFT REGISTER
- THE COUNTS ARE SHIFTED TOWARD THE MSB END OF THE REGISTER AND EACH BIT-SHIFT IS RECORDED IN A 4-BIT SHIFT COUNTER
- THE SHIFTING STOPS WHEN A LOGICAL ONE IS DETECTED IN THE 21ST BIT OR WHEN 14 SHIFTS HAVE OCCURRED
- IF 14 SHIFTS HAVE OCCURRED AND THE 21ST BIT IS STILL A LOGICAL ZERO, THE 4-BIT SHIFT COUNTER IS ADVANCED TO 15 WITH NO CHANGE IN THE 21-BIT REGISTER
- SIX REGISTER BITS (20 THROUGH 15) ARE TRANSFERRED TO THE 10-BIT OUTPUT REGISTER PLUS THE FOUR BITS FROM THE SHIFT COUNTER

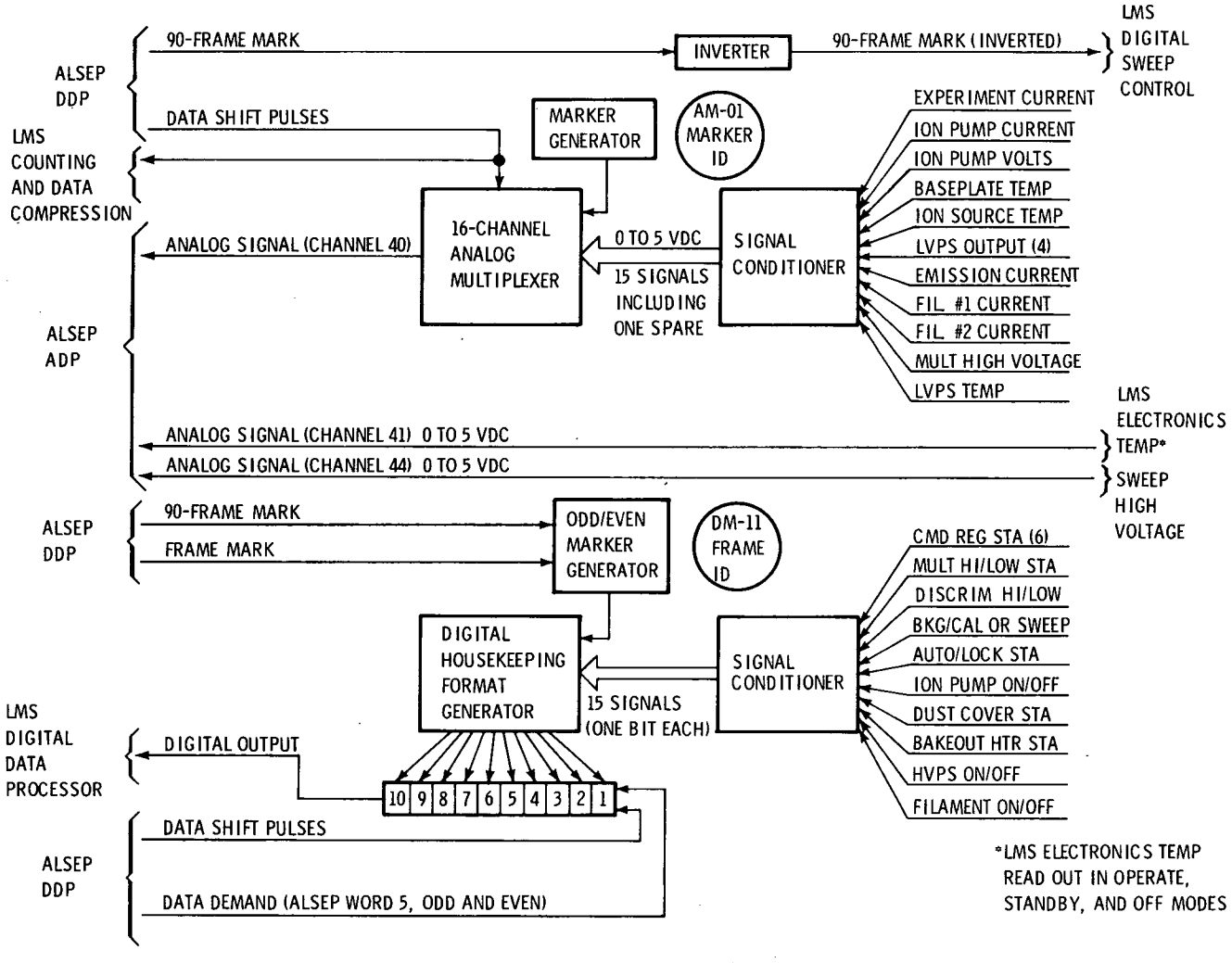
LMS ION PUMP HVPS
(HIGH VOLTAGE POWER SUPPLY)



OPERATION

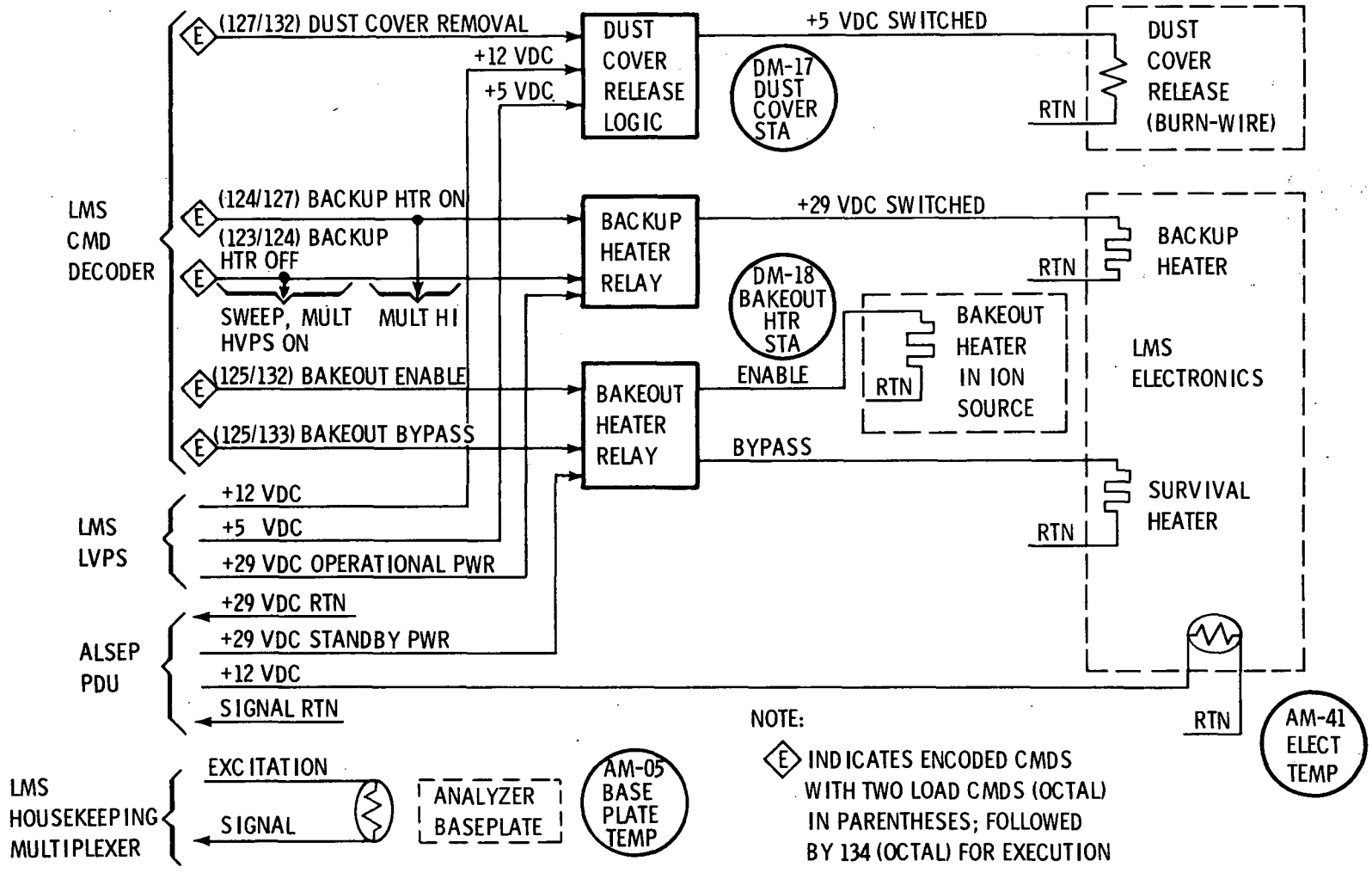
- ION PUMP SERVES TO MONITOR THE INSTRUMENT PRESSURE AND DETERMINE WHETHER IT HAS OUTGASSED SUFFICIENTLY TO ALLOW TURN-ON OF HIGH-VOLTAGE CIRCUITS (PROBABLY FIRST LUNAR NIGHT)

LMS HOUSEKEEPING MULTIPLEXER



JUNE 72 3270.4.20

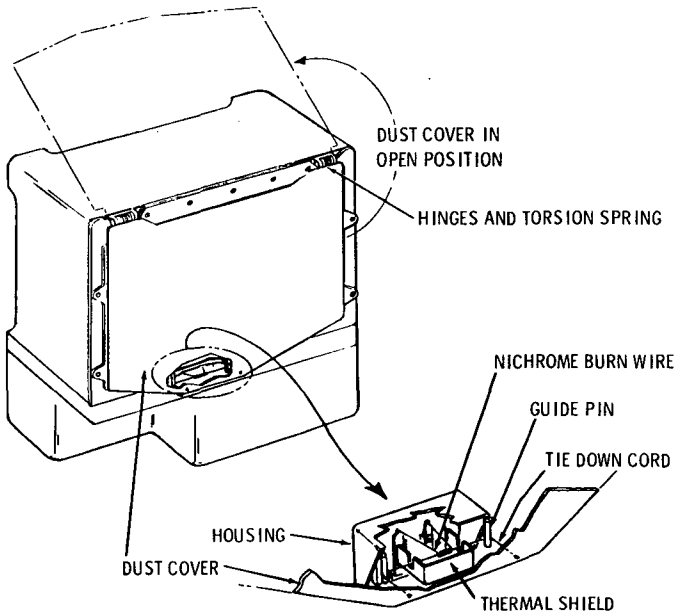
LMS DUST COVER AND THERMAL CONTROL



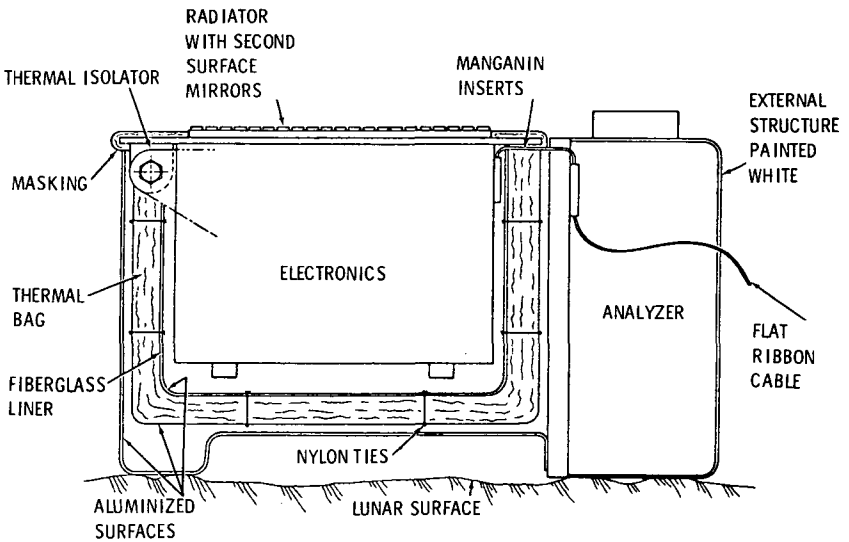
JUNE 72 3270.4.21

LMS DUST COVER AND THERMAL DESIGN

DUST COVER DESIGN

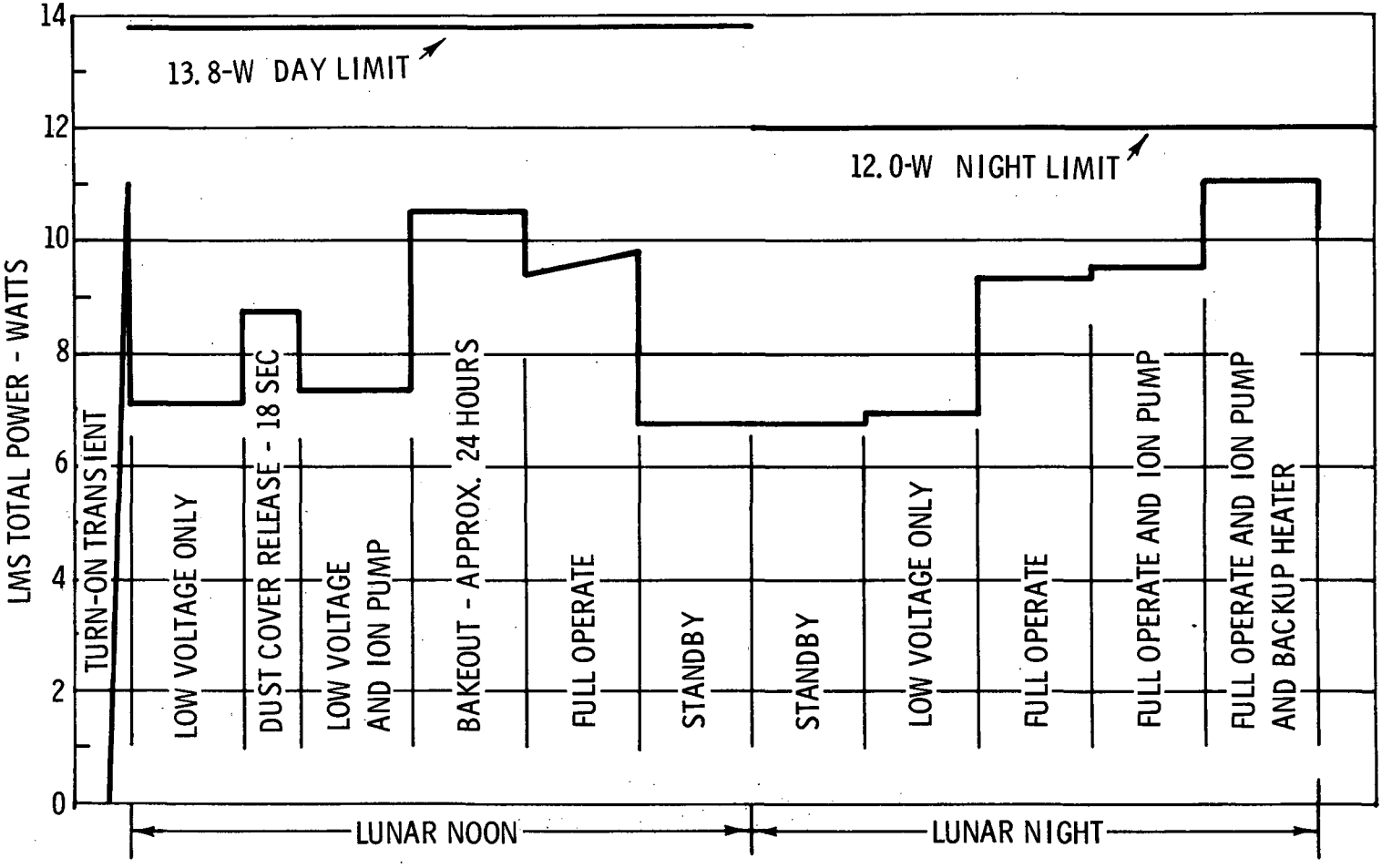


THERMAL DESIGN



JUNE 72 3270.4.22

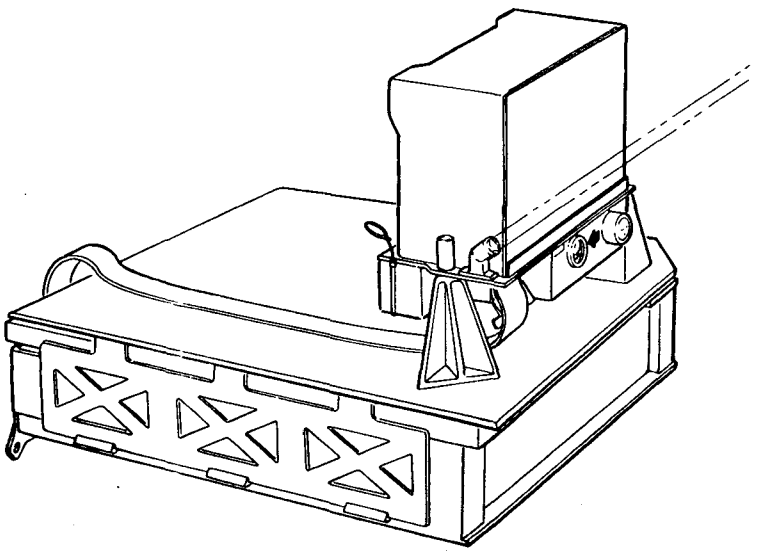
LMS POWER PROFILE



JUNE 72 3270.4.23

LMS DEPLOYMENT

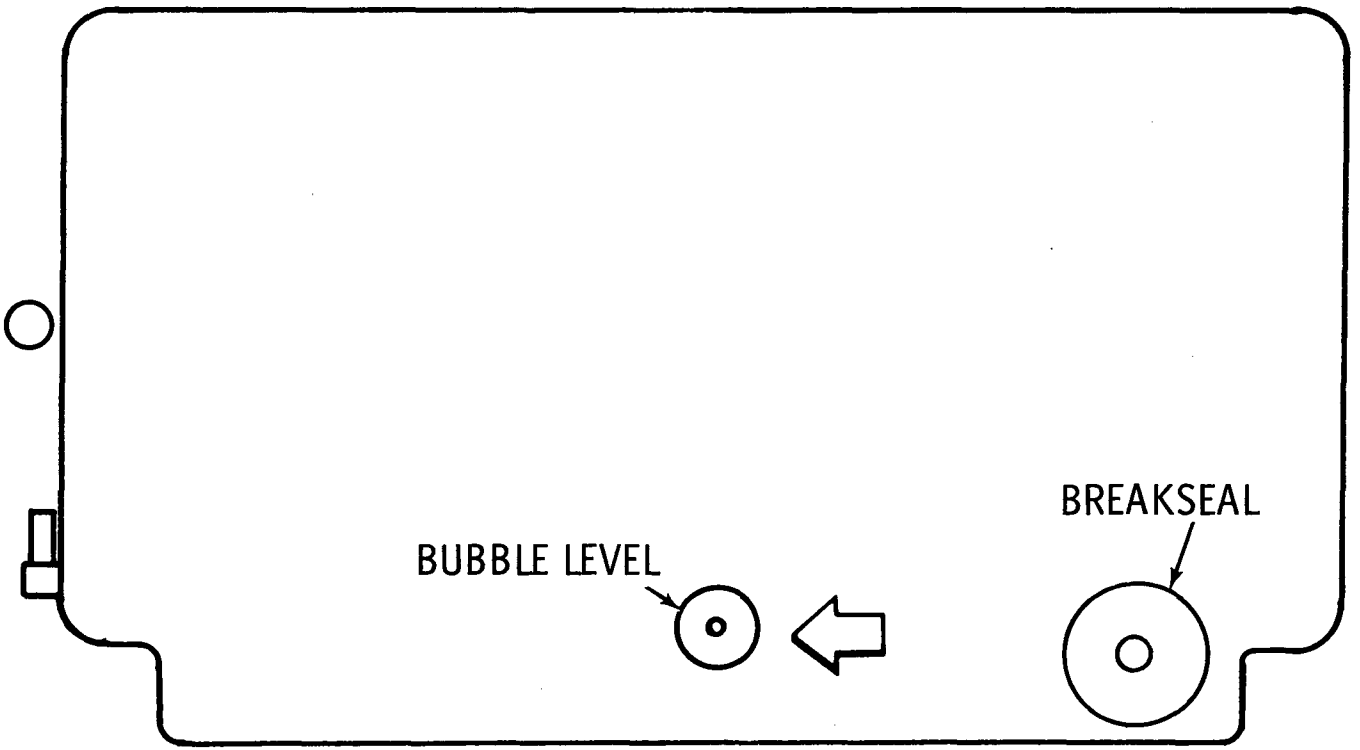
1. ENGAGE UHT HANDLE IN LMS VENT PULL RING.
2. RELEASE LMS VENT PULL RING.
3. OPEN LMS VENT (PULL LMS VENT LANYARD UPWARD).
4. RELEASE 3 BOYDBOLTS SECURING LMS TO SUBPACKAGE #1.
5. ENGAGE UHT IN LMS SWIVEL SOCKET.
6. REMOVE LMS FROM SUBPACKAGE #1 AND TRANSFER TO DEPLOYMENT SITE (45 FEET NORTHEAST OF CENTRAL STATION) USING UHT.
7. ROTATE LMS 90^0 USING SWIVEL SOCKET AND INSURE THAT SWIVEL SOCKET IS LOCKED.
8. EMPLACE LMS ON LUNAR SURFACE USING UHT (SITE SHOULD BE RELATIVELY FLAT, I.E. WITHIN $\pm 15^0$).
9. VERIFY THAT LMS IS LEVEL WITHIN $\pm 15^0$. IF LMS IS NOT LEVEL WITHIN $\pm 15^0$ DO NOT EMBED THE EXPERIMENT; REPOSITION IT ON A MORE LEVEL SPOT.
10. REMOVE UHT FROM LMS SWIVEL SOCKET.
11. ENGAGE UHT IN LMS BREAKSEAL SOCKET.
12. BREAK BREAKSEAL USING UHT (LEVER UHT IN DIRECTION OF ARROW TO SNAP BREAKSEAL).
13. REMOVE BREAKSEAL, USING UHT, AND DISCARD.
14. VERIFY THAT LMS IS LEVEL WITHIN $\pm 15^0$ AND IS NOT EMBEDED IN LUNAR SURFACE.
15. VERIFY THAT ION SOURCE DUST COVER IS COVERING THE INLET.



LMS EMPLACEMENT CRITERIA

PARAMETER	REQUIREMENT	PRIORITY	INDICATOR	COMMENTS
DISTANCE FROM SUBPACKAGE 1	45 ± 5 FT FROM CENTRAL STATION		RACING, CABLE LENGTH	CABLE LENGTH 50 FT
DIRECTION FROM SUBPACKAGE 1	NORTHEAST OF CENTRAL STATION		VISUAL	
SITE SELECTION	HORIZONTAL		VISUAL	AVOID SLOPES, OUT-CROPPINGS, AND RUBBLE
LEVEL, WRT INDICATOR	$\pm 15^0$		BUBBLE LEVEL	$\pm 15^0$ IS OBTAINED WHEN BUBBLE IS FREE FROM CASE
ALIGNMENT	SEE NOTE			SEE NOTE
NOTE	THE FLAT CABLE SHALL GO DIRECTLY TO THE CENTRAL STATION (NOT WRAPPED AROUND THE LMS)			

LMS ALIGNMENT FEATURES



NOTE: NO ALIGNMENT REQUIREMENT OTHER THAN CABLE

LMS COMMAND SUMMARY

OCTAL COMMAND	COMMAND NOMENCLATURE
123	LMS LOAD COMMAND #1
124	LMS LOAD COMMAND #2
125	LMS LOAD COMMAND #3
127	LMS LOAD COMMAND #4
132	LMS LOAD COMMAND #5
133	LMS LOAD COMMAND #6
134	LMS EXECUTE AND CLEAR

OCTAL CMDS 123, 124, 125, 127, 132, 133, AND 134 ARE ENCODED IN SPECIFIC SEQUENCES TO PROVIDE 15 DISCRETE CMDS FOR THE LMS AS LISTED BELOW

FUNCTION	SEQUENCE						
	123	124	125	127	132	133	134
STEP, MULT, SWEEP HV ON & BACKUP HTR OFF	X	X					X
LOCK (SWEEP HOLD), J-PLATE VOLTAGE STEP, & FIXED MODE SELECT	X		X				X
ONE-STEP (SWEEP ADVANCE)	X			X			X
*EMISSION/FILAMENTS OFF & MODE SELECT ENABLE	X				X		X
FILAMENT #1 ON & MODE SELECT INHIBIT	X					X	X
FILAMENT #2 ON & MODE SELECT INHIBIT		X	X				X
MULT HIGH & BACKUP HTR ON		X		X			X
*MULT LOW		X			X		X
DISC HIGH, J-PLATE VOLTAGE STEP ENABLE, & CYCLIC MODE SELECT		X				X	X
*DISC LOW & J-PLATE VOLTAGE STEP INHIBIT			X	X			X
BAKEOUT ENABLE(2)			X		X		X
*BAKEOUT BYPASS			X			X	X
DUST COVER REMOVAL				X	X		X
ION PUMP ON(1)				X		X	X
*ION PUMP, MULT, AND SWEEP HV OFF					X	X	X

NOTES

° PRESET TURN-ON OPERATING MODE; ALL ARE LATCHING RELAYS EXCEPT DISCRIMINATOR (FLIP-FLOP) BUT INITIALIZING PULSE ALSO DRIVES RELAYS

(1) THIS CMD IS INHIBITED IF HIGH VOLTAGES ARE ON; THE OPPOSITE IS NOT INHIBITED

(2) AFTER THIS CMD, THE LMS MUST BE COMMANDED TO STANDBY TO PERFORM BAKEOUT

LMS COMMANDS

OCTAL CMD NUMBER

- 123 LMS LOAD 1

THIS CMD IS ONE OF SIX USED BY THE LMS TO LOAD A 6-STAGE CMD REGISTER IN THE LMS AND PROVIDE 15 ENCODED CMDS. EACH ENCODED CMD CONSISTS OF TWO LOADS IN THE REGISTER AND IS EXECUTED BY RECEIPT OF CMD 134 WHICH ALSO CLEARS THE REGISTER. REPEATED APPLICATION OF CMD 123 HAS NO FURTHER EFFECT PRIOR TO EXECUTION.

- 124 LMS LOAD 2

THIS CMD IS ONE OF SIX USED BY THE LMS TO LOAD A 6-STAGE CMD REGISTER IN THE LMS AND PROVIDE 15 ENCODED CMDS. EACH ENCODED CMD CONSISTS OF TWO LOADS IN THE REGISTER AND IS EXECUTED BY A RECEIPT OF CMD 134 WHICH ALSO CLEARS THE REGISTER. REPEATED APPLICATION OF CMD 124 HAS NO FURTHER EFFECT PRIOR TO EXECUTION.

- 125 LMS LOAD 3

THIS CMD IS ONE OF SIX USED BY THE LMS TO LOAD A 6-STAGE CMD REGISTER IN THE LMS AND PROVIDE 15 ENCODED CMDS. EACH ENCODED CMD CONSISTS OF TWO LOADS IN THE REGISTER AND IS EXECUTED BY RECEIPT OF CMD 134 WHICH ALSO CLEARS THE REGISTER. REPEATED APPLICATION OF CMD 125 HAS NO FURTHER EFFECT PRIOR TO EXECUTION.

- 127 LMS LOAD 4

THIS CMD IS ONE OF SIX USED BY THE LMS TO LOAD A 6-STAGE CMD REGISTER IN THE LMS AND PROVIDE 15 ENCODED CMDS. EACH ENCODED CMD CONSISTS OF TWO LOADS IN THE REGISTER AND IS EXECUTED BY RECEIPT OF CMD 134 WHICH ALSO CLEARS THE REGISTER. REPEATED APPLICATION OF CMD 127 HAS NO FURTHER EFFECT PRIOR TO EXECUTION.

- 132 LMS LOAD 5

THIS CMD IS ONE OF SIX USED BY THE LMS TO LOAD A 6-STAGE CMD REGISTER IN THE LMS AND PROVIDE 15 ENCODED CMDS. EACH ENCODED CMD CONSISTS OF TWO LOADS IN THE REGISTER AND IS EXECUTED BY RECEIPT OF CMD 134 WHICH ALSO CLEARS THE REGISTER. REPEATED APPLICATION OF CMD 132 HAS NO FURTHER EFFECT PRIOR TO EXECUTION.

- 133 LMS LOAD 6

THIS CMD IS ONE OF SIX USED BY THE LMS TO LOAD A 6-STAGE CMD REGISTER IN THE LMS AND PROVIDE 15 ENCODED CMDS. EACH ENCODED CMD CONSISTS OF TWO LOADS IN THE REGISTER AND IS EXECUTED BY RECEIPT OF CMD 134 WHICH ALSO CLEARS THE REGISTER. REPEATED APPLICATION OF CMD 133 HAS NO FURTHER EFFECT PRIOR TO EXECUTION.

- 134 LMS CMD EX

THIS CMD CAUSES EXECUTION OF ONE OF THE 15 ENCODED LMS CMDS AS CONTAINED IN ITS 6-STAGE CMD REGISTER WHICH IS LOADED BY RECEIPT OF TWO OF THE SIX CMDS 123, 124, 125, 127, 132, AND 133. EXECUTION ALSO CLEARS THE REGISTER. REPEATED APPLICATION OF CMD 134 HAS NO FURTHER EFFECT

- APPLICATION OF OPERATIONAL POWER TO THE LMS CAUSES INITIALIZATION OF THE 6-STAGE CMD REGISTER IN THE CLEAR STATE (000 000).
- IF AN INCORRECT CMD LOAD IS RECEIVED BY THE REGISTER, IT WILL NOT AFFECT THE INSTRUMENT UNLESS EXECUTED BY CMD OCTAL 134. INCORRECT LOADS MAY BE CLEARED BY SENDING ADDITIONAL CMDS TO FILL THE REGISTER (111 111) AND THEN EXECUTING BY SENDING CMD 134.
- IF AN INCORRECT LOAD CONSISTING OF THREE CMDS (FOR EXAMPLE) IS INADVERTENTLY EXECUTED (BY CMD 134) THERE ARE THREE COMBINATIONS OF LOAD PAIRS, EACH CORRESPONDING TO AN ENCODED LMS CMD. THE RESPONSE OF THE LMS TO THIS INVALID INPUT IS UNPREDICTABLE, DEPENDING ON SWITCHING TIMES (SIGNAL RACE) AND WHETHER OR NOT SOME OF THE THREE ENCODED CMDS ARE MUTUALLY EXCLUSIVE.

LMS ENCODED COMMANDS

OCTAL CMD LOADS

- 123 & 124 STEP, MULT, SWEEP HV ON & BACKUP HEATER OFF

  THIS COMBINATION OF CMDS, WHEN FOLLOWED BY THE EXECUTE CMD (OCTAL 134):
  - APPLIES POWER TO THE ELECTRON MULTIPLIER HV POWER SUPPLY
  - ENABLES THE DIGITAL SWEEP CONTROL AND SWEEP HV POWER SUPPLY
  - REMOVES POWER FROM THE BACKUP HEATER CIRCUIT
  - INHIBITS TURN-ON OF THE ION PUMP HV POWER SUPPLY

  NOTE THAT THE ION PUMP INTERLOCK IS A ONE-WAY INHIBIT; OPERATION OF CMD 123/124/134 IS NEVER INHIBITED.

  THE DIGITAL SWEEP CONTROL IS LOCKED (SWEEP HOLD) BY THE CMD COMBINATION 123/125; THE TWO HV POWER SUPPLIES ARE COMMANDED OFF BY 132/133; AND THE BACKUP HEATER IS ENERGIZED BY 124/127 (EACH COMBINATION EXECUTED BY CMD 134).

  REPEATED EXECUTION OF 123/124/134 HAS NO FURTHER EFFECT. APPLICATION OF OPERATIONAL POWER TO THE LMS CAUSES INITIALIZATION IN THE LOCK MODE AND WITH THE HV POWER SUPPLIES OFF. THE INITIAL STATE OF THE BACKUP HEATER MAY BE ON OR OFF (UNPREDICTABLE).

- 123 & 125 LOCK (SWEEP HOLD), J-PLATE VOLTAGE STEP, & FIXED MODE SELECT

  THIS COMBINATION OF CMDS, WHEN FOLLOWED BY THE EXECUTE CMD (OCTAL 134), CAUSES THE FOLLOWING CHANGES IN LMS:
  - DEACTIVATES THE DIGITAL SWEEP CONTROL, TO LOCK ITS STEPPING FUNCTION AND HOLD THE SWEEP HV OUTPUT AT THE EXISTING VALUE
  - ADVANCES THE J-PLATE VOLTAGE SEQUENCER OF THE ION SOURCE EMISSION CONTROL BY ONE STEP IF THE SEQUENCER HAS BEEN ENABLED BY 124/133/134
  - SELECTS THE FIXED MODE OF OPERATION OF THE EMISSION CONTROL CIRCUIT IF IT HAS BEEN ENABLED BY 123/132/134.

  REACTIVATION OF AUTOMATIC SWEEP STEPPING IS PERFORMED BY 123/124/134. THE SWEEP REMAINS LOCKED UNTIL THE NEXT 90-FRAME MARK AT WHICH TIME IT RESETS AND STARTS AT THE BEGINNING OF THE COUNTER SEQUENCE (BACK GROUND).

  APPLICATION OF OPERATIONAL POWER TO THE LMS CAUSES INITIALIZATION IN THE LOCK MODE, WITH J-PLATE STEPPING INHIBITED AT THE LAST COMMAND LEVEL BUT WITH POWER APPLIED TO THE J-PLATE SEQUENCER CIRCUIT. REPEATED EXECUTION OF 123/125/134 CAUSES REPEATED STEPPING OF THE J-PLATE VOLTAGE SEQUENCER THROUGH ITS FOUR STATES. THE NOMINAL VOLTAGES (± 1 VOLT, AS A FUNCTION OF TEMPERATURE) FOR THE TWO J-PLATES (J-1 AND J-2) ARE:

PLATE	STATE 1	STATE 2	STATE 3	STATE 4
J-1	1092V	1076V	1070V	1088V
J-2	1060V	1039V	1032V	1055V

- 123 & 127 ONE STEP (SWEEP ADVANCE)

  THIS COMBINATION OF CMDS, WHEN FOLLOWED BY THE EXECUTE CMD (OCTAL 134), CAUSES THE LMS DIGITAL SWEEP CONTROL TO ADVANCE ONE STEP IF IT HAS BEEN PREVIOUSLY LOCKED BY 123/125/134. REPEATED APPLICATION OF 123/127/134 CAUSES REPEATED STEPPING OF THE DIGITAL SWEEP CONTROL THROUGH ITS 1350 STEPS, OR MORE IF DESIRED.

- 123 & 132 EMISSION/FILAMENTS OFF, & MODE SELECT ENABLE

  THIS COMBINATION OF CMDS, WHEN FOLLOWED BY THE EXECUTE CMD (OCTAL 134), DEACTIVATES A PORTION OF THE LMS EMISSION CONTROL POWER SUPPLY TO REMOVE POWER FROM THE LMS ION SOURCE FILAMENTS. IT ALSO ENABLES THE MODE SELECT PORTION OF THE EMISSION CONTROL CIRCUIT. AFTER SENDING 123/132/134, EITHER THE FIXED MODE EMISSION OR CYCLIC MODE EMISSION MAY BE SELECTED AS FOLLOWS:

  FIXED MODE: 123/125/134
  CYCLIC MODE: 124/133/134

  REPEATED APPLICATION OF CMD 123/132/134 HAS NO FURTHER EFFECT. APPLICATION OF OPERATIONAL POWER TO THE LMS CAUSES INITIALIZATION IN THE FILAMENT-OFF MODE CORRESPONDING TO CMD 123/132/134. TURN-ON OF THE FILAMENTS (INCLUDING EMISSION CONTROL) IS ACCOMPLISHED BY ONE OF THE TWO CMDS:

  FILAMENT #1 ON: 123/133/134
  FILAMENT #2 ON: 124/125/134

- 123 & 133 FILAMENT #1 ON & MODE SELECT INHIBIT

  THIS COMBINATION OF CMDS, WHEN FOLLOWED BY THE EXECUTE CMD (OCTAL 134), CAUSES POWER TO BE APPLIED TO FILAMENT #1 OF THE LMS ION SOURCE AND SELECTS RELAY POSITIONS SUCH THAT THE FILAMENT BIAS VOLTAGES ARE APPLIED TO THE CORRECT FILAMENTS. THIS CMD COMBINATION (123/133/134) HAS NO EFFECT UNLESS THE EMISSION/FILAMENTS ARE OFF BY PRIOR EXECUTION OF CMDS 123/132/134; SPECIFICALLY, FILAMENT #1 CANNOT BE TURNED ON IF FILAMENT #2 IS ON. ALSO, THIS CMD COMBINATION INHIBITS THE MODE SELECT CIRCUITRY; SPECIFICALLY, THE MODE OF EMISSION NOT BEING USED CANNOT BE SELECTED WITHOUT FIRST GOING TO THE FILAMENT OFF AND MODE SELECT STATE (CMD 123/132/134). REPEATED APPLICATION OF CMD 123/133/134 HAS NO FURTHER EFFECT. APPLICATION OF OPERATIONAL POWER TO THE LMS CAUSES INITIALIZATION IN THE FILAMENT-OFF AND MODE SELECT ENABLE STATE.

LMS ENCODED COMMANDS (CONT'D)

OCTAL CMD LOADS

- 124 & 125 FILAMENT #2 ON & MODE SELECT INHIBIT

THIS COMBINATION OF CMDS, WHEN FOLLOWED BY THE EXECUTE CMD (OCTAL 134), CAUSES POWER TO BE APPLIED TO FILAMENT #2 OF THE LMS ION SOURCE AND SELECTS RELAY POSITIONS SUCH THAT THE FILAMENT BIAS VOLTAGES ARE APPLIED TO THE CORRECT FILAMENTS. THIS CMD COMBINATION (124/125/134) HAS NO EFFECT UNLESS THE EMISSION/FILAMENTS ARE OFF BY PRIOR EXECUTION OF CMDS 123/132/134; SPECIFICALLY, FILAMENT #2 CANNOT BE TURNED ON IF FILAMENT #1 IS ON. ALSO, THIS CMD COMBINATION INHIBITS THE MODE SELECT CIRCUITRY; SPECIFICALLY, THE MODE OF EMISSION NOT BEING USED CANNOT BE SELECTED WITHOUT FIRST GOING TO THE FILAMENT OFF AND MODE SELECT STATE (CMD 123/132/134). REPEATED APPLICATION OF CMD 124/125/134 HAS NO FURTHER EFFECT. APPLICATION OF OPERATIONAL POWER TO THE LMS CAUSES INITIALIZATION IN THE FILAMENT-OFF AND MODE SELECT ENABLE STATE.

- 124 & 127 MULTIPLIER HIGH & BACKUP HEATER ON

THIS COMBINATION OF CMDS, WHEN FOLLOWED BY THE EXECUTE CMD (OCTAL 134), STEPS THE LMS ELECTRON MULTIPLIER HV POWER SUPPLY FROM ITS NORMAL (LOW) VALUE TO ITS HIGH VALUE, A STEP OF 600 VDC (TWO OPERATIONAL VALUES IN THE OUTPUT RANGE OF -2200 TO -3000 VDC). THIS VOLTAGE IS SUPPLIED TO ALL THREE ELECTRON MULTIPLIER TUBES. CMD 124/127/134 ALSO APPLIES POWER TO THE LMS BACKUP HEATER. SELECTION OF THE ALTERNATE CONDITIONS BY CMD IS AS FOLLOWS:

MULTIPLIER LOW:	124/132/134
BACKUP HEATER OFF:	123/124/134

REPEATED APPLICATION OF CMD 124/127/134 HAS NO FURTHER EFFECT. APPLICATION OF OPERATIONAL POWER TO THE LMS CAUSES INITIALIZATION IN THE MULTIPLIER-LOW STATE. THE INITIAL STATE OF THE BACKUP HEATER MAY BE ON OR OFF (UNPREDICTABLE).

- 124 & 132 MULTIPLIER LOW

THIS COMBINATION OF CMDS, WHEN FOLLOWED BY THE EXECUTE CMD (OCTAL 134), STEPS THE LMS ELECTRON MULTIPLIER HV POWER SUPPLY FROM ITS HIGH VALUE (IF PREVIOUSLY COMMANDED HIGH BY 124/127/134) TO ITS NORMAL LOW VALUE, A STEP OF 600 VDC (TWO OPERATIONAL VALUES IN THE OUTPUT RANGE OF -2200 TO -3000 VDC). THIS VOLTAGE IS SUPPLIED TO ALL THREE ELECTRON MULTIPLIER TUBES. REPEATED APPLICATION OF CMD 124/132/134 HAS NO FURTHER EFFECT. APPLICATION OF OPERATIONAL POWER TO THE LMS CAUSES INITIALIZATION IN THE MULTIPLIER-LOW STATE.

- 124 & 133 DISCRIMINATOR HIGH, J-PLATE VOLTAGE STEP ENABLE, & CYCLIC MODE SELECT

THIS COMBINATION OF CMDS, WHEN FOLLOWED BY THE EXECUTE CMD (OCTAL 134), CAUSES THE FOLLOWING CHANGES IN LMS:

- SELECTS THE HIGHER OF THE TWO LEVELS FOR THE PREAMP DISCRIMINATOR THRESHOLD CONTROL
- ENABLES THE J-PLATE VOLTAGE SEQUENCER OF THE ION SOURCE EMISSION CONTROL SO THAT IT CAN ACCEPT THE STEP CMD (123/125/134)
- SELECTS THE CYCLIC MODE OF EMISSION IF IT HAS BEEN ENABLED BY CMDS 123/132/134

REPEATED APPLICATION OF CMD COMBINATION 124/133/134 HAS NO FURTHER EFFECT. THE LOWER OF THE TWO LEVELS FOR THE PREAMP DISCRIMINATOR THRESHOLD CONTROL IS SELECTED, AND J-PLATE VOLTAGE STEP IS INHIBITED, BY CMDS 124/127/134. APPLICATION OF OPERATIONAL POWER TO THE LMS CAUSES INITIALIZATION IN THE LATTER (LOW/INHIBIT)MODE.

- 125 & 127 DISCRIMINATOR LOW & J-PLATE VOLTAGE STEP INHIBIT

THIS COMBINATION OF CMDS, WHEN FOLLOWED BY THE EXECUTE CMD (OCTAL 134), CAUSES THE FOLLOWING CHANGES IN LMS:

- SELECTS THE LOWER OF THE TWO LEVELS FOR THE PREAMP DISCRIMINATOR THRESHOLD CONTROL
- INHIBITS THE J-PLATE VOLTAGE SEQUENCER OF THE ION SOURCE EMISSION CONTROL SO THAT IT CANNOT ACCEPT THE STEP CMD (123/125/134)

REPEATED APPLICATION OF CMD COMBINATION 125/127/134 HAS NO FURTHER EFFECT. THE HIGHER OF THE TWO LEVELS FOR THE PREAMP DISCRIMINATOR THRESHOLD CONTROL IS SELECTED. THE J-PLATE VOLTAGE STEP ENABLED, AND THE CYCLIC MODE SELECTED BY CMDS 124/133/134. APPLICATION OF OPERATIONAL POWER TO THE LMS CAUSES INITIALIZATION IN THE LOW/INHIBIT MODE CORRESPONDING TO CMD 125/127/134.

LMS ENCODED COMMANDS (CONT'D)

OCTAL CMD LOADS

- 125 & 132 BAKEOUT ENABLE

THIS COMBINATION OF CMDS, WHEN FOLLOWED BY THE EXECUTE CMD (OCTAL 134), SELECTS A RELAY POSITION SUCH THAT A SUBSEQUENT COMMAND OF THE LMS TO STAND-BY POWER WILL PERFORM BAKEOUT OF THE LMS SENSOR AND BYPASS THE LMS SURVIVAL HEATER. TO DISCONTINUE BAKEOUT AFTER IT IS IN PROCESS, THE LMS MUST BE COMMANDED EITHER TO OPERATIONAL POWER OR OFF. PRIOR TO AN LMS STANDBY CMD, REPEATED EXECUTION OF CMDS 125/132/134 HAS NO FURTHER EFFECT. TO CANCEL THIS COMMAND, PRIOR TO LMS STANDBY, THE BAKEOUT BYPASS COMMAND (125/133/134) MUST BE EXECUTED. WHEN OPERATIONAL POWER IS APPLIED TO THE LMS, FROM EITHER STANDBY OR OFF, IT IS POSSIBLE FOR THE RELAY TO RECEIVE SIGNALS DRIVING IT TO THE OPPOSITE POSITION. AT LMS TURN-ON, THE BYPASS STATE IS ASSURED BY TRANSMITTING CMD 134 WITH NO LOAD IN THE LMS REGISTER; THAT IS, A BINARY READING OF 000000.

- 125 & 133 BAKEOUT BYPASS

THIS COMBINATION OF CMDS, WHEN FOLLOWED BY THE EXECUTE CMD (OCTAL 134), SELECTS A RELAY POSITION SUCH THAT A SUBSEQUENT COMMAND OF THE LMS TO STANDBY POWER WILL NOT PERFORM BAKEOUT OF THE LMS SENSOR AND WILL OPERATE THE SURVIVAL HEATER. REPEATED APPLICATION OF CMD 125/133/134 HAS NO FURTHER EFFECT, IF THERE HAS BEEN NO BAKEOUT ENABLE CMD IN BETWEEN. WHEN OPERATIONAL POWER IS APPLIED TO THE LMS, FROM EITHER STANDBY OR OFF, IT IS POSSIBLE FOR THE RELAY TO RECEIVE SIGNALS DRIVING IT TO THE OPPOSITE POSITION. AT LMS TURN-ON, THE BYPASS STATE IS ASSURED BY TRANSMITTING CMD 134 WITH NO LOAD IN THE LMS REGISTER; THAT IS, A BINARY READING OF 000 000.

- 127 & 132 DUST COVER REMOVAL

THIS COMBINATION OF CMDS, WHEN FOLLOWED BY THE EXECUTE CMD (OCTAL 134), ACTIVATES THE CIRCUITS OF A BURN-WIRE DEVICE FOR A PERIOD OF 12 TO 20 SECONDS TO RELEASE THE DUST COVER WHICH PROTECTS THE LMS THERMAL CONTROL MIRROR. THIS BURN-WIRE SEVERS A CORD CAUSING MINIMUM RELEASE OF GAS WHICH COULD CONTAMINATE THE LMS SCIENCE MEASUREMENTS. REPEATED EXECUTION OF CMDS 127/132/134 CAUSES REPEATED ACTIVATION OF THE BURN-WIRE. REMOVAL OF THE MIRROR COVER IS SCHEDULED AFTER LM ASCENT. PRIOR TO REMOVAL, THE EXTENT OF LMS OPERATIONS IS CONSTRAINED BY THERMAL CONTROL LIMITATIONS.

- 127 & 133 ION PUMP ON

THIS COMBINATION OF CMDS, WHEN FOLLOWED BY THE EXECUTE CMD (OCTAL 134), ENERGIZES THE LMS ION PUMP WHICH APPLIES A HIGH-VACUUM PUMPING ACTION TO THE LMS GAS ANALYZER (SENSOR). REPEATED APPLICATION OF CMDS 127/133/134 HAS NO FURTHER EFFECT. IF THE HV POWER SUPPLIES ARE ON (CMDS 123/124/134), THE ION PUMP ON CMD, 127/133/134, IS INHIBITED AND, TO TURN ON THE PUMP, THE HV POWER SUPPLY OFF CMD, 132/133/134, MUST BE EXECUTED FIRST. TURN-OFF OF THE ION PUMP IS ACCOMPLISHED BY CMDS 132/133/134. APPLICATION OF OPERATIONAL POWER TO THE LMS CAUSES INITIALIZATION IN THE PUMP-OFF MODE.

- 132 & 133 ION PUMP, MULTIPLIER, AND SWEEP HV OFF

THIS COMBINATION OF CMDS, WHEN FOLLOWED BY THE EXECUTE CMD (OCTAL 134), REMOVES POWER FROM THE FOLLOWING LMS CIRCUITS:

- ION PUMP
- ELECTRON MULTIPLIER HV POWER SUPPLY
- SWEEP HV POWER SUPPLY

THE ION PUMP IS TURNED ON BY 127/133, AND THE TWO HV POWER SUPPLIES ARE TURNED ON BY 123/124 (EACH COMBINATION EXECUTED BY CMD 134).

REPEATED APPLICATION OF 132/133/134 HAS NO FURTHER EFFECT. APPLICATION OF OPERATIONAL POWER TO THE LMS CAUSES INITIALIZATION IN THE PUMP AND HV OFF MODE CORRESPONDING TO CMDS 132/133/134.

SEQUENCE OF LMS CMDS

123/132/134*
124/133/134
125/127/134
123/133/134
OR
124/125/134
123/124/134

} CYCLIC MODE OPERATION

*REQUIRED ONLY IF A FILAMENT IS ON

THIS SEQUENCE OF LMS CMDS ACTIVATES A CYCLIC MODE OPERATION OF THE EMISSION CONTROL CIRCUIT IN WHICH THE 1350 SWEEP STEPS ARE PROGRAMMED TO OCCUR WITH FOUR DIFFERENT VALUES, IN SUCCESSION, OF THE FILAMENT BIAS, AS FOLLOWS:

FILAMENT BIAS	SWEEP STEPS		
-70 VDC	FIRST	1350	STEPS
-18 VDC	SECOND	1350	STEPS
-25 VDC	THIRD	1350	STEPS
-20 VDC	FOURTH	1350	STEPS
-70 VDC	FIFTH	1350	STEPS
ETC.		ETC.	

THE SEQUENCE CAN START AT ANY OF THE BIAS VOLTAGES DEPENDING ON PRIOR OPERATION OF THE LMS. TO RETURN TO THE FIXED MODE OF OPERATION OF THE EMISSION CONTROL CIRCUIT REQUIRES THE FOLLOWING SEQUENCE OF CMDS: 123/132/134, 123/125/134, 123/133/134 (OR 124/125/134), AND 123/124/134.

LMS DIGITAL DATA

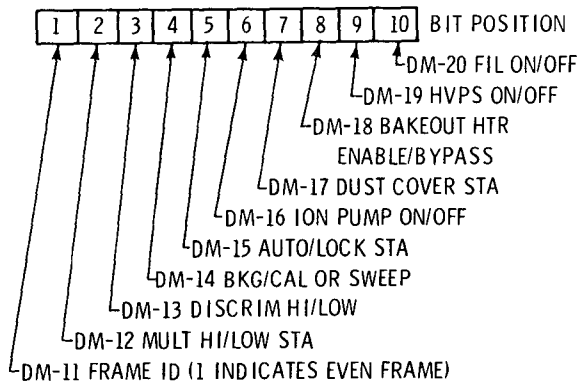
ALSEP WORD ASSIGNMENT

1 C	2 C	3 C	4	5 LMS FLAG & CV	6	7 CV	8
9	10	11	12	13	14	15	16
17 LMS CH. A	18	19 LMS CH. B	20	21 LMS CH. C	22	23	24
25	26	27	28	29	30	31	32
33 HK	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64

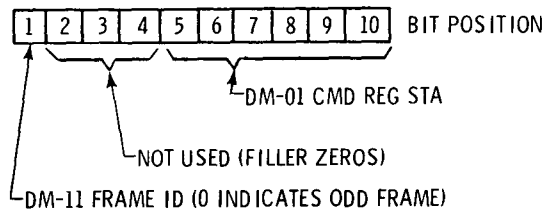
EACH BOX REPRESENTS ONE 10-BIT WORD IN THE 640-BIT ALSEP FRAME

C - ALSEP CONTROL WORDS
CV - ALSEP COMMAND VERIFICATION
LMS FLAG & CV - STATUS FLAGS & CMD REG STATUS
LMS CH. A - LOW MASS RANGE COUNT
LMS CH. B- INTERMEDIATE MASS RANGE COUNT
LMS CH. C - HIGH MASS RANGE COUNT
HK - ALSEP AND EXPERIMENTS HOUSEKEEPING MULTIPLEXED TO SAMPLE EACH SOURCE ONCE EVERY 90 ALSEP FRAMES (EVERY 54 SECONDS AT NORMAL DATA RATE)

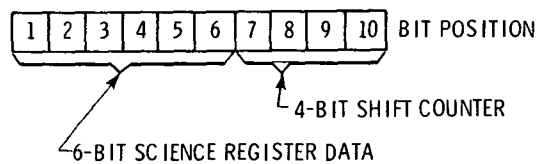
ALSEP WORD 5, EVEN FRAME



ALSEP WORD 5, ODD FRAME



ALSEP WORDS 17 (DM-03), 19 (DM-04), AND 21 (DM-05)



LMS ANALOG DATA

IN THE ALSEP HOUSEKEEPING WORD (WORD 33 OF THE ALSEP FRAME) THREE CHANNELS ARE ASSIGNED TO THE LMS. THEY ARE CHANNELS 40, 41, AND 44, READ OUT DURING THOSE THREE FRAMES OF THE ALSEP 90-FRAME SEQUENCE (ONCE EVERY 54 SECONDS AT THE NORMAL DATA RATE).

- CHANNEL 40 (THIS CHANNEL IS MULTIPLEXED TO PRESENT 16 PARAMETERS)

MULTIPLEXED SEQUENCE	CODE	PARAMETER
1	AM-01	MARKER ID (EIGHT ONES)
2	AM-02	EXPERIMENT CURRENT
3	AM-03	ION PUMP CURRENT
4	AM-04	ION PUMP VOLTS
5	AM-05	BASEPLATE TEMP
6	AM-06	ION SOURCE TEMP
7	AM-07	+12 VDC LVPS
8	AM-08	+5 VDC LVPS
9	AM-09	-12 VDC LVPS
10	AM-10	-15 VDC LVPS
11	AM-11	EMISSION CURRENT
12	AM-12	FIL. #1 CURRENT
13	AM-13	FIL. #2 CURRENT
14	AM-14	MULT. HIGH VOLTAGE
15	AM-15	LVPS TEMP
16	AM-16	SPARE (APPROX. ZERO)

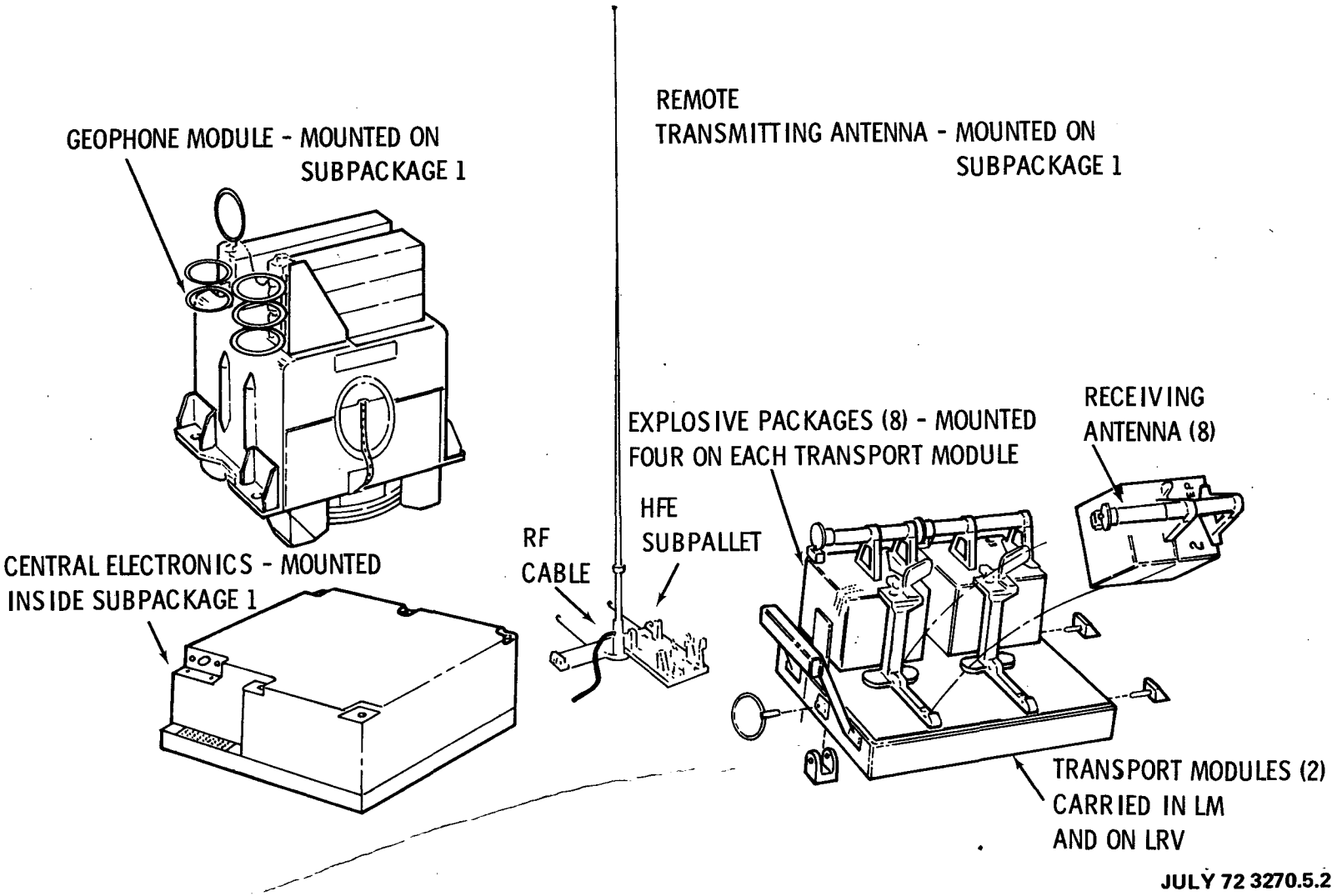
- CHANNEL 41 READS AM-41, ELECTRONICS TEMP, NOT ONLY WHEN THE LMS IS OPERATIONAL BUT ALSO IN STANDBY AND OFF
- CHANNEL 44 READS AM-44, LMS SWEEP HIGH VOLTAGE

LMS INITIAL LUNAR SETUP

FUNCTIONS	COMMENTS
INSTRUMENT TURN-ON	CMD OPERATIONAL PWR WITH PRESET HIGH VOLTAGES OFF, MONITOR TM
DUST COVER REMOVAL	CMD DUST COVER REMOVAL AFTER LM ASCENT; MAY BE DELAYED UNTIL AFTER LSP DETONATION
BAKEOUT OPERATION	EXECUTE BAKEOUT ENABLE CMD AND SWITCH LMS TO STANDBY (SUBSEQUENT TURN-ON FOR TM CHECK); WILL BE REPEATED FOR TOTAL OF 12 HOURS
ION PUMP OPERATION	CMD ION PUMP ON TO DETERMINE WHEN PRESSURE IS ACCEPTABLE FOR HIGH-VOLTAGE OPERATION
FILAMENT #1 ON	CMD FILAMENT ON AND MONITOR FILAMENT CURRENT
STEP, MULT, AND SWEEP ON	CMD FULL OPERATION AND MONITOR SCIENCE/TM DATA (MAKE ADJUSTMENTS AS NECESSARY)
FULL INSTRUMENT OPERATION	FOLLOWS ANY ADJUSTMENTS, ABOVE

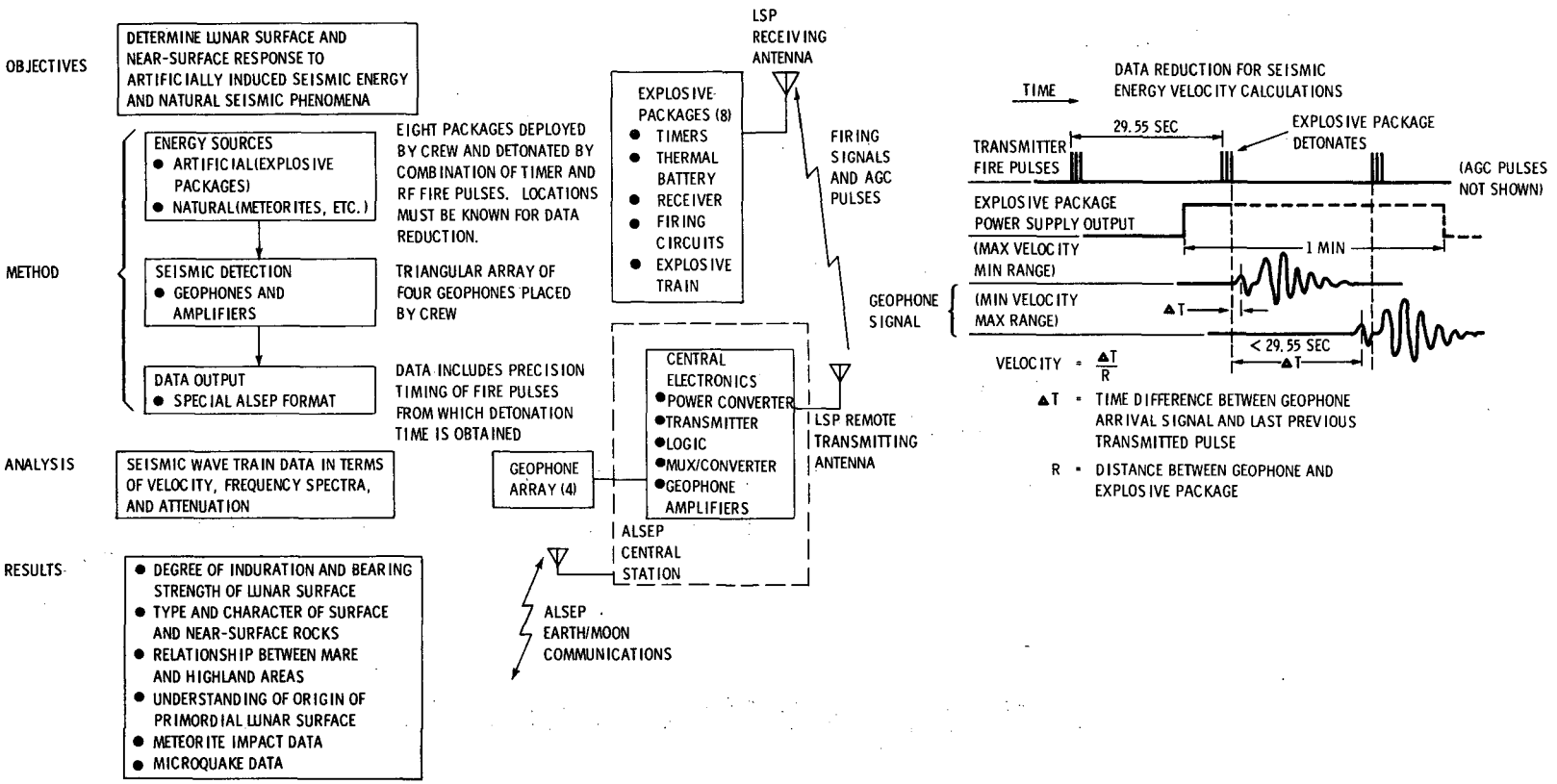
LUNAR SEISMIC PROFILING EXPERIMENT (LSP)

LSP EQUIPMENT



JULY 72 3270.5.2

LSP SCIENTIFIC SUMMARY



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LSP OPERATIONS SUMMARY

DEPLOYMENT

EVA 1
- PLACE EXPLOSIVE TRANSPORT MODULES IN SUN
- PLACE GEOPHONE MODULE 30 FT SOUTH OF CENTRAL STATION
- DEPLOY FOUR GEOPHONES, ONE AT A TIME, FROM GEOPHONE MODULE; TWO ALONG SUN LINE AND TWO PERPENDICULAR TO SUN LINE
- ERECT LSP TRANSMITTING ANTENNA 37 FT NW OF CENTRAL STATION

EVA 2
- PLACE TRANSPORT MODULE #1 ON LRV
- AT EACH OF FOUR PRESCRIBED LOCATIONS, PLACE APPROPRIATE EXPLOSIVE PACKAGE ON LUNAR SURFACE WITH RECEIVING ANTENNA EXTENDED AND PULL (FOUR PINS) THREE PULL-RINGS

EVA 3
- REPEAT STEPS OF EVA 2 FOR TRANSPORT MODULE #2 USING APPROPRIATE PACKAGES/LOCATIONS

PRELIMINARY CONCEPT

POST-DEPLOYMENT

- COMMAND LSP OPERATIONAL POWER AND DATA FORMAT
- INITIATE LSP FIRING SIGNALS (TRANSMITTER PULSES) BY COMMAND AT TIME DEPENDING ON DEPLOYMENT HISTORY
- TRANSMIT COMMANDS FOR GEOPHONE CALIBRATION
- OTHER COMMANDS AS NECESSARY

LSP COMMUNICATIONS SUMMARY

COMMANDS

- POWER ON/STANDBY/OFF (STANDBY IS EFFECTIVELY OFF FOR LSP)
- LSP DATA FORMAT
- DATA RATE (3533.3 BITS PER SEC IS NORMAL FOR LSP; LOW RATE OF 1060 BITS PER SEC USED ONLY FOR LISTENING MODE BECAUSE PROPER FIRE PULSES CANNOT BE GENERATED - NETWORK HAS NO PROVISION FOR THROUGHPUT OF LOW RATE TO MCC)
- 5 SPECIAL LSP CONTROL COMMANDS USED FOR:
  - LSP XMTR PULSES ON
  - LSP XMTR PULSES OFF
  - AMPLIFIER GAIN NORMAL
  - AMPLIFIER GAIN LOW
  - GEOPHONE CALIBRATE
- WHENEVER LSP IS ACTIVATED BY POWER ON CMD, XMTR FIRE AND AGC PULSES INITIALIZE OFF AND AMPLIFIER GAIN INITIALIZES NORMAL

DATA

- IN THE ALSEP DATA PROCESSOR FORMAT, LSP ELECTRONICS TEMPERATURE (PARAMETER AP-01) IS OBTAINED ONCE EVERY 90 ALSEP FRAMES, REGARDLESS OF LSP ON/STANDBY/OFF STATUS
- IN THE LSP FORMAT, ALL SCIENCE DATA FROM OTHER EXPERIMENTS IS BYPASSED, AND A SPECIAL DOWNLINK FORMAT IS GENERATED BY THE LSP
- THIS FORMAT CONSISTS OF AN 1800-BIT MAIN FRAME MADE UP OF THREE 600-BIT SUBFRAMES, EACH HAVING TWENTY 30-BIT WORDS
- IN EACH LSP MAIN FRAME, THERE ARE SIX CRITICAL ALSEP HOUSEKEEPING PARAMETERS (8 BITS EACH), THE REMAINDER IS EITHER LSP DATA (SCIENCE AND HOUSEKEEPING) OR SYNCHRONIZATION
- AT THE NORMAL LSP DATA RATE, EACH SEISMIC DATA CHANNEL IS SAMPLED 118 TIMES PER SECOND

LSP PHYSICAL PARAMETERS

SIZE

- CENTRAL ELECTRONICS: 6.755 X 6.505 X 2.8 IN.
- GEOPHONE MODULE: 9.84 X 8.665 X 6.85 IN.
- EXPLOSIVE PACKAGES (ON TRANSPORT FRAME): 18.39 X 11.12 X 10.88 IN.
- TRANSMITTING ANTENNA LENGTH: 13 IN. STOWED, 62 IN. DEPLOYED

EARTH WEIGHT

TRANSPORT MODULE NO. 1:	20.10 LB
TRANSPORT MODULE NO. 2:	18.66 LB
CENTRAL ELECTRONICS:	3.70 LB
ANTENNA AND CABLE:	5.00 LB
GEOPHONE MODULE:	8.95 LB
ANCHOR, FLAGS, ETC.:	2.90 LB
TOTAL:	59.31 LB

OPERATIONAL POWER: 6.8 W

SURVIVAL POWER: ZERO

LSP PERFORMANCE CHARACTERISTICS

EXPLOSIVE PACKAGES
- PLACED AT RANGES OF 500 FT TO 3.5 KM
- LARGER EXPLOSIVE CHARGES AT LONG-RANGE LOCATIONS

GEOPHONES (SENSORS)
- ELECTROMAGNETIC TYPE

LOGARITHMIC COMPRESSION AMPLIFIERS
- DYNAMIC RANGE: 64 DB TO 78 DB

GEOPHONE/AMPLIFIER
- SENSITIVITY: THE RMS VALUE OF A 6 MILLIMICRON ($m\mu$) PEAK-TO-PEAK SIGNAL AT 10 Hz WILL BE A MINIMUM OF 18 DB ABOVE THE RMS NOISE
- BANDWIDTH: 3 TO 20 Hz WITH RESPECT TO VELOCITY (GEOPHONES SENSE RATE OF CHANGE IN VERTICAL POSITION)
- DYNAMIC RANGE: 64 TO 78 DB

BASIC DATA WORD
- 7-BIT READOUT FROM EACH OF FOUR SEISMIC DATA CHANNELS (GEOPHONE/AMPLIFIER)
- 1.28-DB RESOLUTION PER BIT

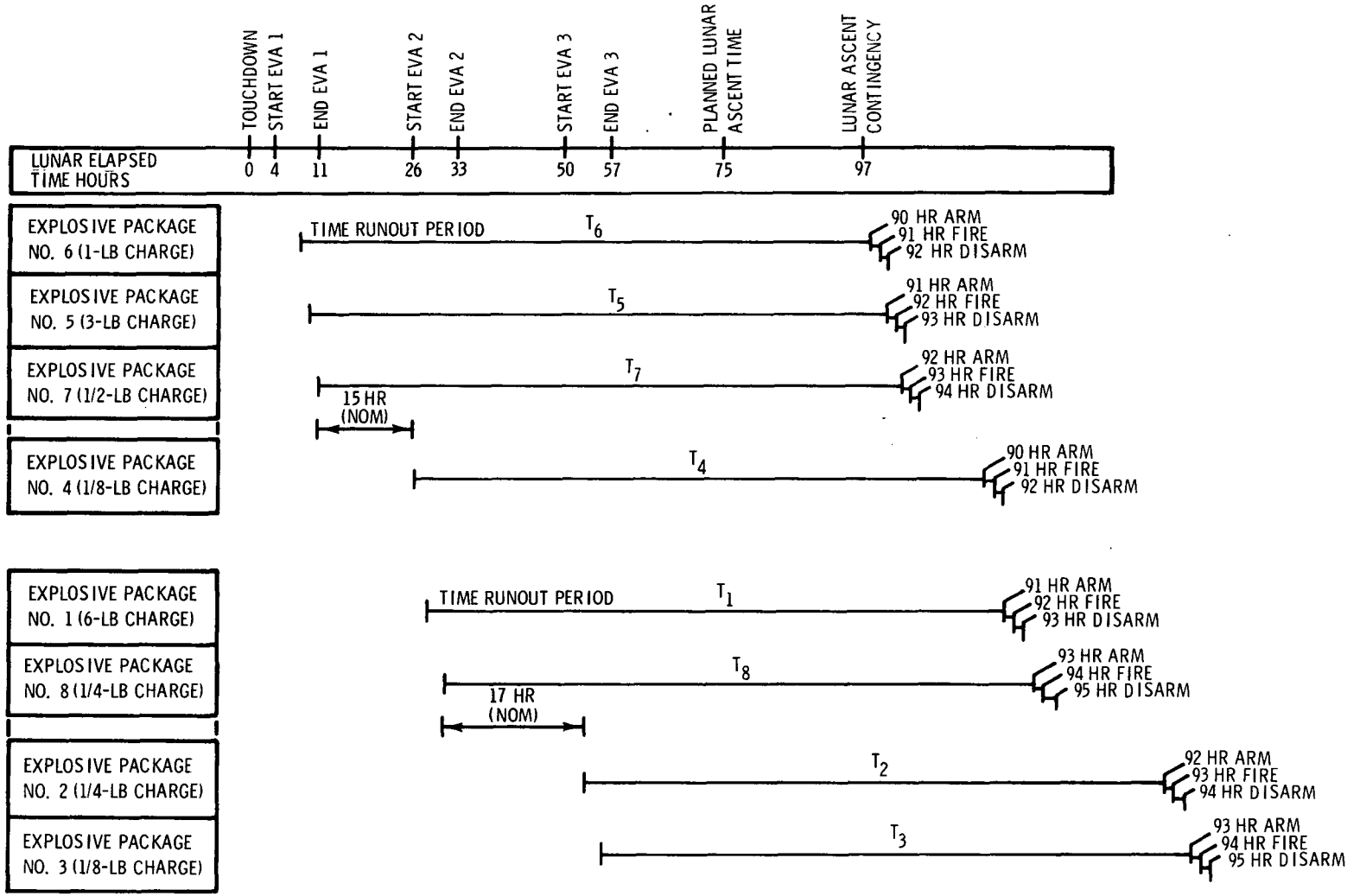
SHOT TIME
- DETERMINED BY CORRELATING SEISMIC RESPONSE FROM DETONATION OF EXPLOSIVE PACKAGE WITH TIME OF FIRE PULSE SETS; TIMING OF EACH FIRE PULSE SET IS SYNCHRONIZED IN DATA FORMAT AS WELL AS DETECTED FOR VERIFICATION IN TM

NOTES:

(1) ACCURATE DETERMINATION OF SHOT TIME AND RANGE IS FUNDAMENTAL IN THE ANALYSIS OF GEOPHONE DATA

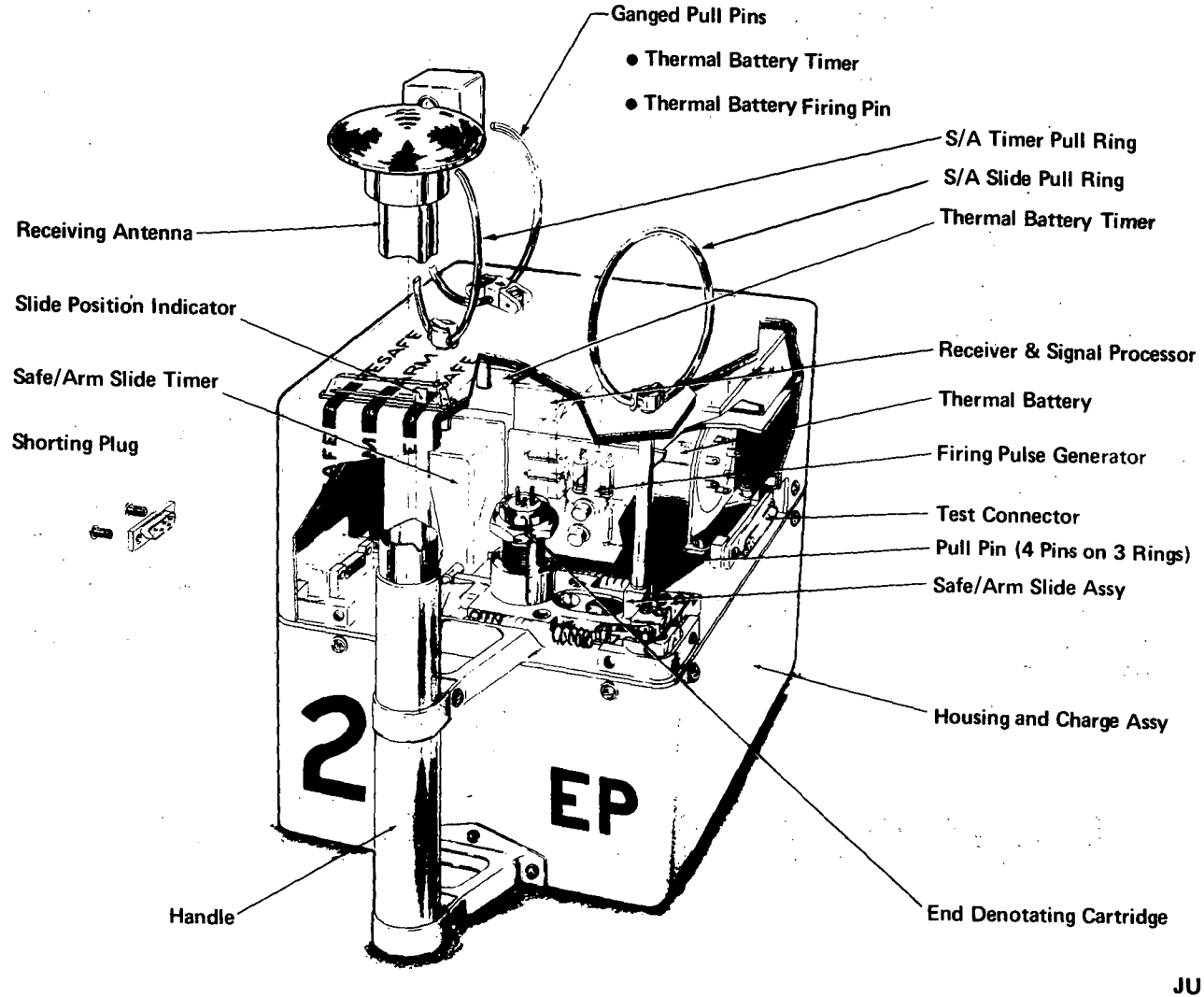
(2) THE VARIETY OF RANGES AND EXPLOSIVE CHARGES ALLOWS INVESTIGATION OF SEISMIC WAVE PENETRATION THROUGH SEVERAL LAYERS OF SUBSURFACE MATERIAL DOWN TO DEPTHS OF 3 OR 4 KM

LSP EXPLOSIVE PACKAGE TIME SEQUENCE



JULY 72 3270.5.8

LSP EXPLOSIVE PACKAGE DESIGN



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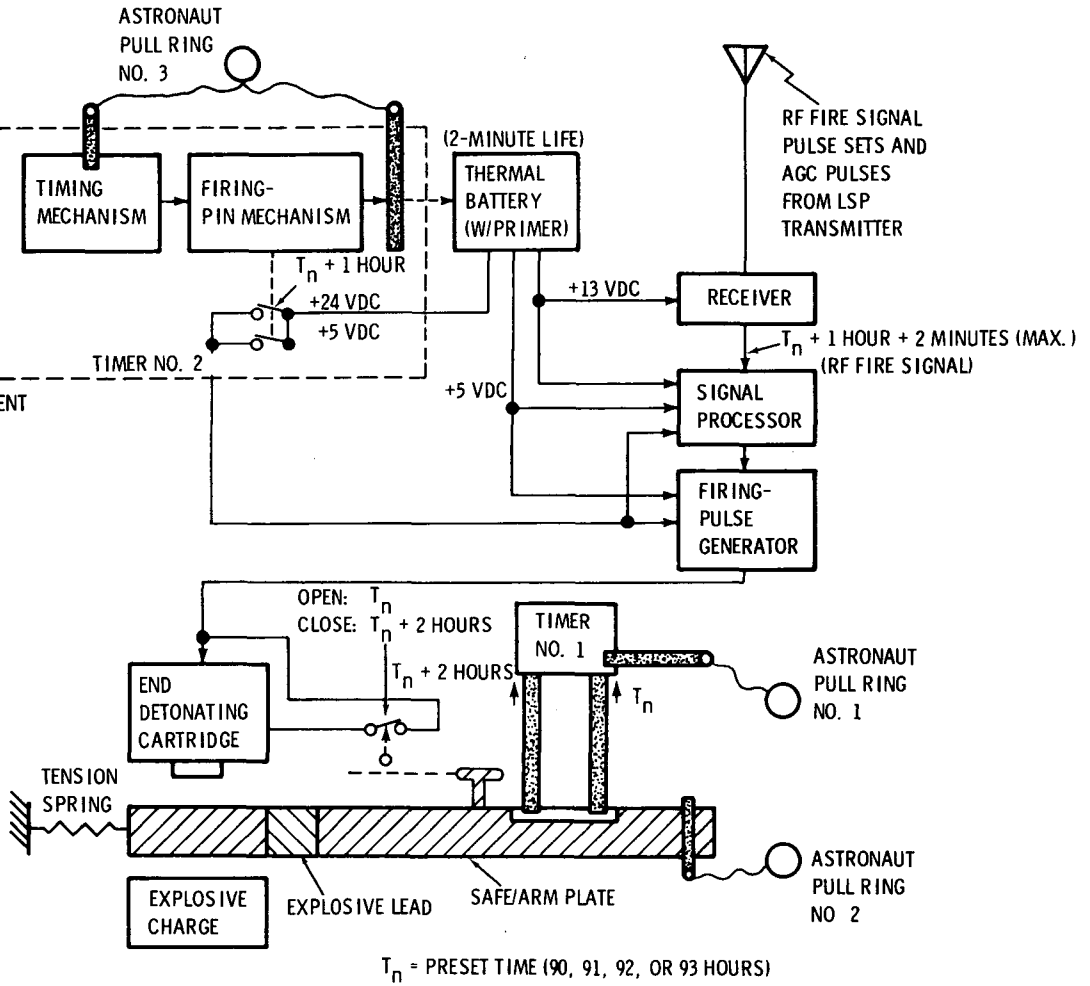
LSP EXPLOSIVE PACKAGE FUNCTIONS

- SAFE/ARM TIMER ARMS EXPLOSIVE PACKAGE ≈ 90 HOURS AFTER DEPLOYMENT
- THERMAL-BATTERY TIMER ACTIVATES BATTERY TO SUPPLY PWR TO RECEIVER, SIGNAL PROCESSING, AND FIRING CIRCUIT ≈ 91 HOURS AFTER DEPLOYMENT
- EXPLOSIVE PACKAGE DETONATES UPON RECEIVING CODED RF SIGNAL FROM LSP CENTRAL ELECTRONICS IF SAFE/ARM SLIDE PLATE IS IN POSITION AND THERMAL BATTERY IS ACTIVATED
- SHORTING SWITCH ON END DETONATING CARTRIDGE IS OPENED BY ROLLER ENGAGEMENT WITH SAFE/ARM SLIDE PLATE



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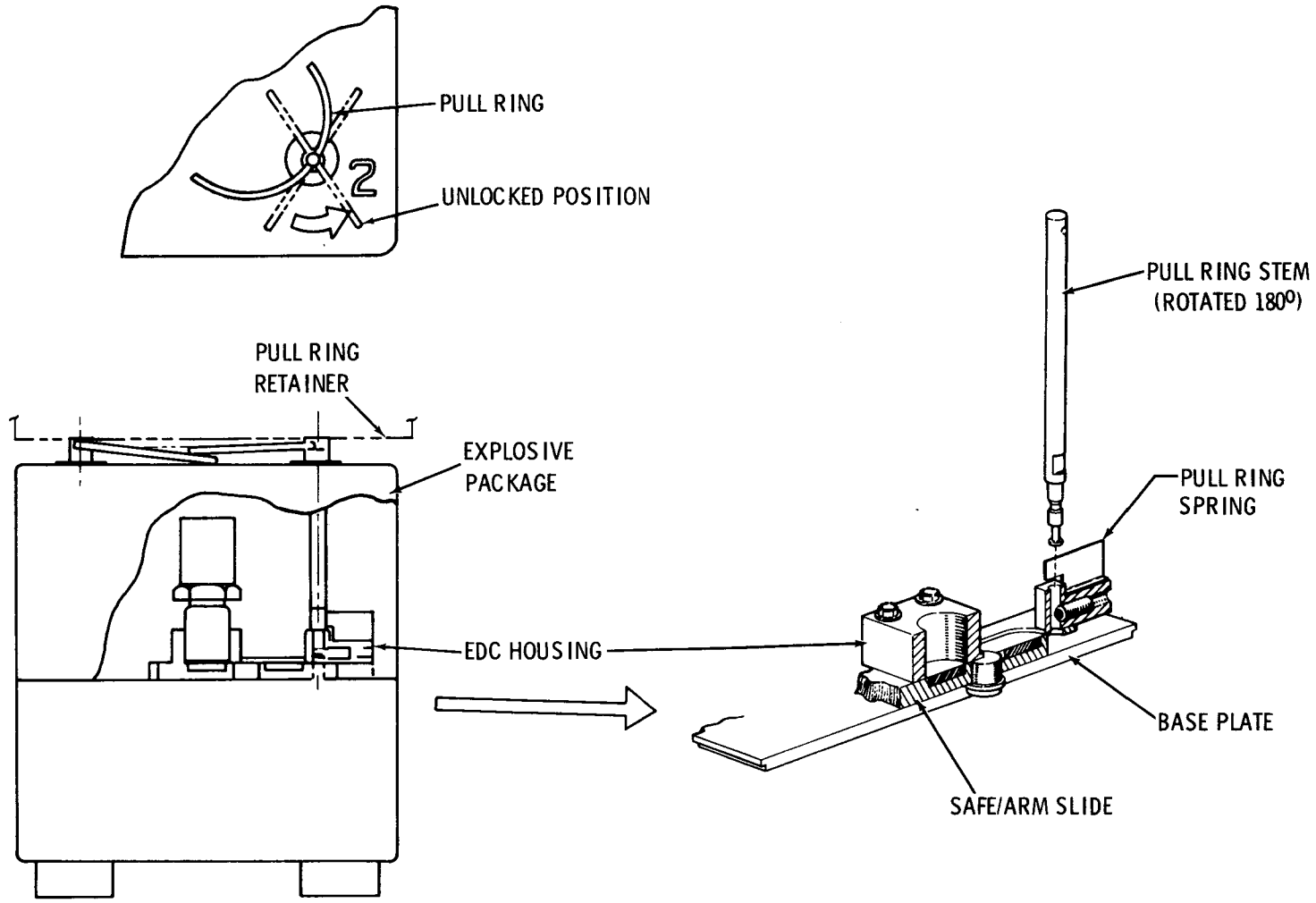
LSP EXPLOSIVE PACKAGE SAFETY FEATURES

- THREE INDEPENDENT EVENTS OCCUR FOR DETONATION
  - RUN-OUT OF SAFE/ARM SLIDE TIMER
  - RUN-OUT OF BATTERY TIMER
  - RADIO RECEPTION OF CODED FIRING SIGNAL (PROPERLY GENERATED ONLY AT 3533.3-BPS DATA RATE)
- TIMER PULL PINS WILL PERMANENTLY LOCK IN PLACE IF TIMER STARTS PREMATURELY
- FIRING PIN SAFING PULL PIN WILL PERMANENTLY LOCK IN PLACE, PREVENTING THERMAL BATTERY INITIATION, IF THE BATTERY FIRING PIN RELEASES PRIOR TO DEPLOYMENT
- SAFE/ARM SLIDE PULL PIN WILL PERMANENTLY LOCK IN PLACE, PREVENTING THE SLIDE FROM MOVING TO THE ARM POSITION, IF THE SAFE/ARM SLIDE PLATE RELEASES PRIOR TO DEPLOYMENT
- SAFE/ARM SLIDE IN SAFE POSITION
  - PREVENTS PROPAGATION OF EXPLOSIVE TRAIN DETONATION
  - SHORTS END DETONATING CARTRIDGE
- BATTERY TIMER, PRIOR TO RUN-OUT, OPEN CIRCUITS THE SIGNAL PROCESSOR AND FIRING PULSE GENERATOR POWER LINE
- THERMAL BATTERY HAS A ONE-TIME OPERATIONAL LIFETIME OF THREE MINUTES MAXIMUM
- TIMEOUT OF TIMERS MUST COINCIDE WITHIN LIMITS SUCH THAT THE SAFE/ARM SLIDE PLATE IS IN THE ARM POSITION WHEN THE THERMAL BATTERY IS ACTIVATED
- FIRING CAPACITORS DISCHARGE THROUGH LEAK RESISTORS IF FIRING SIGNAL IS NOT RECEIVED WITHIN THREE MINUTES OF THERMAL BATTERY ACTIVATION
- IF EXPLOSIVE PACKAGE IS NOT DETONATED WITHIN THE TWO-HOUR SAFE/ARM SLIDE FIRING WINDOW, THE SLIDE WILL MOVE TO THE RESAFE POSITION (VISUAL INDICATOR SHOWS STATUS)

LSP SAFE/ARM SLIDE PULL PIN



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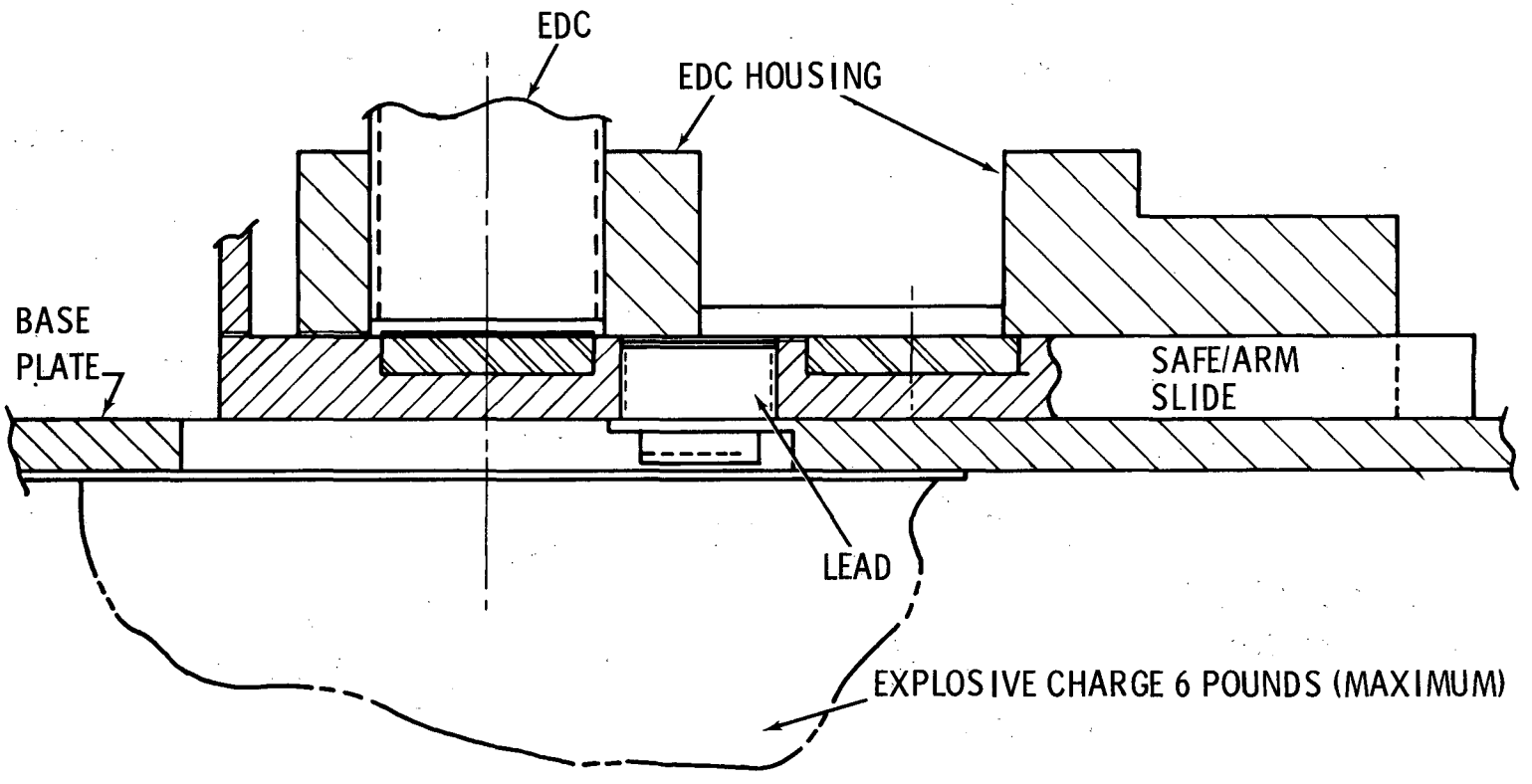
LSP EXPLOSIVE TRAIN SAFE POSITION



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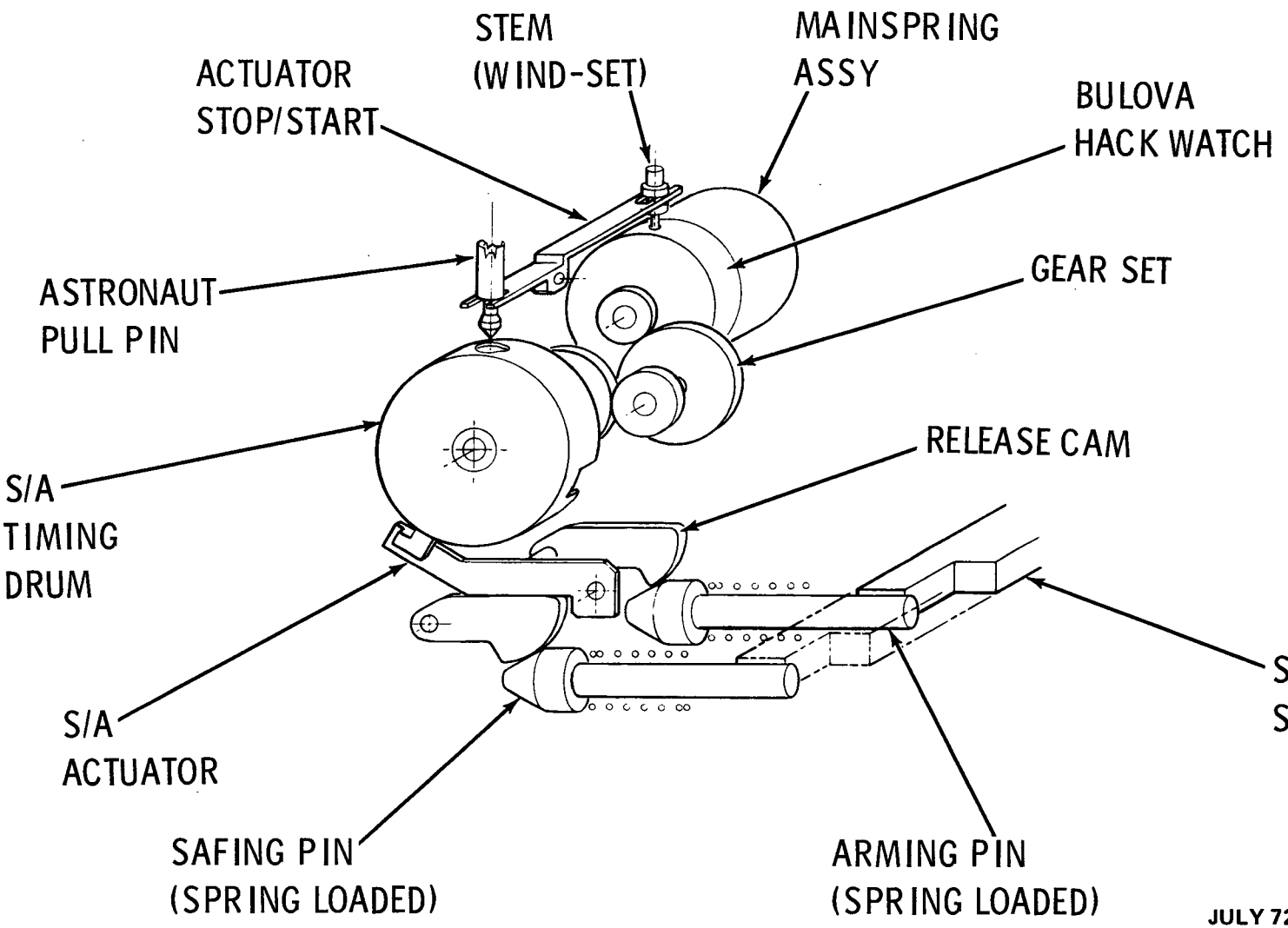
LSP SAFE/ARM SLIDE TIMER



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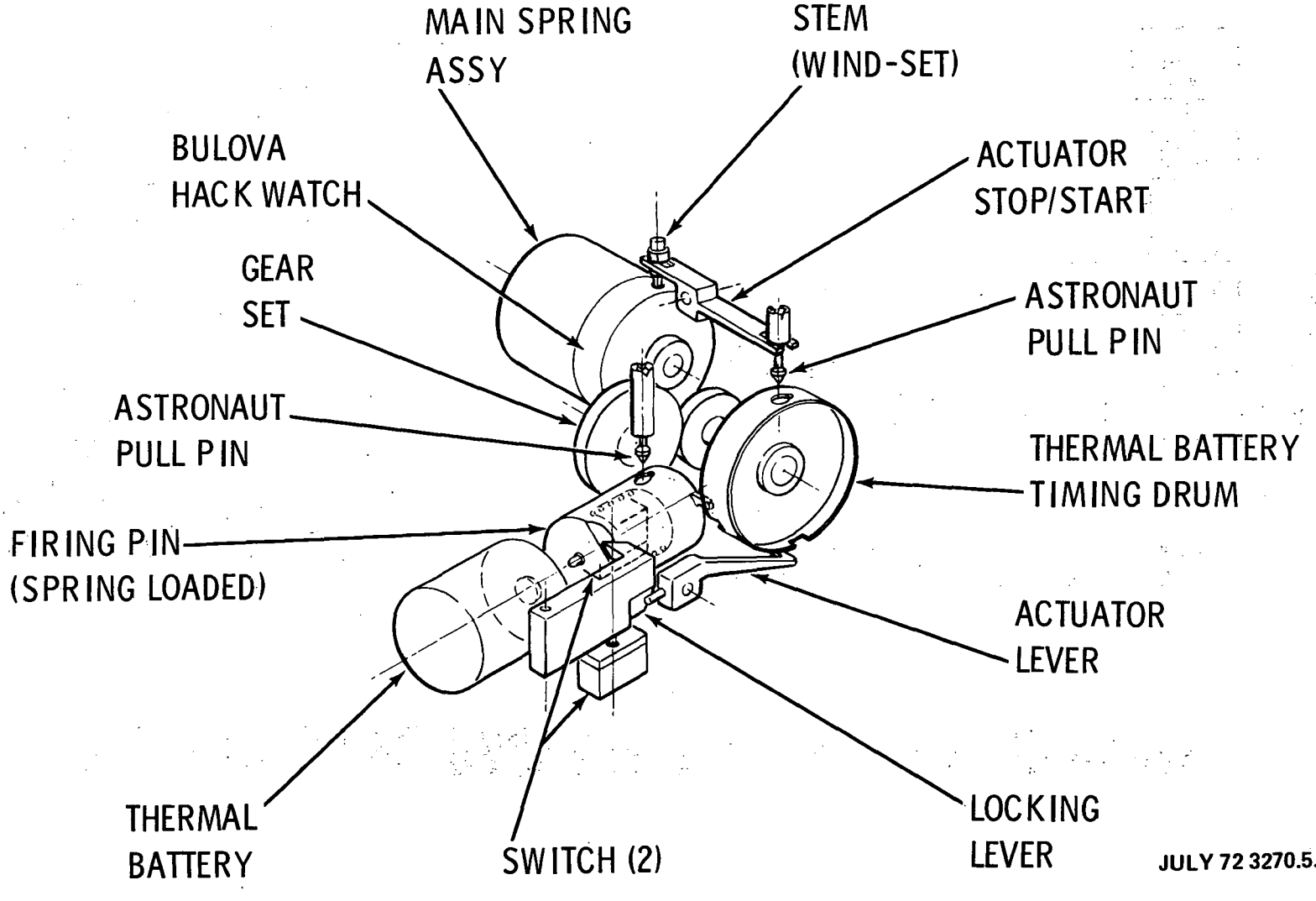
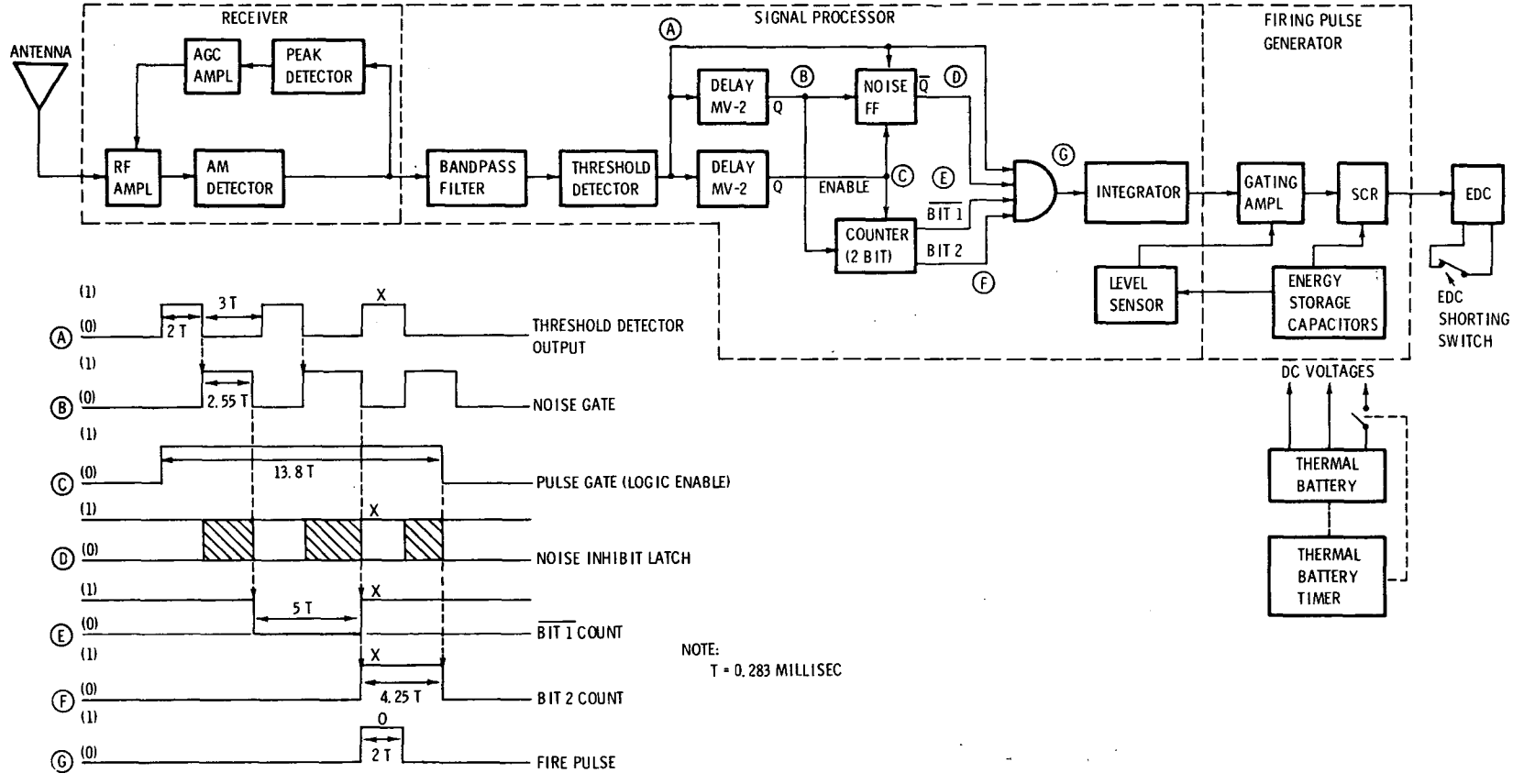
LSP THERMAL BATTERY TIMER

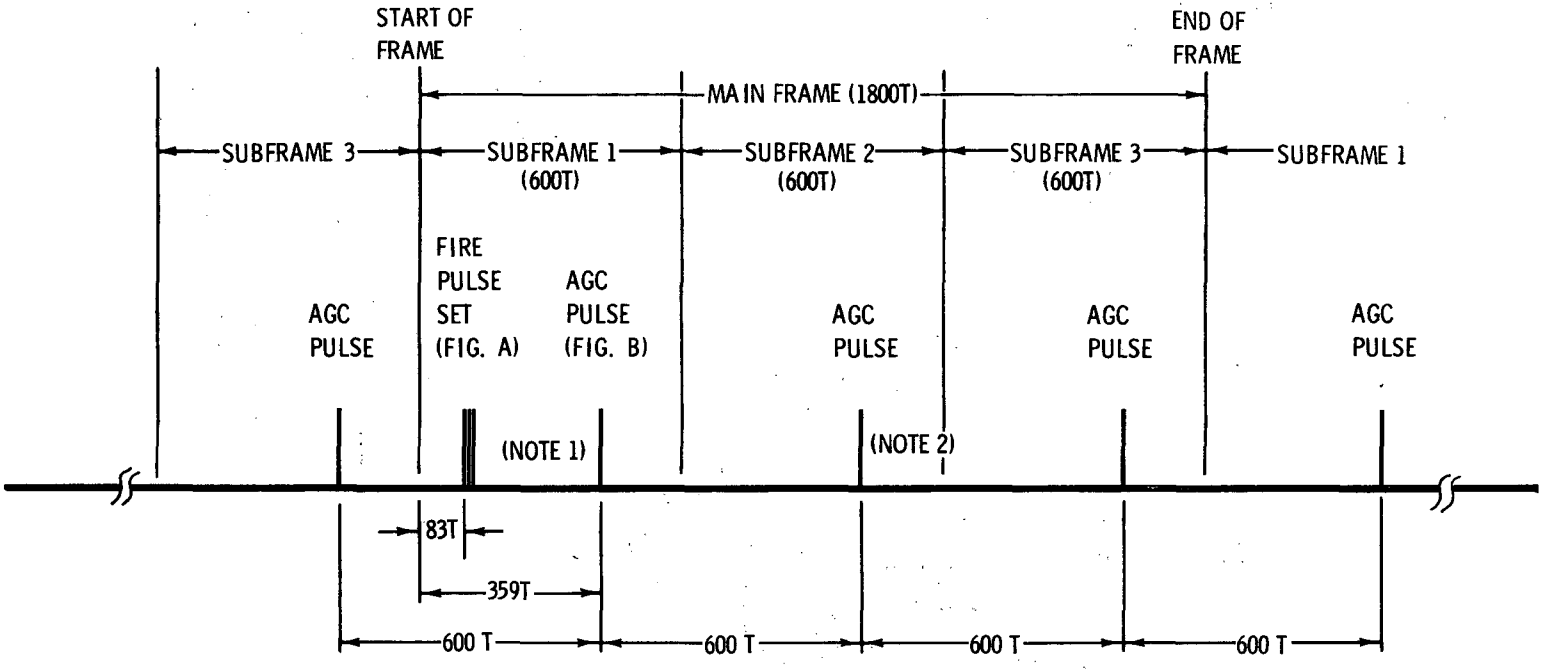


LSP EXPLOSIVE PACKAGE ELECTRONICS DIAGRAM



JULY 72 3270.5.16

LSP TRANSMITTER PULSE TIMING



T = 0.283 MILLISEC = 1 CLOCK PULSE WIDTH
2T = 0.566 MILLISEC
3T = 0.849 MILLISEC
12T = 3.40 MILLISEC
83T = 23.49 MILLISEC
359T = 101.6 MILLISEC
600T = 169.8 MILLISEC
1800T = 504.4 MILLISEC

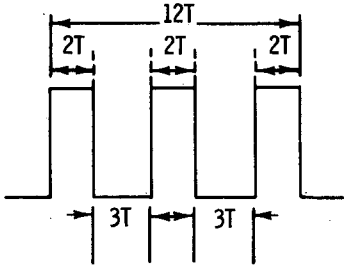


FIG. A
FIGURE PULSE SET

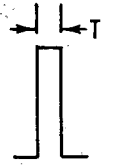


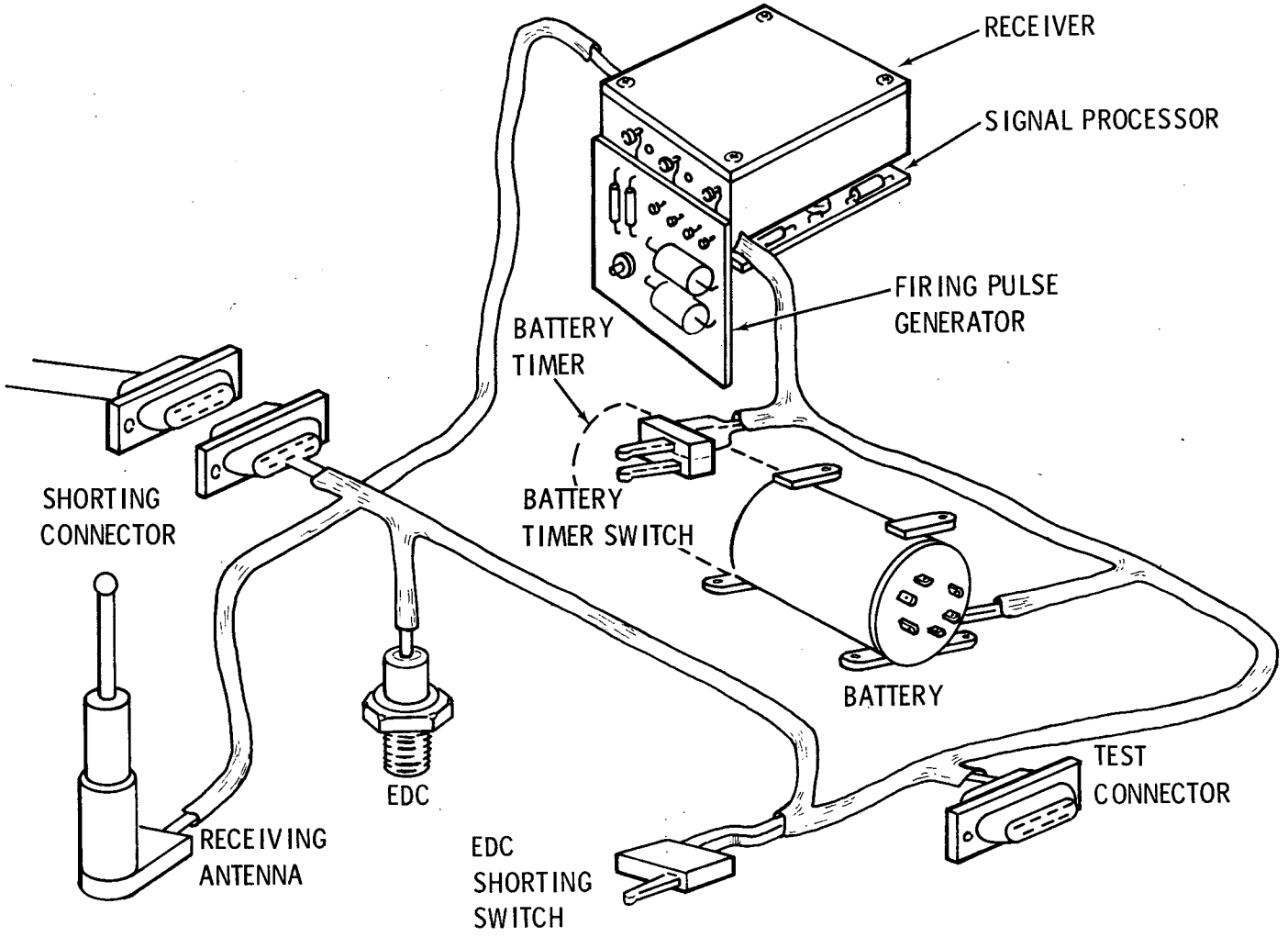
FIG. B
AGC PULSE

NOTES:

1. FIRE PULSE SETS OCCUR ONCE EVERY 58 FRAMES (174 SUBFRAMES) (58 FRAMES = 29.55 SEC)
2. AGC PULSE OCCURS ONCE PER SUBFRAME (169.8-MILLISEC INTERVALS)
3. TIMING SHOWN APPLIES ONLY TO 3533.3 BPS CLOCK RATE

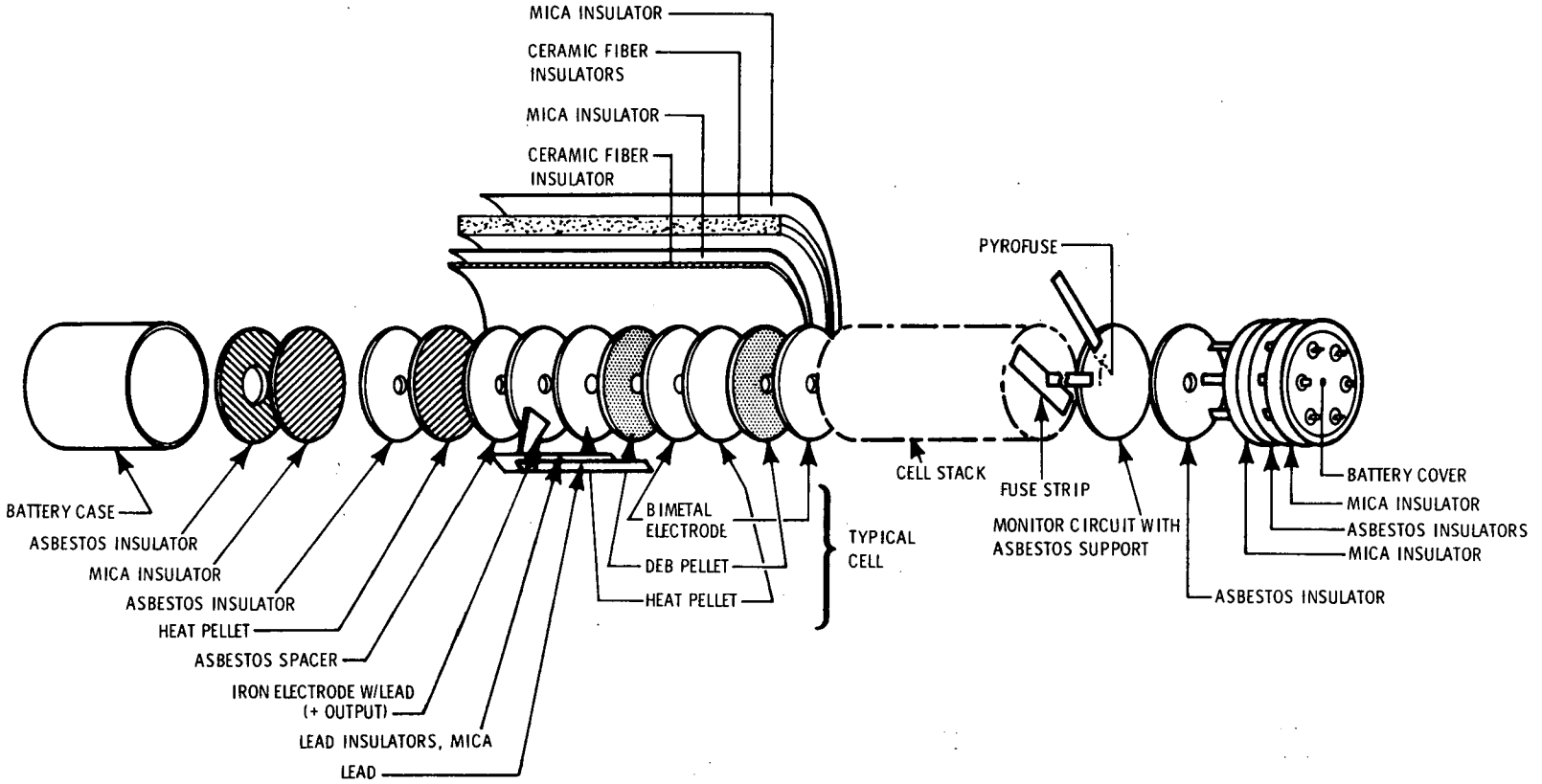
JULY 72 3270.5.17

LSP EXPLOSIVE PACKAGE ELECTRONICS CONFIGURATION



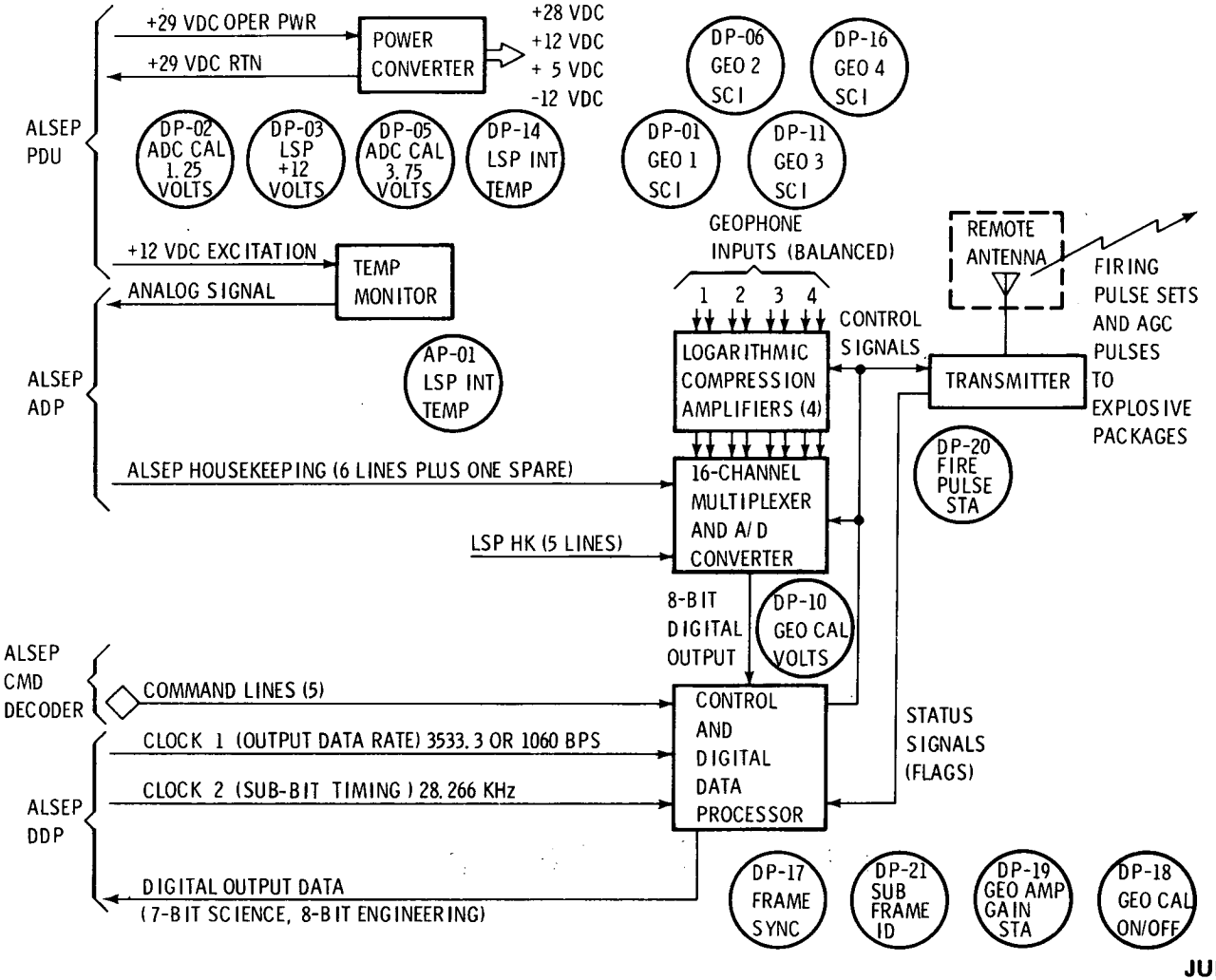
JULY 72 3270.5.18

LSP THERMAL BATTERY



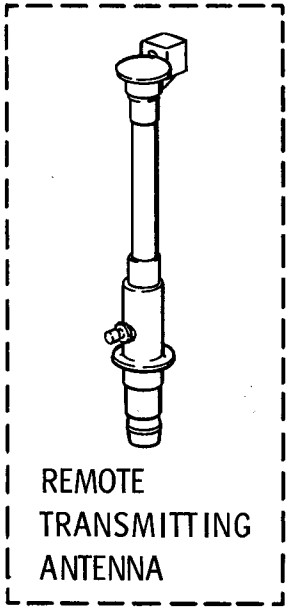
JULY 72 3270.5.19

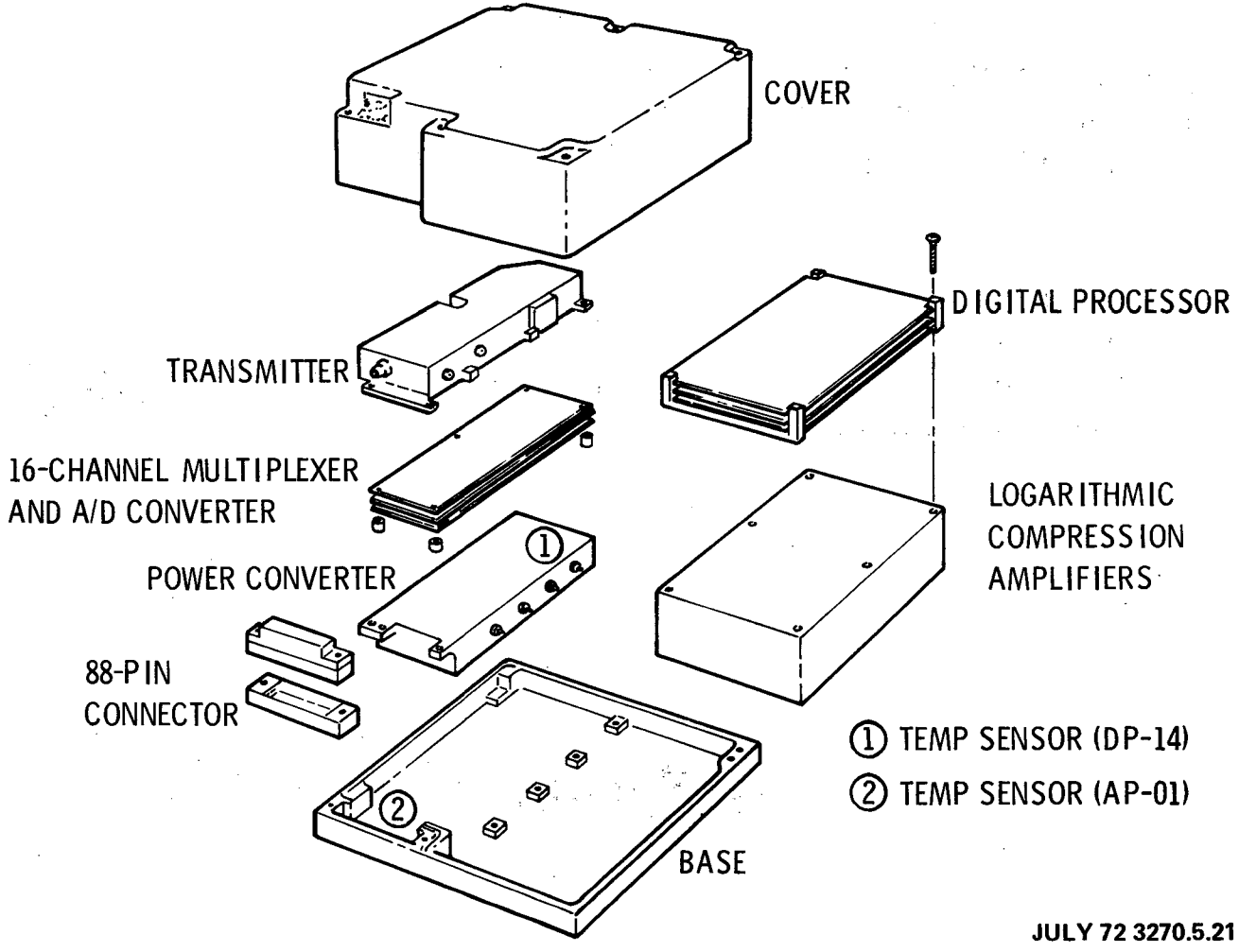
LSP CENTRAL ELECTRONICS DIAGRAM



JULY 72 3270.5.20

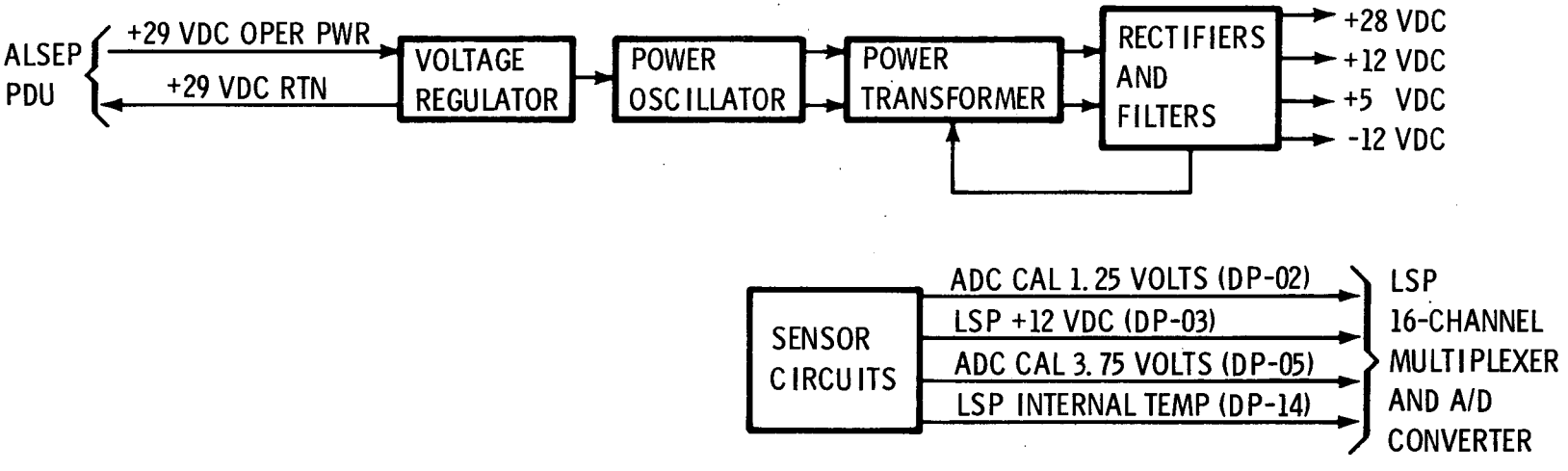
LSP CENTRAL ELECTRONICS CONFIGURATION





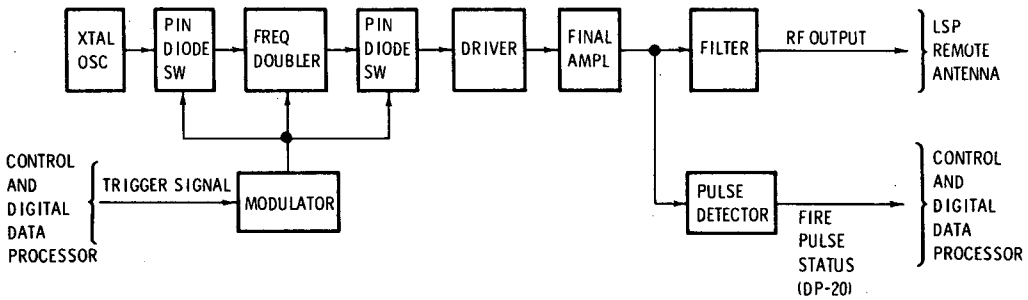
JULY 72 3270.5.21

LSP POWER CONVERTER



JULY 72 3270.5.22

LSP TRANSMITTER



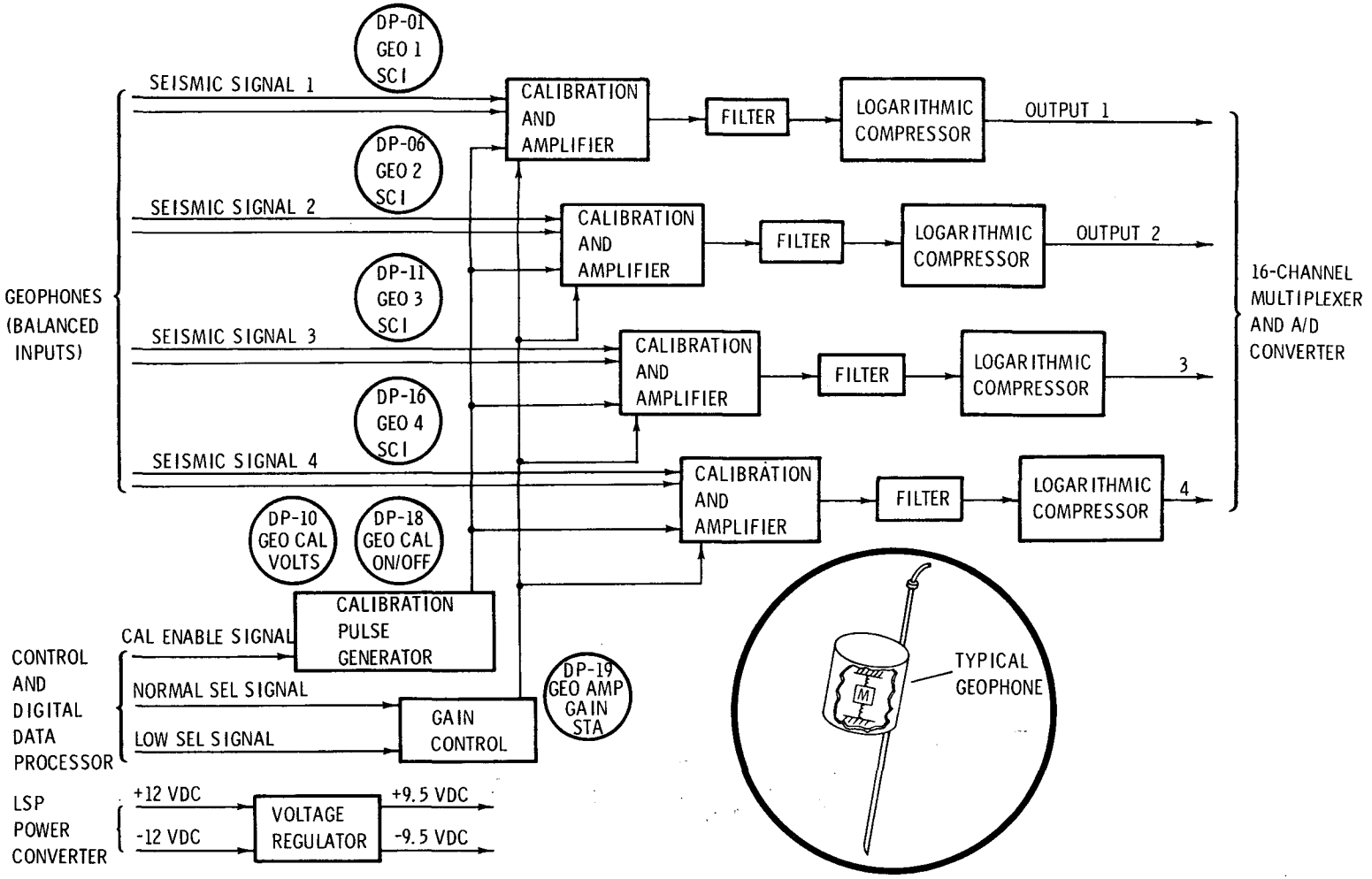
OPERATION

- USES A PULSED CARRIER-WAVE (CW) TYPE TRANSMISSION
- WHENEVER OPERATIONAL POWER IS APPLIED TO THE LSP, THE CRYSTAL OSCILLATOR IS ON BUT OUTPUT IS NOT MODULATED UNTIL COMMANDED TO RF PULSES MODE
- EXECUTION OF THE "PULSES ON" CMD CAUSES A CONTINUOUS SERIES OF TRIGGER SIGNALS, UNTIL THE "PULSES OFF" CMD IS RECEIVED WITH THE FOLLOWING TIMING:
  - ONE PULSE FOR 0.283 MILLISEC, COINCIDING WITH THE 359TH BIT IN EVERY LSP SUBFRAME (EVERY 169.3 MILLISECONDS)
  - A FIRE PULSE SET CONSISTING OF THREE PULSES OF 0.566 MILLISEC EACH SPACED 0.849 MILLISEC APART, COINCIDING WITH THE FOLLOWING BIT PAIRS IN THE LSP FRAME (AT 58-FRAME INTERVALS): 84-85, 89-90, AND 94-95
- THE ONE-BIT PULSES SET RECEIVER AGC THRESHOLD
- TRANSMISSION OF FIRE PULSE SETS ARE INDICATED IN TM, DP-20, (BITS 89-90) THROUGH A DIODE DETECTOR AT THE TRANSMITTER OUTPUT
- DETONATION OCCURS ON THE LEADING EDGE OF THE THIRD PULSE

RF LINK PARAMETERS (WORST CASE)

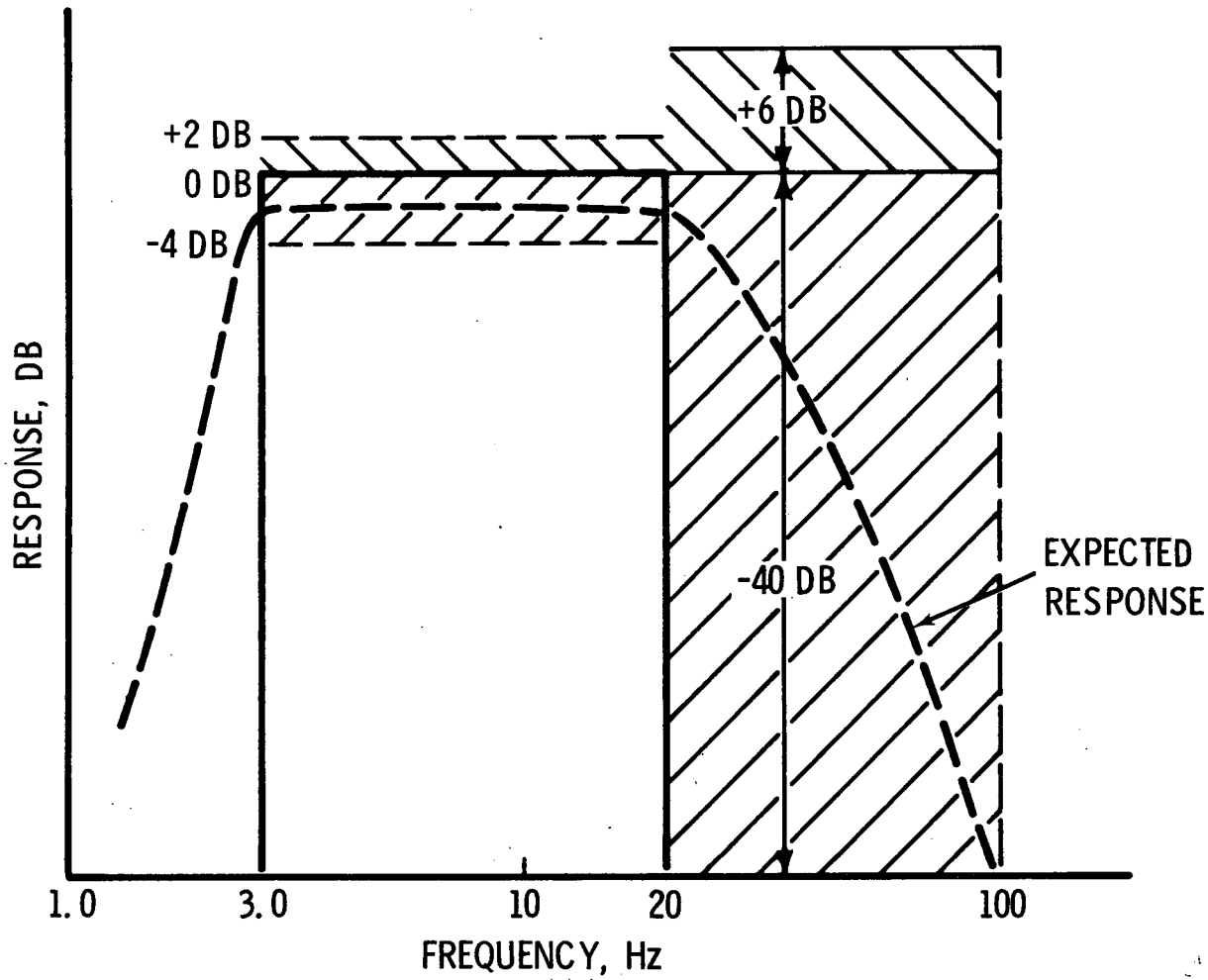
FREQUENCY, MHz	41.2
PEAK XMTR POWER, WATTS	10 (MINIMUM)
XMTR FIRING PULSE, MILLISEC	0.566
XMTR AGC PULSE, MILLISEC	0.283
RCVR NOISE FIGURE, DB	7
RCVR BANDWIDTH, KHz	10
SIG PROC BANDWIDTH, KHz	5
XMTR ANTENNA GAIN, DB	0
RCVR ANTENNA GAIN, DB	0
XMTR ANTENNA HEIGHT, IN.	63
RCVR ANTENNA HEIGHT, IN.	60
XMTR ANT PROXIMITY LOSS, DB	3
RCVR ANT PROXIMITY LOSS, DB	7
RANGE, KM	3.5

LSP SEISMIC AMPLIFIERS



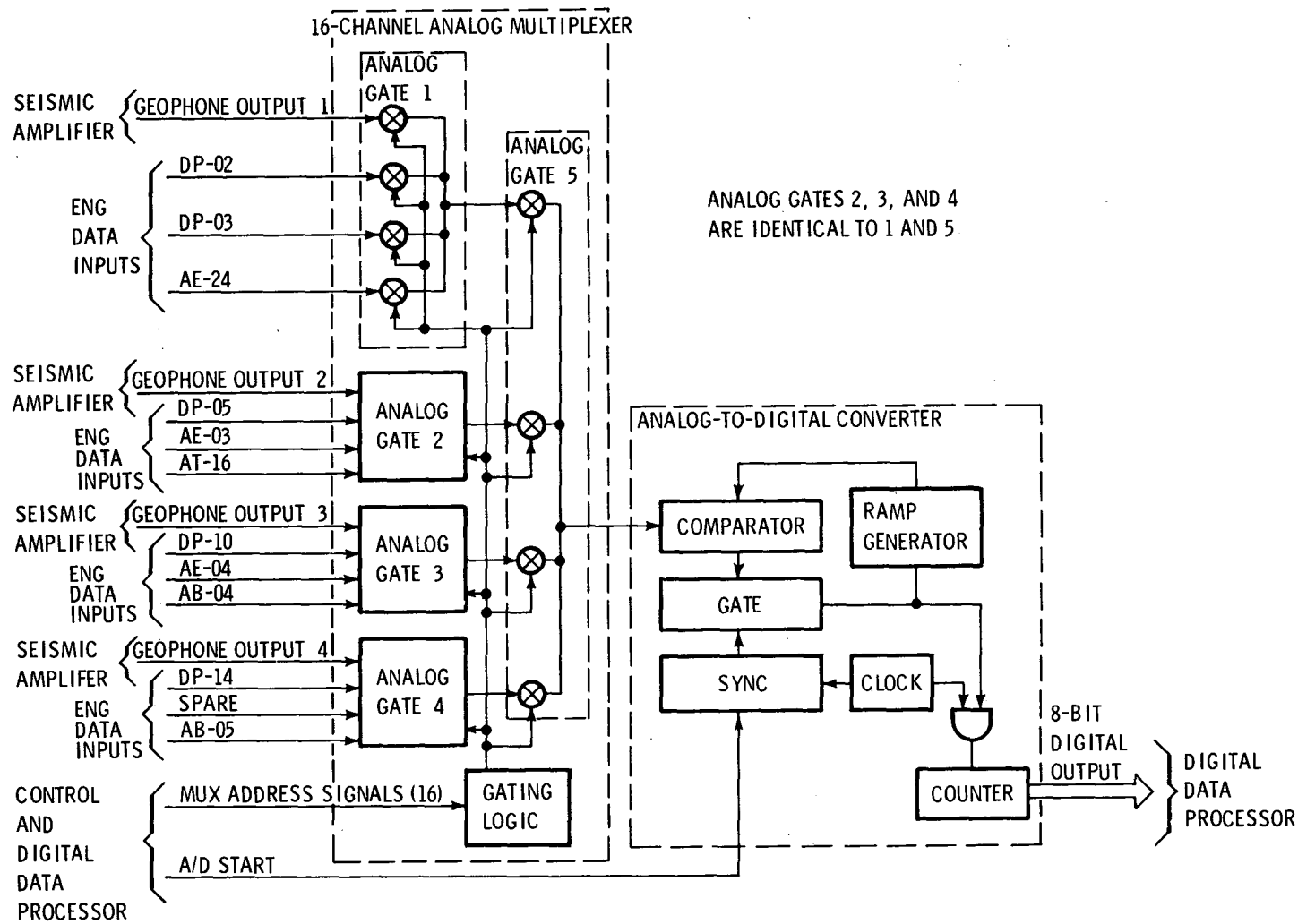
JULY 72 3270.5.24

LSP GEOPHONE/AMPLIFIER RESPONSE



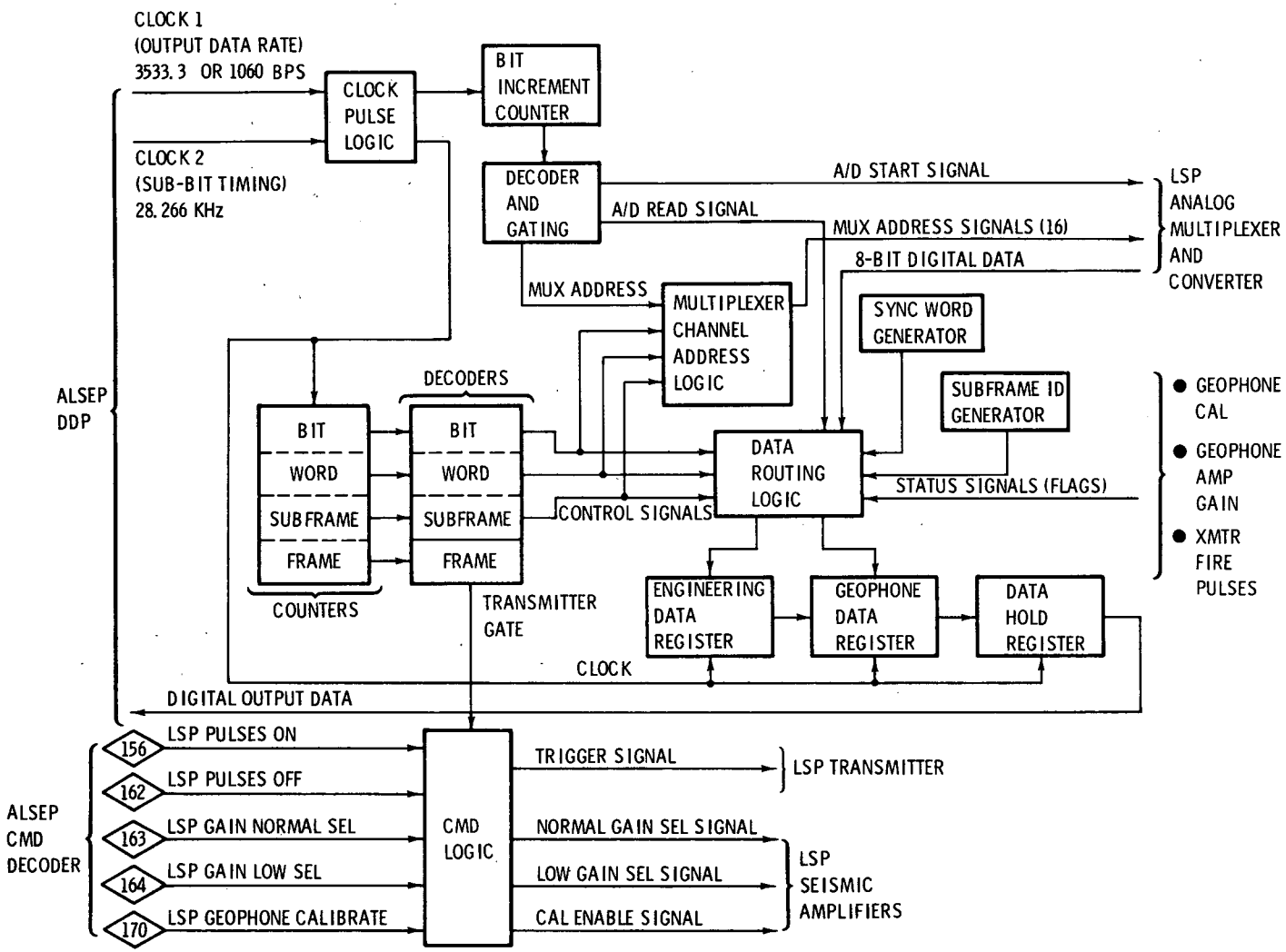
JULY 72 3270.5.25

LSP ANALOG MULTIPLEXER/CONVERTER



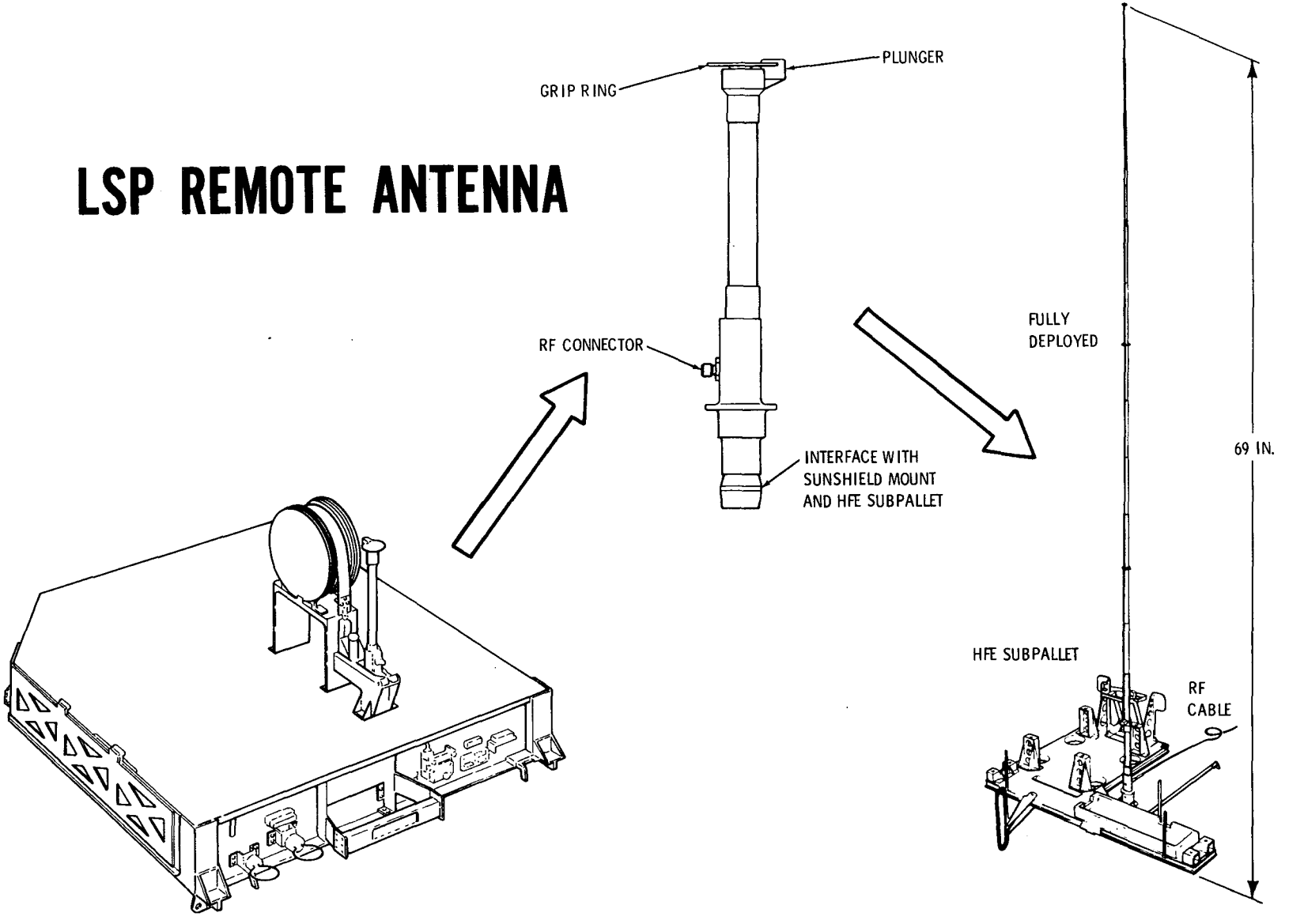
JULY 72 3270.5.26

LSP CONTROL AND DIGITAL DATA PROCESSING



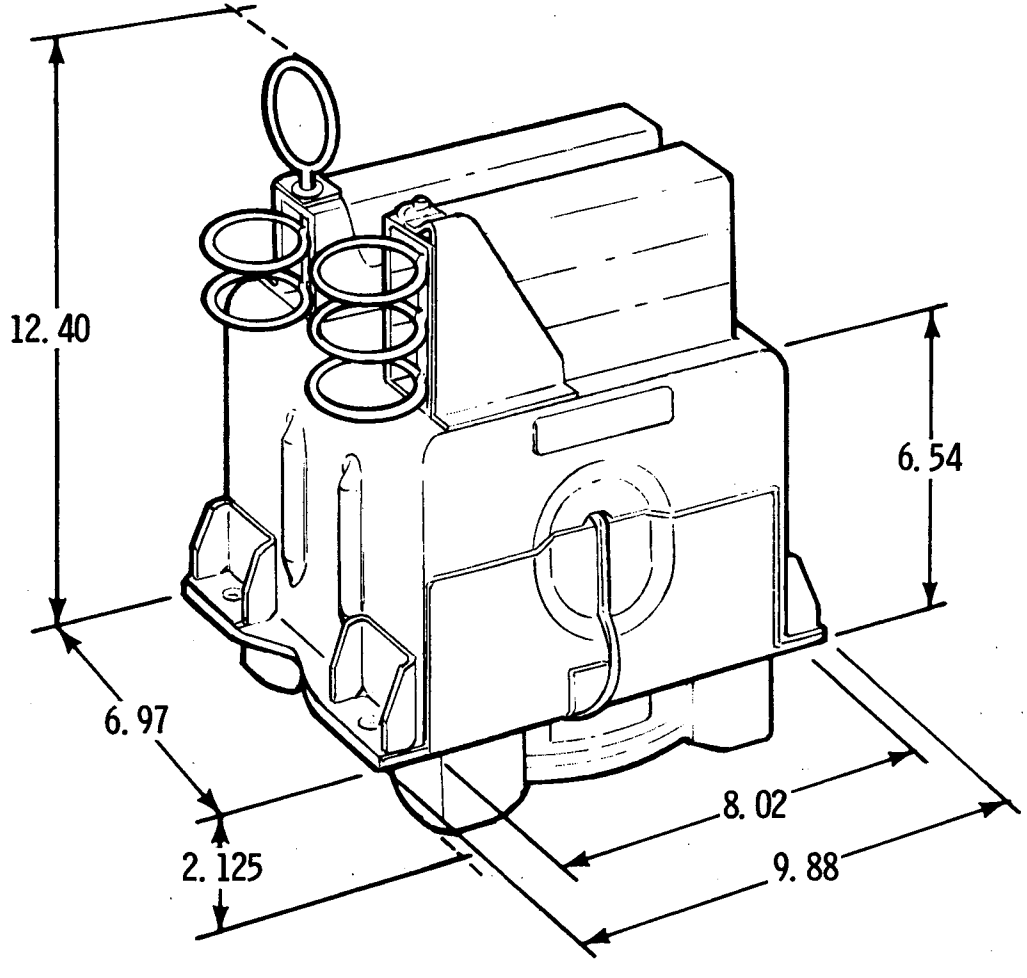
JULY 72 3270.5.27

LSP REMOTE ANTENNA



JULY 72 3270.5.28

LSP GEOPHONE MODULE



JULY 72 3270.5.29

LSP POWER SUMMARY

FUNCTION	POWER, WATTS		COMMENTS
	INCREMENT	TOTAL	
BASIC EXPERIMENT	5.3	5.3	STARTUP TRANSIENT OF LESS THAN 13 WATTS FOR LESS THAN 2 MILLISEC
PASSIVE LISTENING MODE	0	5.3	SAME AS BASIC EXPERIMENT
GEOPHONE CALIBRATION PULSE	0.8	6.1	CAL PULSE OPERATES FOR APPROX 1.5 SEC FOLLOWING EXECUTION OF COMMAND
TRANSMITTER FIRE PULSES (NOT CALIBRATING)	0.7	6.0	ENERGY STORAGE (CAPACITORS) REQUIRE 0.6 TO 0.8 WATT
TRANSMITTER FIRE PULSES (WITH GEOPHONE CALIBRATION)	0.8	6.8	APPROX 1.5 SEC EACH TIME

NOTE: THERE IS NO STANDBY POWER (SURVIVAL HEATER) FOR THE LSP

LSP ANTENNA AND GEOPHONE DEPLOYMENT

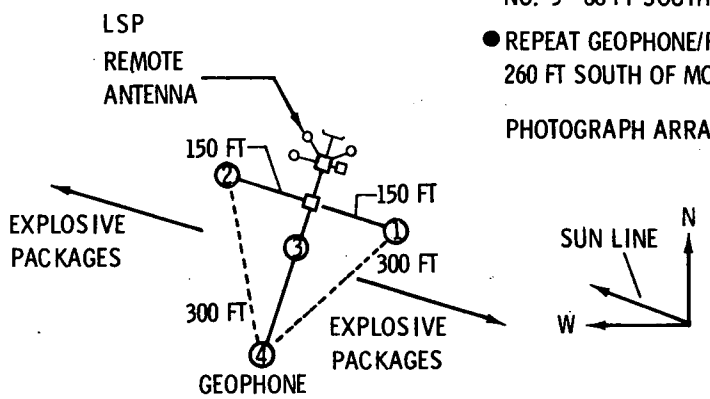
ANTENNA

- RELEASE ANTENNA AND CABLE REEL FROM SUBPACKAGE 1
- CARRY 37 FT NORTHWEST OF CENTRAL STATION
- EXTEND ANTENNA TO FULL LENGTH
- ATTACH TO HEAT FLOW SUBPALLET TO PROVIDE BASEPLATE
- ALIGN VERTICAL AND CHECK STABILITY (PRESS ON SUBPALLET WITH BOOT IF NECESSARY)

GEOPHONES

- RELEASE GEOPHONE MODULE FROM SUBPACKAGE 1 AND ENGAGE UHT WITH CARRY SOCKET
- CARRY 30 FT SOUTH OF CENTRAL STATION, PLACE ON SURFACE, AND ENGAGE UHT HANDLE WITH COVER PULL RING
- REMOVE COVER, RETAIN STAKE/FLAGS, AND DISCARD COVER
- SECURE MODULE WITH STAKE/FLAG, RETAIN ONE FLAG (INSERT UHT THROUGH FLAG RING), AND ENGAGE UHT WITH GEOPHONE NO. 1 REEL
- CARRY 150 FT EAST, INSERT GEOPHONE IN SURFACE, DISCARD REEL, AND INSTALL FLAG SECURING GEOPHONE
- REPEAT GEOPHONE/FLAG INSTALLATION FOR GEOPHONE NO. 2 150 FT WEST OF MODULE
- REPEAT GEOPHONE/FLAG INSTALLATION FOR GEOPHONE NO. 3 88 FT SOUTH OF MODULE
- REPEAT GEOPHONE/FLAG INSTALLATION FOR GEOPHONE NO. 4 260 FT SOUTH OF MODULE

PHOTOGRAPH ARRAY



JULY 72 3270.5.31

LSP EMPLACEMENT CRITERIA

COMPONENT	PARAMETER	REQUIREMENT	PRIORITY	INDICATOR	COMMENTS
REMOTE ANTENNA	LOCATION AND SITE	37 ± 7 FT NORTHWEST OF CENTRAL STATION ON HORIZONTAL SURFACE		CABLE LENGTH AND VISUAL	45-FT CABLE SURFACE MAY BE PACKED OR SMOOTHED WITH BOOT
	LEVEL	STABILITY		VISUAL	ON HFE SUBPALLET
	ALIGN	NONE			OMNIDIRECTIONAL
GEOPHONE MODULE	LOCATION AND SITE	30 ± 5 FT SOUTH OF CENTRAL STATION ON HORIZONTAL SURFACE		PACING, CABLE LENGTH, AND VISUAL	MIDDLE OF BASELINE FOR GEOPHONE TRIANGLE, PACK SURFACE, AVOID CRATERS, SLOPES, AND ROCKY MATERIAL
	LEVEL	STABILITY		VISUAL	
	ALIGN	ALONG SUN LINE		ARROW	
GEOPHONES	LOCATION WRT GEOPHONE MODULE	1 150 FT EAST 2 150 FT EAST 3 88 FT SOUTH 4 260 FT SOUTH		CABLE LENGTH AND VISUAL	PLACE A FLAG WITH EACH GEOPHONE; MAKES 300-FT TRIANGULAR ARRAY WITH ONE GEOPHONE IN CENTER
	SITE				AVOID CRATERS, SLOPES, AND ROCKY MATERIAL
	LEVEL	VERTICAL ± 7^0		VISUAL	PACK SURFACE FOR STABILITY
	ALIGN	NONE			PHOTOGRAPH ARRAY

NOTES: (1) SEPARATE CRITERIA FOR EXPLOSIVE PACKAGES
(2) GEOPHONE CABLE AND LSP ANTENNA CABLE SHOULD NOT BE DEPLOYED PARALLEL TO EACH OTHER OR TOUCH

LSP EXPLOSIVE PACKAGE INTERIM STOWAGE

- LM WILL LAND WITH SUN AT AN ANGLE BETWEEN 15^0 AND 75^0 FROM THE NORMAL TO QUAD III

NOTE

LM RIGHTHAND PALLET AND LSP TRANSPORT FRAMES CAN NOT BE EXPOSED TO DIRECT SUNLIGHT WHILE REMAINING IN QUAD III BECAUSE

- WITH THE SUN 15^0 FROM THE NORMAL, THE LSP TRANSPORT FRAMES WILL REACH A TEMPERATURE 267^0 OR GREATER. AT 75^0, THE TEMPERATURE WILL BE 121^0F OR GREATER
- IF THE RIGHTHAND PALLET WERE TO BE SHADED BY QUAD III SIDE CURTAIN, THE TEMPERATURE OF THE LSP TRANSPORT FRAMES WOULD RANGE BETWEEN 32^0F AND 21^0F BETWEEN EVA 1 AND EVA 2

- THE RIGHTHAND PALLET MUST BE REMOVED FROM QUAD III AND PLACED ON THE LUNAR SURFACE IN THE SUN, WITH LSP PACKAGES FACING THE SUN, AT LEAST 10 HOURS PRIOR TO THE LRV STOWAGE
- THE LSP TRANSPORT FRAME REMAINING FOR DEPLOYMENT DURING EVA 3 MUST REMAIN ON THE LUNAR SURFACE IN DIRECT SUNLIGHT UNTIL ITS STOWAGE ABOARD LRV

LSP THERMAL CONSTRAINTS ON LRV

- THE SAFE-ARM AND THERMAL-BATTERY TIMERS MUST BE +40^{0}F WHEN TIMERS ARE ACTIVATED.

- SINCE TIMER ACTIVATION MAY OCCUR ANY TIME DURING LRV MISSION, HIGH-EXPLOSIVE BASEPLATE TEMPERATURES MUST NEVER DROP BELOW +40^{0}F DURING AN EVA.

- BECAUSE LSP TRANPORT FRAMES ARE CONDUCTIVELY ISOLATED FROM THE TOOL PALLET, TRANSPORT FRAME EQUILIBRIUM TEMPERATURES TEND TO BE INDEPENDENT OF TOOL PALLET TEMPERATURES.

- THE LSP HIGH-EXPLOSIVE BASEPLATE INTERFACES WITH LSP TRANSPORT FRAME THROUGH STAINLESS STEEL SPRING PINS WHICH RESIST HEAT LEAK TO TRANSPORT FRAME. THIS DESIGN ALLOWS 45 MINUTES OF LRV SHADE EXPOSURE WITH NO ADDITIONAL MEANS OF HIGH-EXPLOSIVE PACKAGE ISOLATION.

- LSP TRANSPORT FRAME ASSEMBLY TEMPERATURES MUST BE BETWEEN +90^{0}F AND +185^{0}F AT THE TIME OF STOWAGE ABOARD LRV IN ORDER TO MEET THE LRV SHADE REQUIREMENT.

LSP EXPLOSIVE PACKAGE DEPLOYMENT

PREPARATION

- REMOVE EXPLOSIVE PACKAGE TRANSPORT MODULE, ON LM PALLET, FROM LM AND PLACE IN SUN PRIOR TO DEPLOYING GEOPHONES AND REMOTE ANTENNA
- USE UHT TO ROTATE ASTRO SW-2 CW TO OPERATIONAL POSITION AFTER DEPLOYING GEOPHONES

INSTALLATION ON LRV

- RELEASE PULL RING FOR TRANSPORT FRAME
- REMOVE PULL PIN SECURING TRANSPORT FRAME TO LM PALLET
- REMOVE TRANSPORT FRAME, WITH FOUR EXPLOSIVE PACKAGES, AND TRANSFER TO LRV
- ENGAGE LATCH TO SECURE FRAME ON LRV

PACKAGE EMPLACEMENT (TYPICAL)

- TRAVERSE TO EXPLOSIVE PACKAGE DEPLOYMENT SITE (LOCATIONS ARE 160 TO 3500 METERS FROM ALSEP CENTRAL STATION)
- REMOVE CAMLOCK SECURING EXPLOSIVE PACKAGE TO TRANSPORT FRAME BY ROTATING CAMLOCK CW (DISCARD CAMLOCK)
- GRASP EXPLOSIVE PACKAGE HANDLE AND LIFT FROM FRAME
- EXTEND ANTENNA, REMOVE PULL RING NO. 1 (SAFE/ARM TIMER), ROTATE AND REMOVE PULL RING NO. 2 (SAFE/ARM SLIDE), AND REMOVE PULL RING NO. 3 (BATTERY TIMER AND FIRING PIN)
- GRASP ANTENNA AND LOWER EXPLOSIVE PACKAGE TO SURFACE IN STABLE POSITION
- AVOID LARGE ROCKS OR SLOPES THAT WOULD SHADOW PACKAGE
- REPEAT FOR OTHER THREE PACKAGES ON THIS TRANSPORT FRAME AND FOR THE OTHER TRANSPORT FRAME DURING EVA 1, 2, AND 3

LSP COMMANDS

OCTAL CMD NUMBER

● 156 LSP PULSES ON

THIS CMD IS REQUIRED TO ACTIVATE THE PULSE FUNCTION OF THE 41.2-MHZ LSP XMTR WHICH TRANSMITS TIME-CODED FIRE PULSE SETS (3 PER SET) AT 29.55-SEC INTERVALS AND AGC PULSES ONCE PER LSP SUBFRAME (169.8 MILLISEC). ONE FIRE PULSE SET WILL TRIGGER DETONATION OF AN EXPLOSIVE PACKAGE PROVIDED THAT TIMER-CONTROLLED FUNCTIONS IN THE EXPLOSIVE PACKAGE ARE IN THE PROPER CONFIGURATION TO ACCEPT, ARM, AND EXECUTE THE FIRING INPUT. AGC PULSES DESENSITIZE THE EXPLOSIVE PACKAGE RECEIVER TO AMBIENT NOISE AND EMI. CMD 156 IS TO BE TRANSMITTED TO SWITCH THE LSP XMTR PULSE FUNCTION ON FROM A TIME 90 MINUTES BEFORE THE FIRST NORMAL ARM TIME THROUGH THE DETONATION OF THE LAST EXPLOSIVE PACKAGE IN EACH GROUP OF FOUR. PRESENCE OF LSP XMTR PULSE FUNCTION IS READ OUT IN THE LSP TM. REPEATED APPLICATION OF CMD 156 HAS NO FURTHER EFFECT.

● 162 LSP PULSES OFF

THIS CMD DEACTIVATES THE PULSE FUNCTION OF THE LSP XMTR IF THE FUNCTION WAS ACTIVATED BY APPLICATION OF A CMD 156. REPEATED APPLICATION OF CMD 162 HAS NO FURTHER EFFECT. WHEN THE LSP IS ACTIVATED BY APPLICATION OF OPERATIONAL POWER, THE LSP XMTR PULSE FUNCTION WILL BE IN THE DEACTIVATED MODE.

● 163 LSP GAIN NORM

THIS CMD SWITCHES THE FOUR LSP GEOPHONE AMPLIFIER CHANNELS BACK TO THE NORMAL, HIGH-GAIN MODE, IF THE AMPLIFIER HAD BEEN SWITCHED TO THE LOW GAIN MODE BY APPLICATION OF A CMD 164. THE RATIO OF NORMAL TO LOW GAIN IS NOMINALLY 10 BUT MAY VARY FROM 8 TO 12.5 (20 $\pm$ 2 DB). REPEATED APPLICATION OF CMD 163 HAS NO FURTHER EFFECT. WHEN THE LSP IS ACTIVATED BY APPLICATION OF OPERATIONAL POWER, THE LSP WILL BE IN THE GEOPHONE AMP NORMAL GAIN MODE.

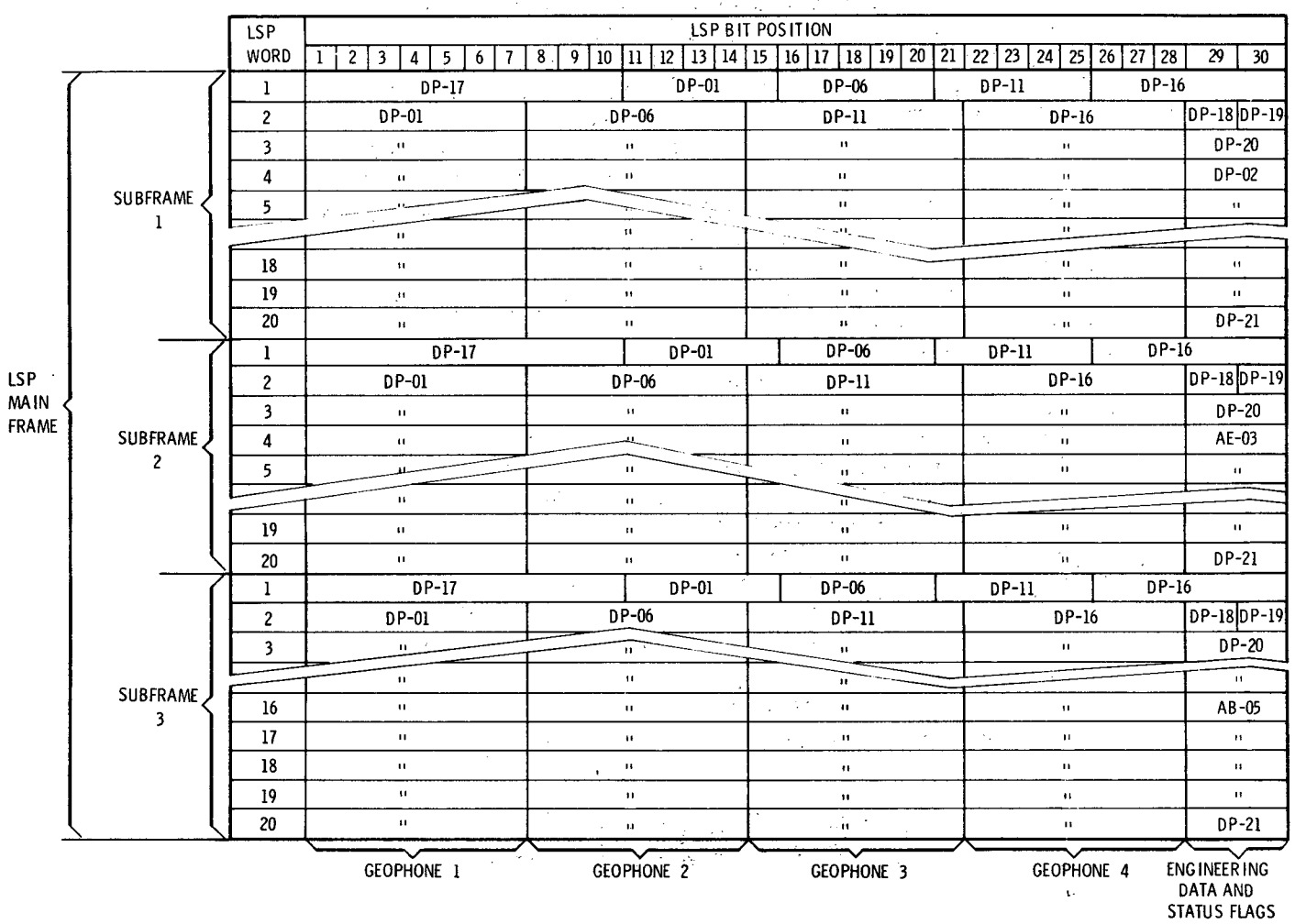
● 164 LSP GAIN LOW

THIS CMD IS REQUIRED TO SWITCH THE FOUR LSP GEOPHONE AMPLIFIER CHANNELS TO THE LOW-GAIN MODE OF OPERATION. THE RATIO OF NORMAL TO LOW GAIN IS NOMINALLY 10 BUT MAY VARY FROM 8 TO 12.5 (20 $\pm$ 2 DB). REPEATED APPLICATION OF CMD 164 HAS NO FURTHER EFFECT.

● 170 LSP GEO CAL

THIS CMD CAUSES THE SEISMIC DETECTION SYSTEM TO SWITCH TO THE CALIBRATION MODE FOR APPROXIMATELY 1.5 SEC. THIS PRODUCES A RELATIVE CALIBRATION OF ALL FOUR GEOPHONE CHANNELS FOR COMPARISON TO AN ABSOLUTE PREFLIGHT CALIBRATION, TO DETECT ANY CHANGES IN SUCH PARAMETERS AS GEOPHONE RESONANT FREQUENCY AND SYSTEM SENSITIVITY. THE CALIBRATION SIGNAL IS FIXED, SHOWING LOWER RESPONSE AT LOW GAIN. REPEATED APPLICATION OF CMD 170 CAUSES REPEATED SWITCHOVERS TO THE CALIBRATION MODE.

LSP DIGITAL DATA FORMAT



JULY 72 3270.5.37

LSP DIGITAL DATA

- IDENTICAL FORMATS (1800 BITS-PER-MAIN-FRAME) IN EITHER OF TWO DATA RATES:

  3533.3-BPS (NORMAL) OR 1060-BPS (LOW); 1060 IS NOT THROUGHPUT BY MSFN TO HOUSTON

- EACH SUBFRAME (600 BITS) CONTAINS THE FOLLOWING PARAMETERS:

  DP-17; FRAME SYNC, (0000111011) MODIFIED BARKER CODE IN FIRST 10 BITS
  DP-01, DP-06, DP-11, AND DP-16; GEOPHONE DATA (TRUNCATED TO 5 MOST SIGNIFICANT BITS IN LSP WORD 1 OF EACH SUBFRAME AND TO 7 MOST SIGNIFICANT BITS IN WORDS 2 THROUGH 20)
  DP-18; GEOPHONE CALIBRATION PULSE ON/OFF (IN BIT 59 OF EACH SUBFRAME)
  DP-19; GEOPHONE AMPLIFIER GAIN NORMAL/LOW (IN BIT 60 OF EACH SUBFRAME)
  DP-20; RF FIRE PULSE STATUS (11 IN BITS 89 AND 90 OF THE FIRST SUBFRAME IF FIRE PULSES ARE BEING TRANSMITTED, 00 IF NOT, AND ALWAYS 00 IN SUBFRAMES 2 AND 3)
  NOTE: FIRE PULSES, AND THEIR TM, OCCUR ONCE IN EACH 58 MAIN FRAMES (174 SUBFRAMES)
  DP-21; SUBFRAME IDENTIFICATION (BITS 599 AND 600 OF EACH SUBFRAME; CODED 11 FOR SUBFRAME 1, 01 FOR SUBFRAME 2, AND 10 FOR SUBFRAME 3)

- EACH MAIN FRAME (1800 BITS) CONTAINS THE FOLLOWING 8-BIT ENGINEERING PARAMETERS:

  DP-02; LSP 1.25-VOLT ADC CAL
  DP-03; LSP +12-VOLT OUTPUT
  AE-24; ALSEP RESERVE CURRENT
  DP-05; LSP 3.75-VOLT ADC CAL
  AE-03; ALSEP PCU 1 INPUT VOLTS
  AT-16; ALSEP THERMAL PLATE 6
  DP-10; LSP GEO CAL VOLTS
  AE-04; ALSEP PCU INPUT AMPS
  AB-04; ALSEP EXPER 1/2 STA
  DP-14; LSP ELECT TEMP
  AB-05; ALSEP EXPER 3/4 STA

  } THESE PARAMETERS, PLUS ONE SPARE CHANNEL, ARE ALLOCATED LOCATIONS IN THE LSP FORMAT IN PIECES; THAT IS, THE LAST 2 BITS OF AN LSP 30-BIT WORD FOR 4 CONSECUTIVE WORDS (MOST SIGNIFICANT BITS FIRST)

LSP ANALOG DATA

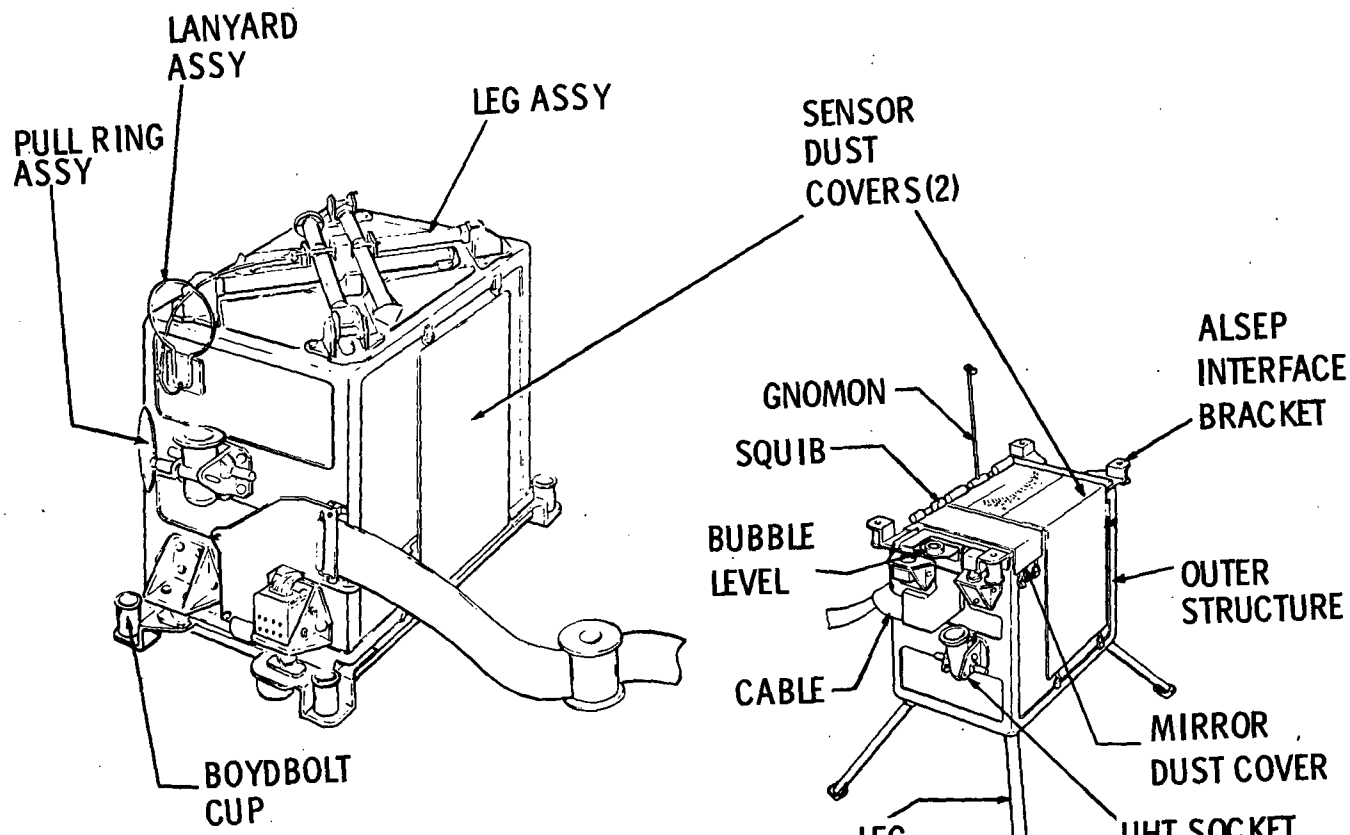
THE FOLLOWING LSP ENGINEERING PARAMETER IS READ OUT VIA THE ALSEP ADP (ALSEP WORD 33, CHANNEL 25):

AP-01; LSP ELECTRONICS TEMPERATURE

THIS PARAMETER IS AVAILABLE IN THE ALSEP DATA PROCESSOR FORMAT REGARDLESS OF WHETHER THE LSP POWER IS ON OR OFF (NO STANDBY MODE)

LUNAR EJECTA AND METEORITES (LEAM)

LEAM EQUIPMENT



JULY 72 3270.6.2

LEAM SCIENTIFIC SUMMARY

OBJECTIVES

- MEASURE LONG-TERM VARIATIONS IN COSMIC DUST INFLUX RATES ON THE LUNAR SURFACE
- DETERMINE THE DIRECTIONS, FLUX DENSITY, AND SPEED OF PARTICLES IN METEOR STREAMS
- DETERMINE THE EXTENT AND NATURE OF LUNAR EJECTA PRODUCED BY METEORITE IMPACTS ON THE MOON
- PERFORM A CONTROLLED EXPERIMENT ON THE RELIABILITY OF THE ACOUSTICAL SENSOR AS A COSMIC DUST SENSOR
- CORRELATE THE ABOVE MEASUREMENTS IN AN EFFORT TO ANSWER CURRENT QUESTIONS ON THE ORIGIN AND NATURE OF LUNAR SOIL

METHODS

- METEORITE AND EJECTA IMPACT ON FILM/GRID ASSEMBLIES CAUSES IONIZED PLASMA WHICH IS SENSED IN MAGNITUDE AND LOCATION
- DETERMINE VELOCITY FROM TIMING BETWEEN FRONT AND REAR FILM/GRID RESPONSES
- PARTICLE MOMENTUM INDICATED BY RESPONSE OF PIEZOELECTRIC ELEMENT

LEAM OPERATIONS SUMMARY

DEPLOYMENT

- CONNECT CABLE TO CENTRAL STATION (ASTROMATE CONNECTOR) AND REMOVE INSTRUMENT FROM SUBPALLET
- LOCATE 25 FT SOUTHEAST OF CENTRAL STATION
- RELEASE LEAM LEGS AND GNOMON
- PLACE INSTRUMENT ON SURFACE, LEVEL WITHIN $\pm 5^0$, AND ALIGN GNOMON SHADOW WITHIN $\pm 5^0$ OF ALIGNMENT INDEX ON SUN DIAL

POST - DEPLOYMENT

- TURN ON, BY COMMAND, FOR INITIAL CHECKOUT
- REMOVE DUST COVER FROM THERMAL CONTROL MIRROR BY COMMAND AFTER LM ASCENT
- REMOVE SENSOR COVERS BY COMMAND AFTER DETONATION OF LSP EXPLOSIVE PACKAGES AND AT LEAST TWO DAYS OF BACKGROUND DATA
- OTHER OPERATIONAL COMMANDS (INCLUDING CALIBRATION) AS REQUIRED

LEAM COMMUNICATIONS SUMMARY

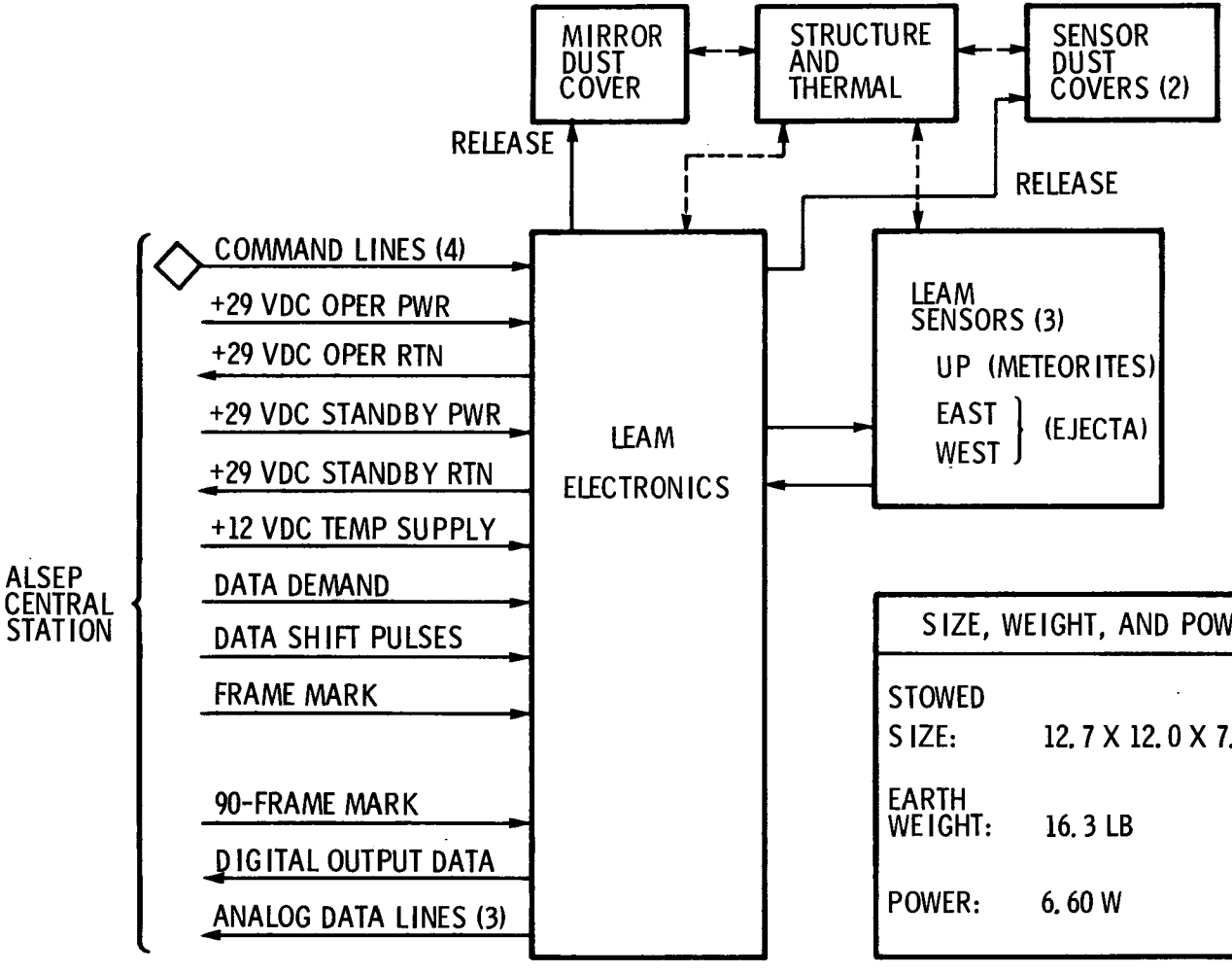
COMMANDS

- POWER OPERATIONAL, STANDBY, AND OFF
- FOUR INDIVIDUAL COMMAND LINES FOR
  - DUST COVERS (2)
  - HEATER CONTROL
  - CALIBRATION

DATA

- TWO 10-BIT SCIENCE DATA WORDS IN EACH ALSEP DATA FRAME (TEN WORDS, IN FIVE FRAMES, MAKE UP ONE COMPLETE LEAM READOUT)
- THREE ANALOG LINES, PROCESSED IN THE ALSEP ADP (ALSEP WORD 33), ARE MULTIPLEXED TO PROVIDE READOUT OF 11 LEAM ENGINEERING PARAMETERS
  - EACH LINE IS SAMPLED ONCE EVERY 90 ALSEP DATA FRAMES (ONCE EVERY 54 SECONDS AT NORMAL DATA RATE)
  - TWO OF THE LINES ARE MULTIPLEXED FOR FIVE PARAMETERS EACH; HENCE, EACH PARAMETER IS SAMPLED ONCE EVERY 450 FRAMES
  - THE THIRD LINE IS LEAM TEMPERATURE, WHICH OPERATES REGARDLESS OF THE EXPERIMENT STATUS (ON, STANDBY, OR OFF)

LEAM PHYSICAL PARAMETERS



SIZE, WEIGHT, AND POWER	
STOWED SIZE:	12.7 X 12.0 X 7.8 IN.
EARTH WEIGHT:	16.3 LB
POWER:	6.60 W

JULY 72 3270.6.6

LEAM SENSOR CHARACTERISTICS

- DUAL SENSORS (EAST AND UP) HAVE TWO FILM/GRID ASSEMBLIES
- SINGLE SENSOR (WEST) HAS ONE FILM/GRID ASSEMBLY
- EACH FILM/GRID ASSEMBLY HAS COLLECTOR AND SUPPRESSOR GRIDS
- EACH SENSOR HAS AN IMPACT PLATE WITH MICROPHONE (ISOLATED MICROPHONE BEHIND SINGLE WEST SENSOR TO REGISTER NOISE EFFECTS)
- MEASUREMENT PARAMETERS

  PARTICLE VELOCITY RANGE: 1 TO 75 KM-PER-SECOND

  PARTICLE ENERGY RANGE: 1 TO 1000 ERGS

  PARTICLE MOMENTUM RANGE: 2.5×10^{-5} TO 7×10^{-4} DYNE-SECOND

  FREQUENCY OF MEASUREMENT

  - PRIMARY PARTICLE: 10^{-4} IMPACTS/SQUARE-METER/SECOND
  - EJECTA: 10^{-1} IMPACTS/SQUARE-METER/SECOND

  ANGULAR RESOLUTION OF RADIANT: $\pm 26^{0}$ (FUNCTION OF GRID/FILM DESIGN)
  SENSOR FIELD OF VIEW: $\pm 60^{0}$

- GRID/FILM MATERIALS

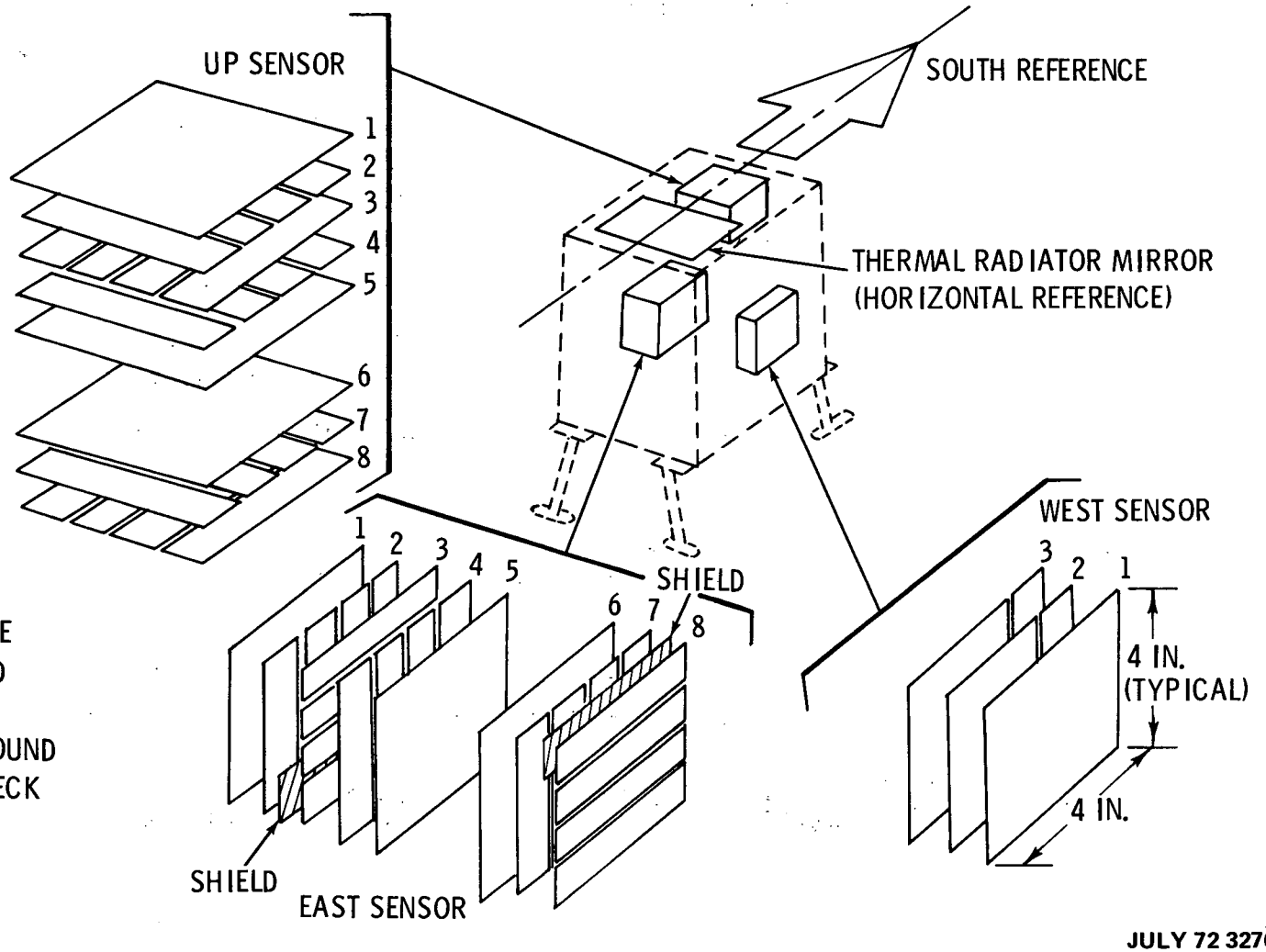
  GRID: BERYLLIUM COPPER, 97% TRANSPARENT, 0.006-INCH THICKNESS

  FILM SUBSTRATE: PARALENE C, 2800- TO 3300-ANGSTROM UNITS THICKNESS

  FILM DEPOSITION: ALUMINUM, 650- TO 750- ANGSTROM UNITS THICKNESS

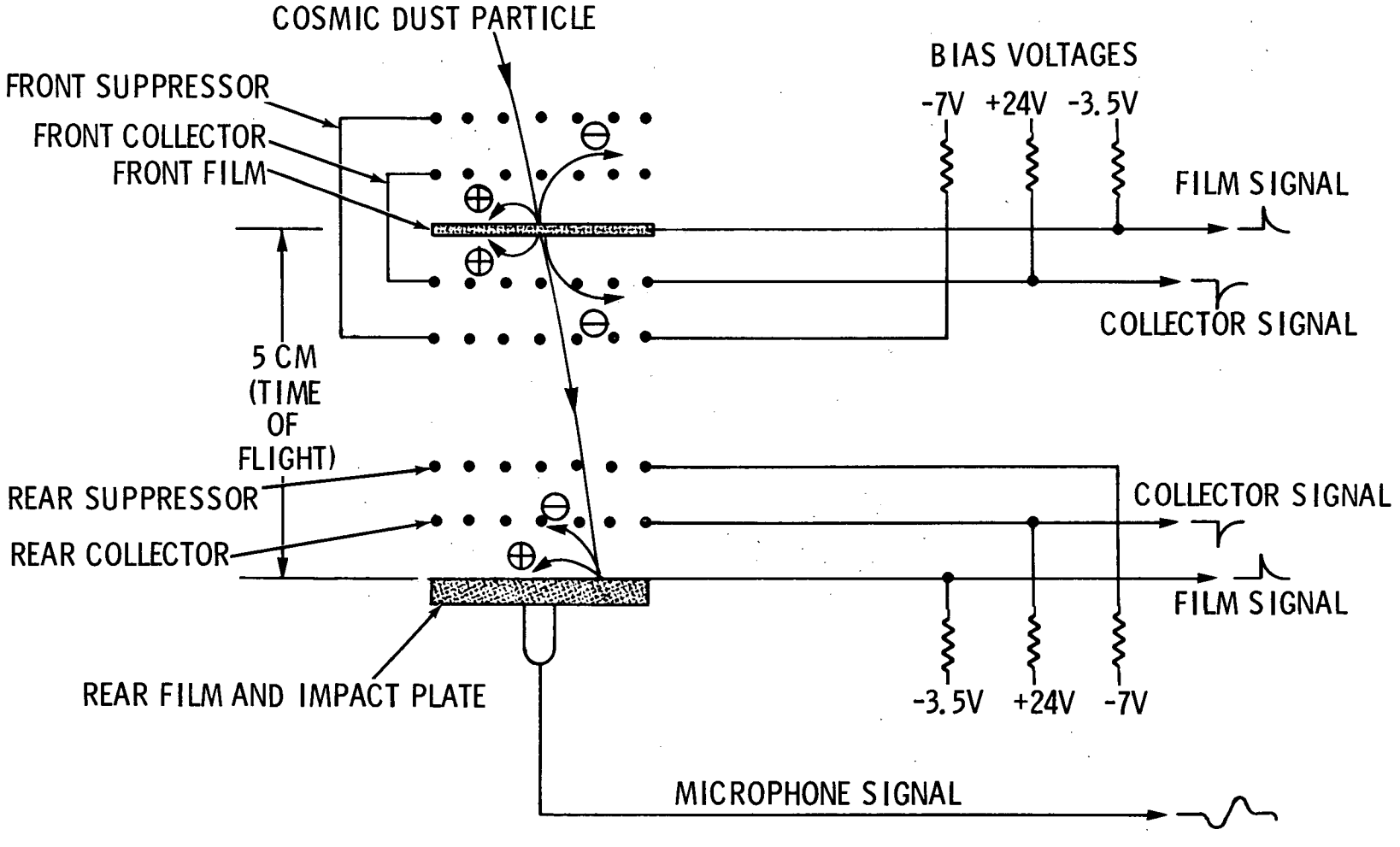
  FILM OUTER LAYER: SILICON OXIDE, 3000-TO 3500-ANGSTROM UNITS THICKNESS

LEAM SENSOR GEOMETRY



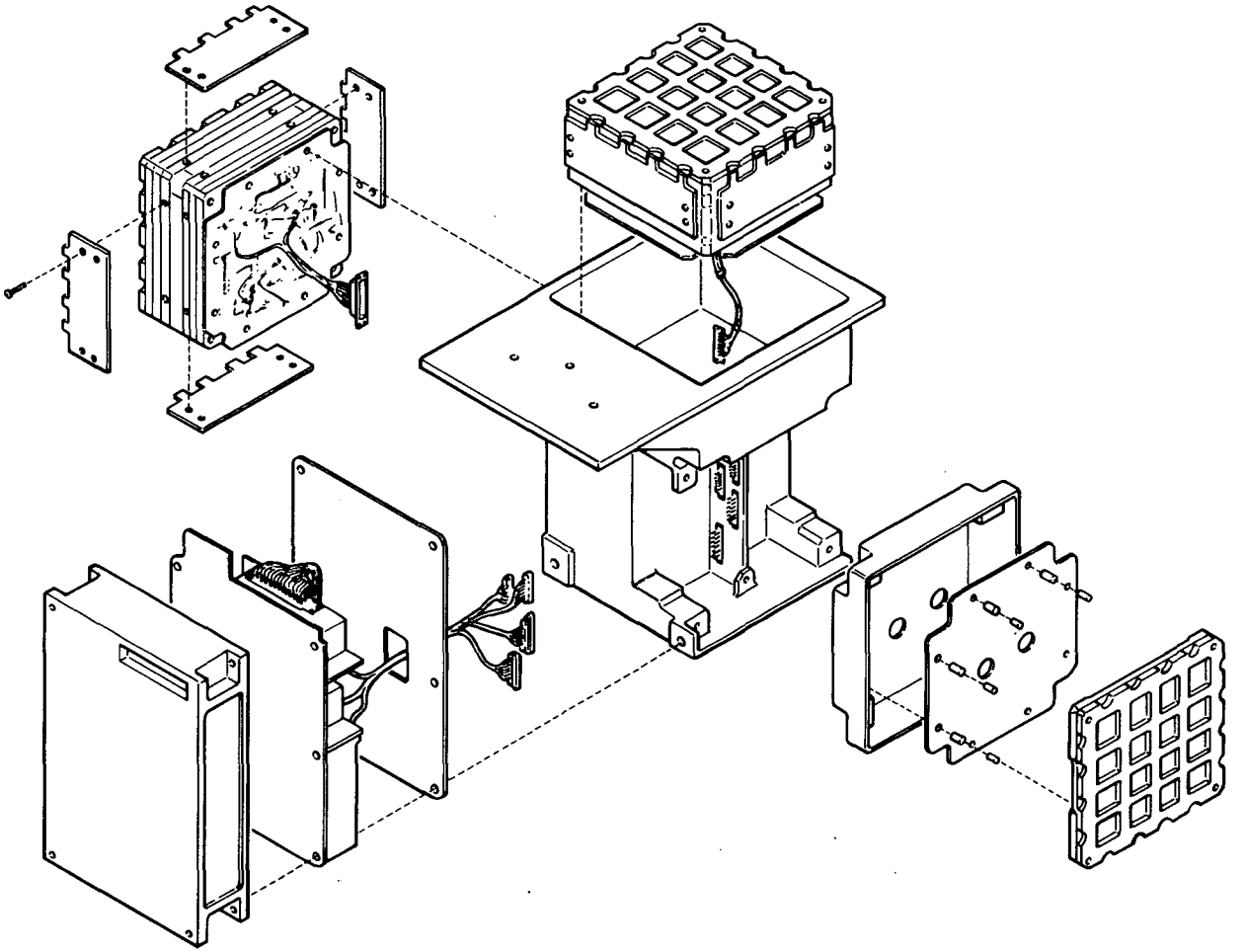
JULY 72 3270.6.8

LEAM DUAL SENSOR FUNCTION



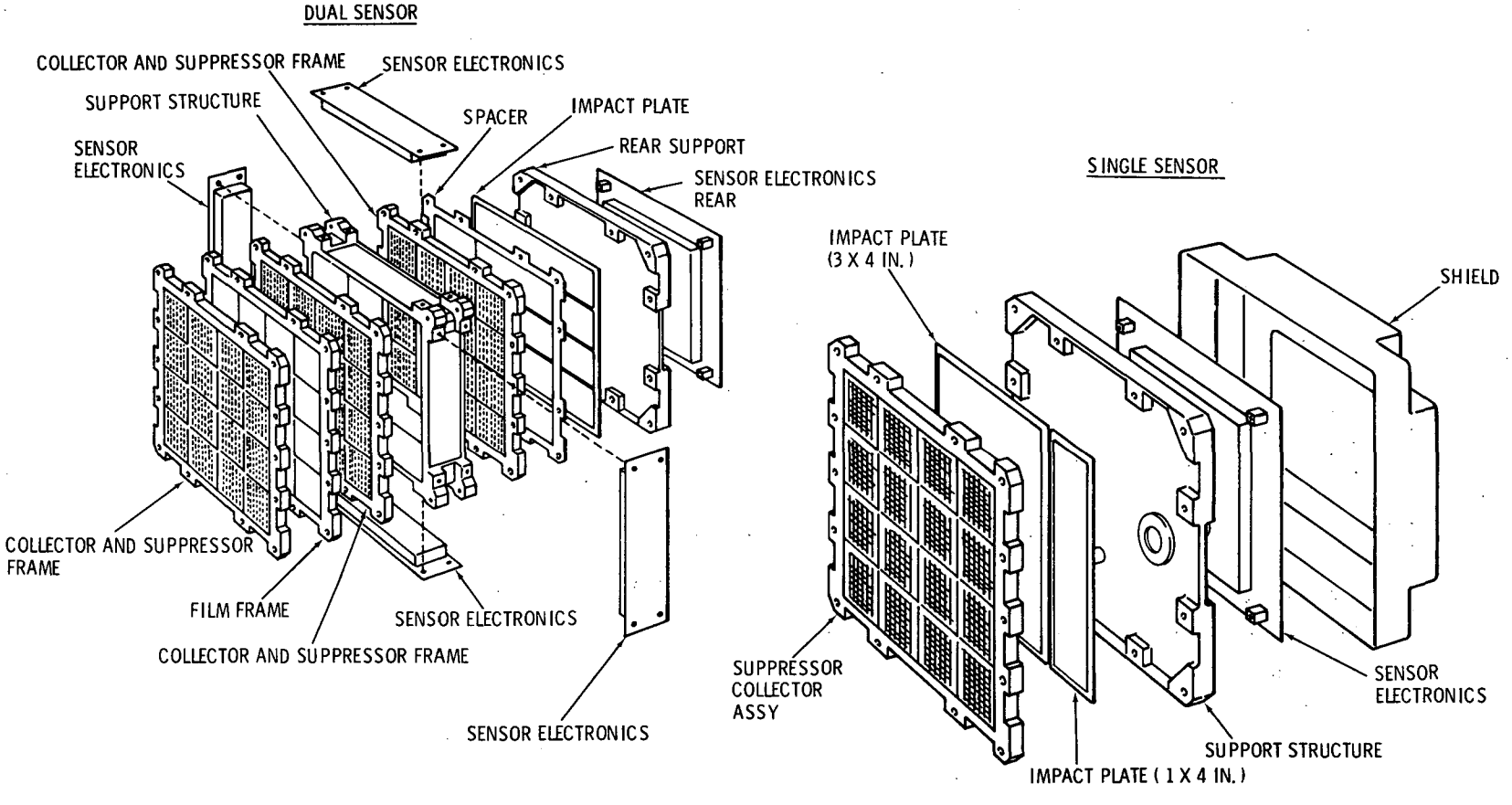
JULY 72 3270.6.9

LEAM INSTRUMENT CONSTRUCTION



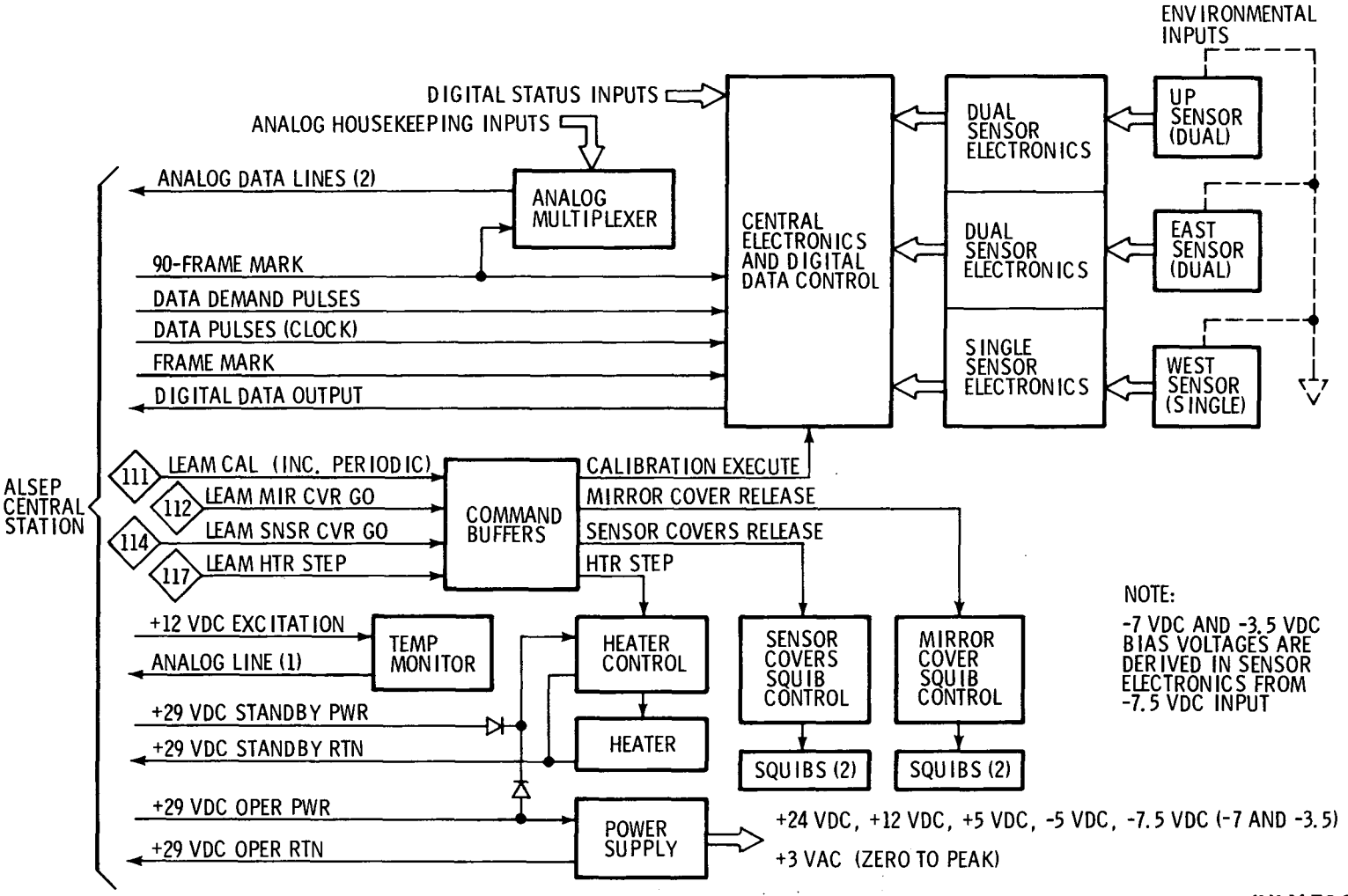
JULY 72 3270.6.10

LEAM SENSOR EXPLODED VIEWS



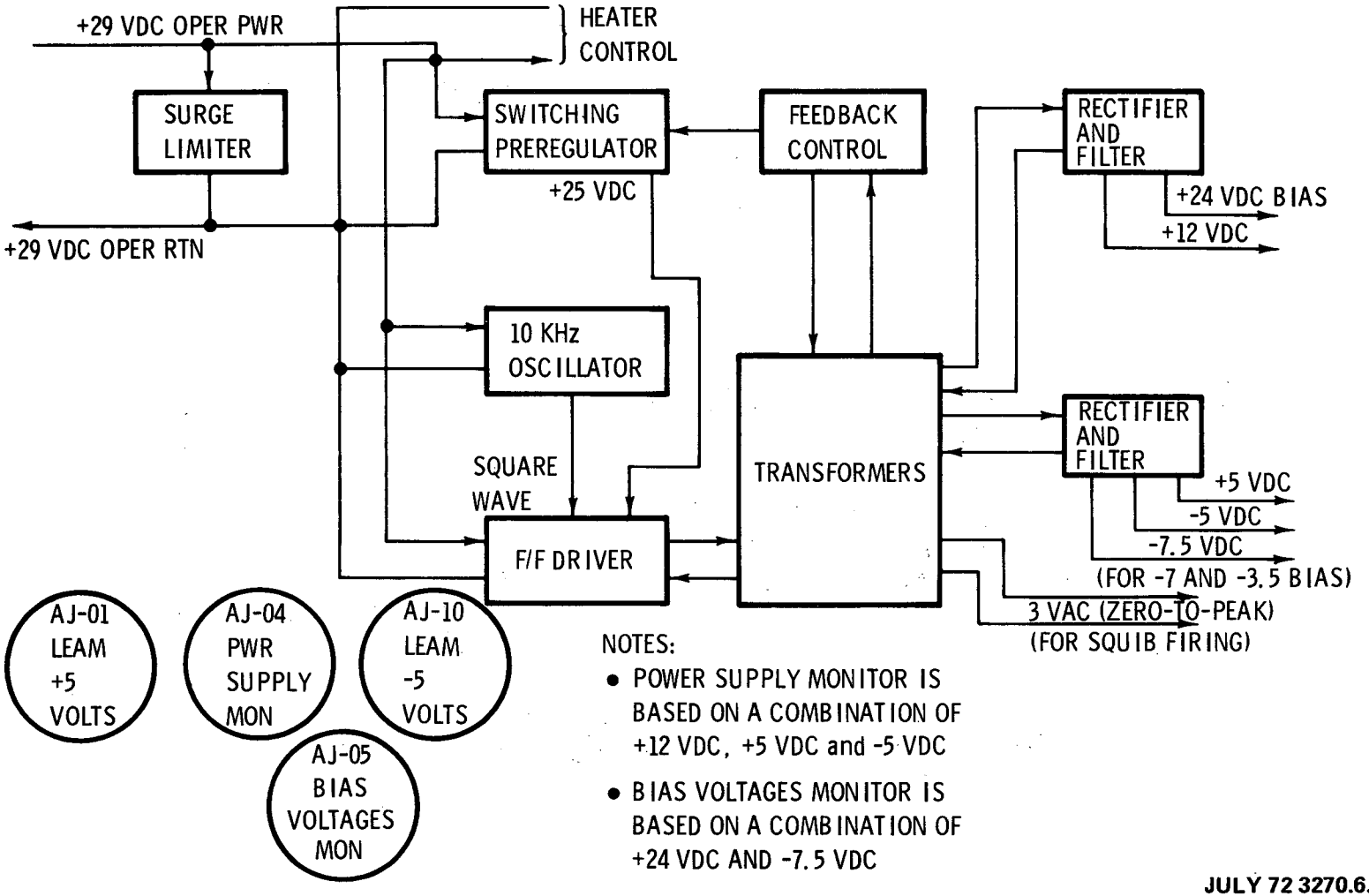
JULY 72 3270.6.11

LEAM ELECTRONICS FUNCTIONS



JULY 72 3270.6.12

LEAM POWER SUPPLY

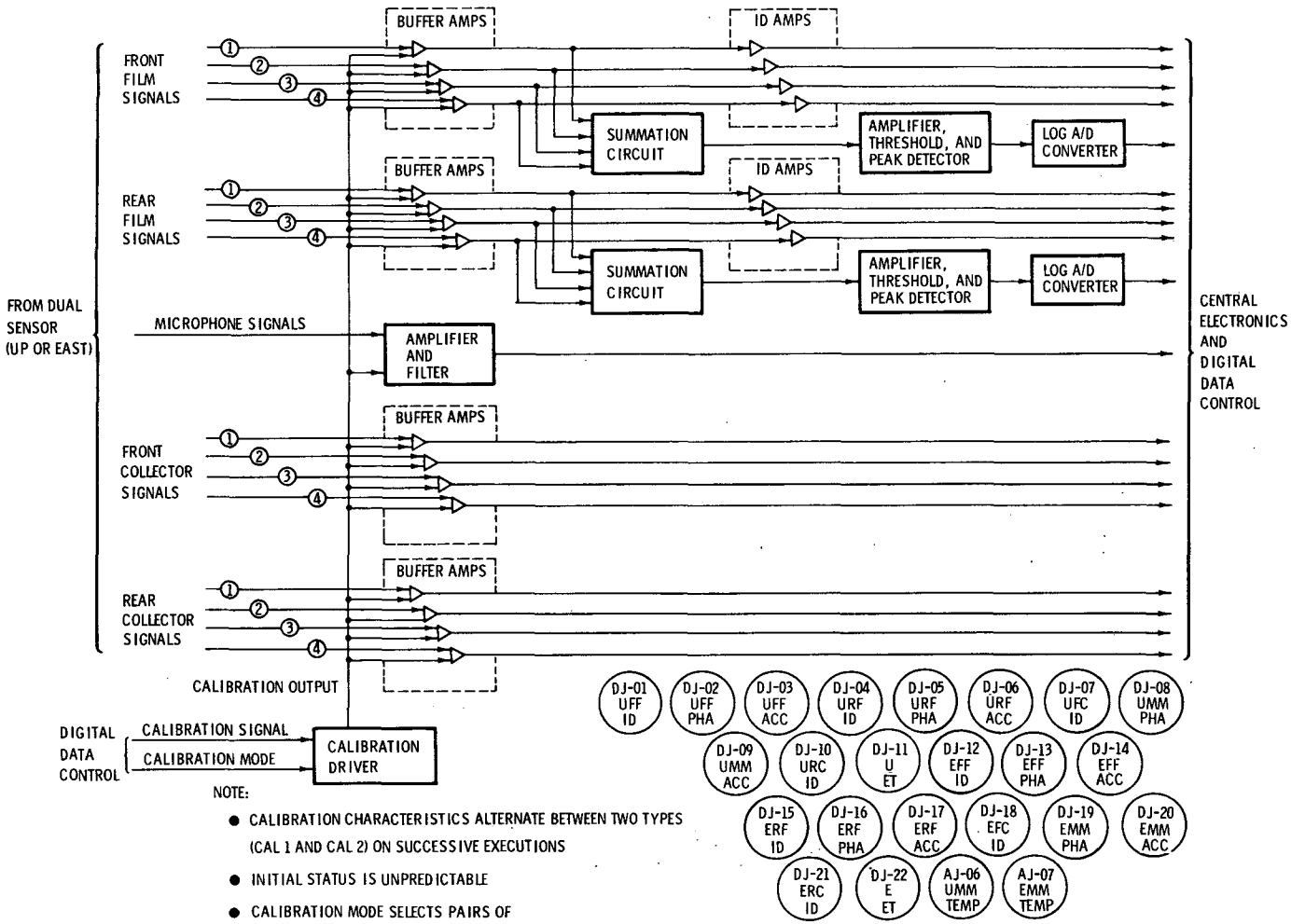


NOTES:

- POWER SUPPLY MONITOR IS BASED ON A COMBINATION OF +12 VDC, +5 VDC and -5 VDC
- BIAS VOLTAGES MONITOR IS BASED ON A COMBINATION OF +24 VDC AND -7.5 VDC

JULY 72 3270.6.13

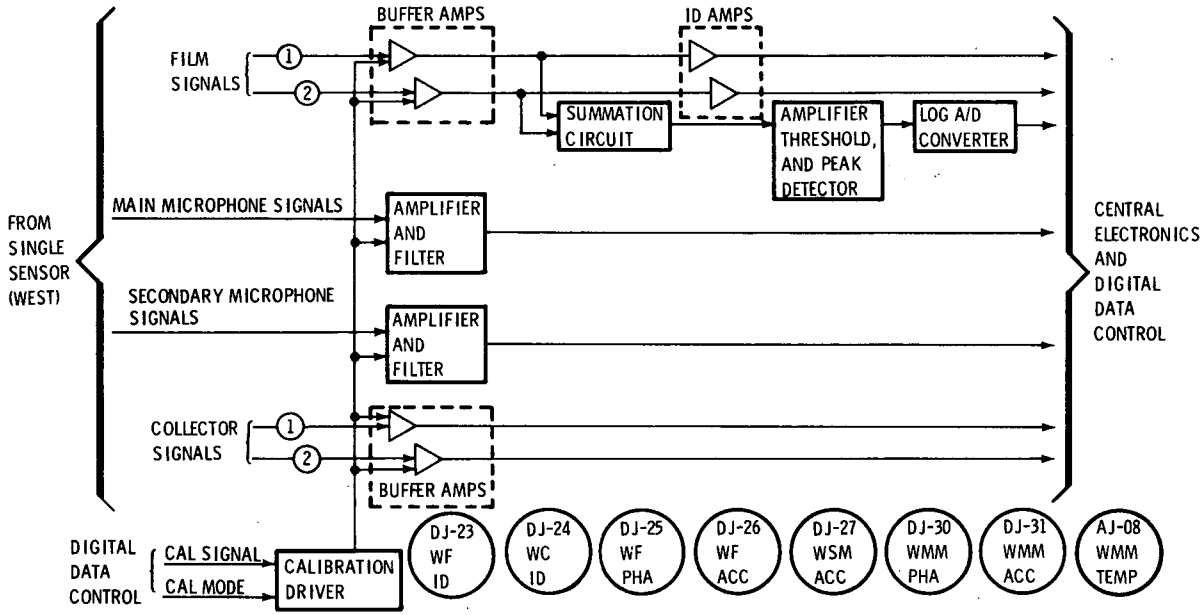
LEAM DUAL SENSOR ELECTRONICS



NOTE:

- CALIBRATION CHARACTERISTICS ALTERNATE BETWEEN TWO TYPES (CAL 1 AND CAL 2) ON SUCCESSIVE EXECUTIONS
- INITIAL STATUS IS UNPREDICTABLE
- CALIBRATION MODE SELECTS PAIRS OF FILM STRIPS (1-2 AND 3-4) ON SUCCESSIVE EXECUTIONS

LEAM SINGLE SENSOR ELECTRONICS



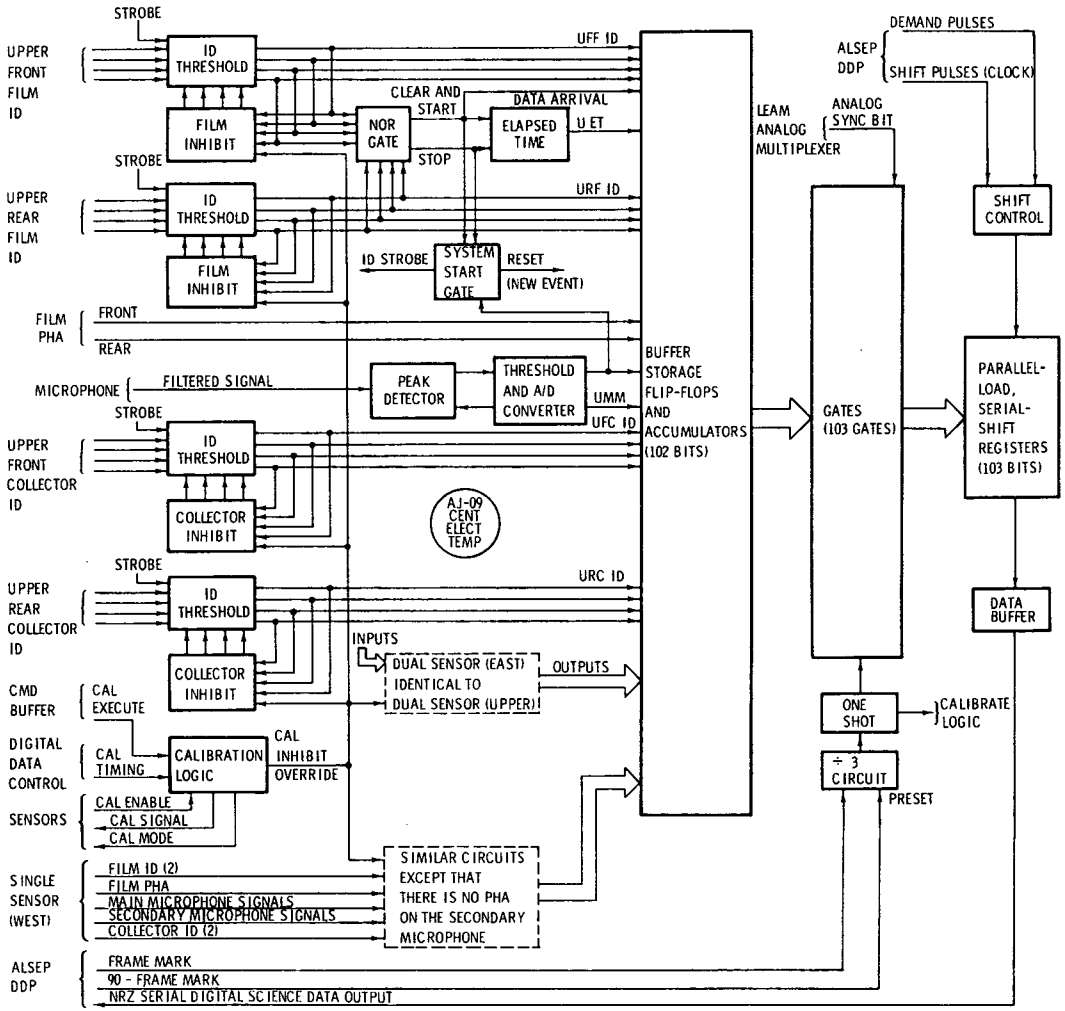
CODE:

UFF - UPPER FRONT FILM
URF - UPPER REAR FILM
UFC - UPPER FRONT COLLECTOR
UMM - UPPER MAIN MICROPHONE
URC - UPPER REAR COLLECTOR
U - UPPER SENSOR
EFF - EAST FRONT FILM
ERF - EAST REAR FILM
EFC - EAST FRONT COLLECTOR
EMM - EAST MAIN MICROPHONE
ERC - EAST REAR COLLECTOR
E - EAST SENSOR

WF - WEST FILM
WC - WEST COLLECTOR
WSM - WEST SECONDARY MICROPHONE
WMM - WEST MAIN MICROPHONE
ID - IDENTIFICATION
PHA - PULSE HIEGHT ANALYSIS
ACC - ACCUMULATOR
ET - ELAPSED TIME
TEMP - TEMPERATURE

LEAM DIGITAL DATA CONTROL

(INCLUDING SENSOR CENTRAL ELECTRONICS)

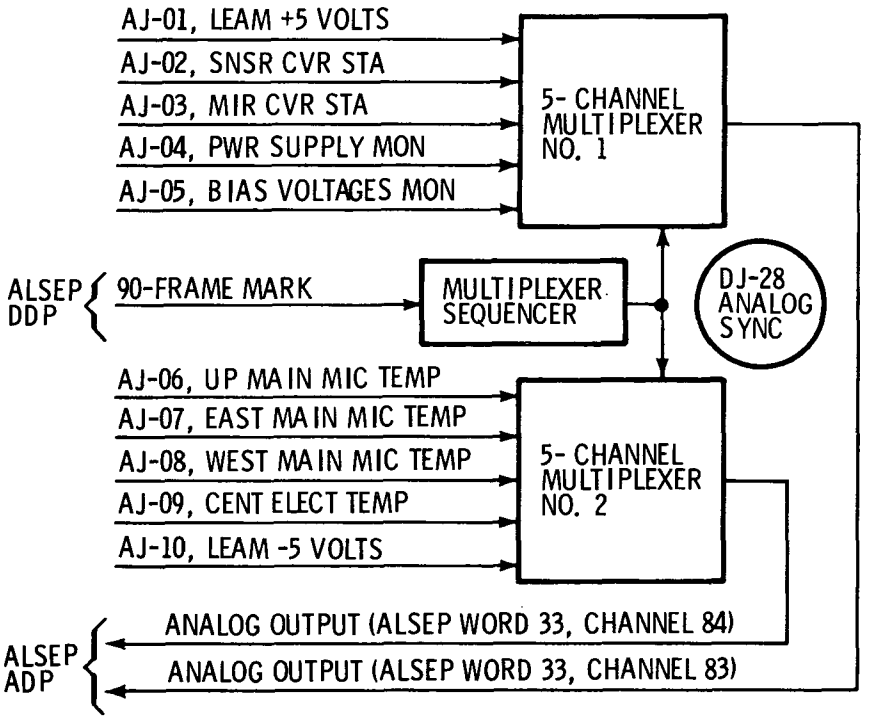


JULY 72 3270.6.16

LEAM DIGITAL DATA OPERATION

- SENSOR ELECTRONICS INTERFACE WITH EACH OF THE SENSOR ELEMENTS THROUGH CHANNELS OF DEDICATED CIRCUITRY (ALLOWS ANY COMBINATION OF EVENTS TO OCCUR WITHOUT MUTUAL INTERFERENCE)
- INTERNAL CROSS-CHECKS ENSURE THE VALIDITY OF AN EVENT BEFORE FINAL PROCESSING
- DATA INHIBITING IS USED TO ENSURE THAT AN EVENT IS PROCESSED WITHOUT ENSUING EVENTS ALTERING OR ERASING THE DATA
- THE PROCESSING OPERATION STARTS ON EITHER A FILM OR A MAIN MICROPHONE EVENT (ABOVE ZERO THRESHOLD); THUS, A COLLECTOR EVENT WITHOUT A FILM EVENT IS NOT RECORDED
- FILM EVENTS, IF VALID, WILL USUALLY PRODUCE CONFIRMING COLLECTOR EVENTS AND, IF LARGE ENOUGH, REAR FILM AND COLLECTOR EVENTS (FOR DUAL SENSORS), PLUS MICROPHONE EVENTS; IF THERE IS NO COLLECTOR EVENT, THE PI WILL SUBTRACT IT DURING DATA ANALYSIS
- THE COMBINED FILM AND COLLECTOR ID'S INDICATE THE AREA OF IMPACT, WHILE FRONT AND REAR DATA GIVE THE ANGLE OF IMPACT; THE ELAPSED TIME IS TRANSLATED INTO PARTICLE VELOCITY
- FILM PULSES RESULTING FROM A FRONT FILM EVENT ARE SUMMED AND THE SUM IS PEAK-DETECTED FOR ENCODING ON A LOGARITHMIC SCALE; THE SAME IS TRUE FOR REAR FILM EVENTS
- MAIN MICROPHONE OUTPUTS ARE APPLIED TO NARROW BANDPASS FILTERS BECAUSE THE CRYSTAL MICROPHONES PRODUCE A 100-KHZ SINE WAVE IN THEIR PRIMARY MODE; THE OUTPUTS ARE INHIBITED AFTER APPROXIMATELY 75 MICROSECONDS (FOR A PERIOD OF 30 MILLISECONDS) TO AVOID RECORDING REFLECTED WAVE MOTION IN THE QUARTZ PLATE
- FILM AND COLLECTOR ID CIRCUITS INCLUDE AN INHIBIT FUNCTION TO SUPPRESS CROSS-TALK SIGNALS; THIS INHIBIT IS BYPASSED DURING CALIBRATION
- THE SECONDARY (NOISE) MICROPHONE ON THE WEST SENSOR IS MECHANICALLY ISOLATED AND PROVIDES A CHECK AGAINST FALSE EVENTS
- DATA READOUT TO THE ALSEP DDP, ON DEMAND, CONSISTS OF TEN 10-BIT WORDS (TWO WORDS PER ALSEP FRAME) SYNCHRONIZED TO START AT AN ALSEP 90-FRAME MARK; HENCE, 18 COMPLETE SETS OF LEAM DIGITAL DATA IN 90 ALSEP FRAMES
- WHEN DATA FROM ONE SENSOR ARE BEING READ OUT (4 ALSEP WORDS IN TWO ALSEP FRAMES FOR A DUAL SENSOR), A TRANSFER INHIBIT CAUSES DATA FROM A NEW EVENT TO BE HELD IN THE BUFFER STORAGE; IT IS TRANSFERRED TO THE OUTPUT REGISTER WHEN THE EXISTING DATA HAVE BEEN READ OUT ONCE
- IF THERE ARE NO NEW EVENTS, SUCCESSIVE SETS OF LEAM DATA ARE IDENTICAL (REGISTER DOES NOT CLEAR ON READOUT)
- INITIAL READINGS ARE RANDOM (MEANINGLESS) AND WILL BE REPEATED UNTIL THERE IS A VALID HIT OR A CALIBRATION

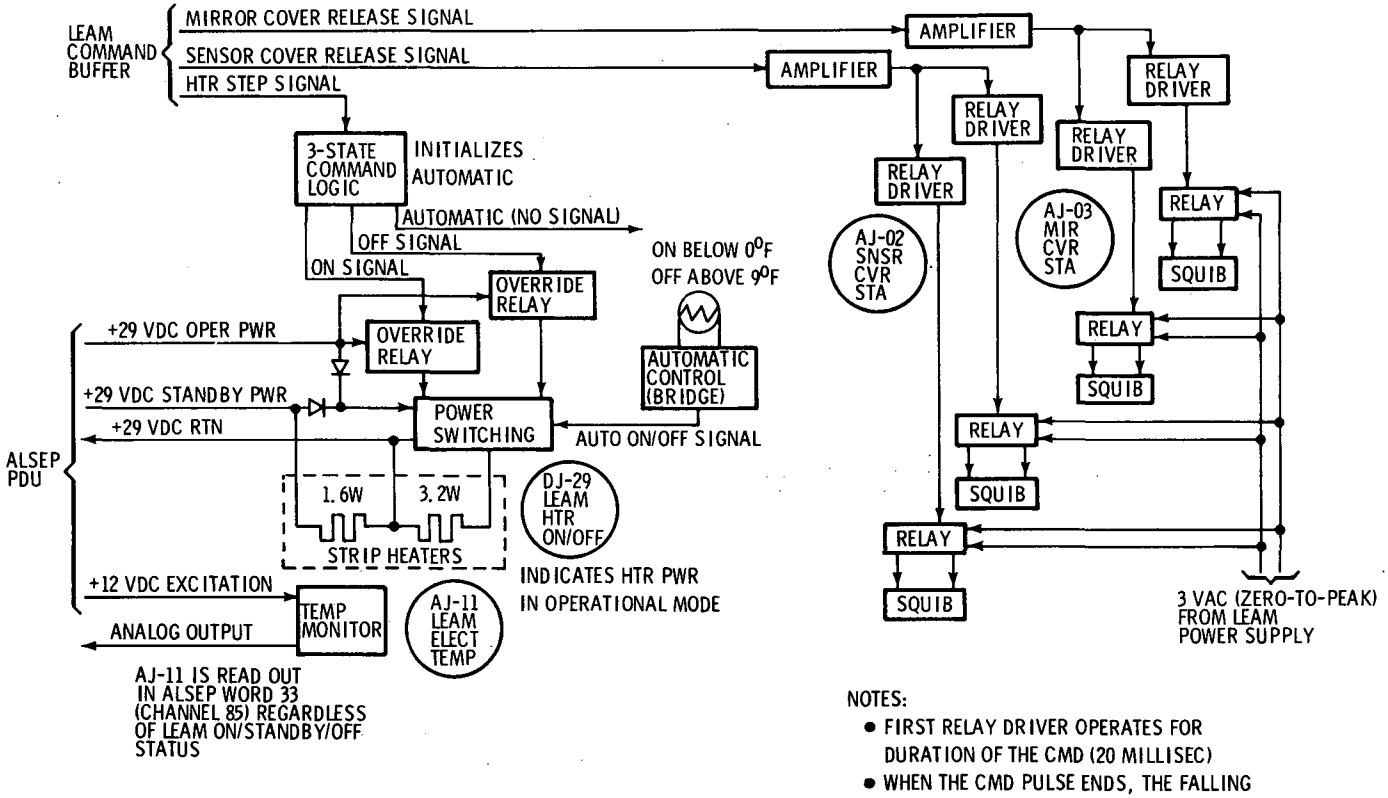
LEAM ANALOG DATA MULTIPLEXER



NOTES:

- DJ-28 INDICATES A LOGICAL ONE IN THE LEAM DIGITAL DATA DURING THE 90 ALSEP FRAMES WHEN AJ-01 AND AJ-06 ARE INPUT TO THE ALSEP ADP; DURING THE INTERVENING 360 ALSEP FRAMES, IT INDICATES A LOGICAL ZERO (DIGITAL ENCODING PRODUCES THE LOGICAL ONE 18 TIMES IN 90 SUCCESSIVE ALSEP FRAMES)
- MULTIPLEXER INITIALIZES TO ANY ONE OF THE FIVE STEPS BUT BOTH 1 AND 2 WILL BE AT THE SAME STEP
- EACH LEAM PARAMETER APPEARS IN THE ALSEP DOWNLINK DATA ONCE EVERY 450 ALSEP FRAMES (EVERY 4.5 MINUTES AT NORMAL DATA RATE)

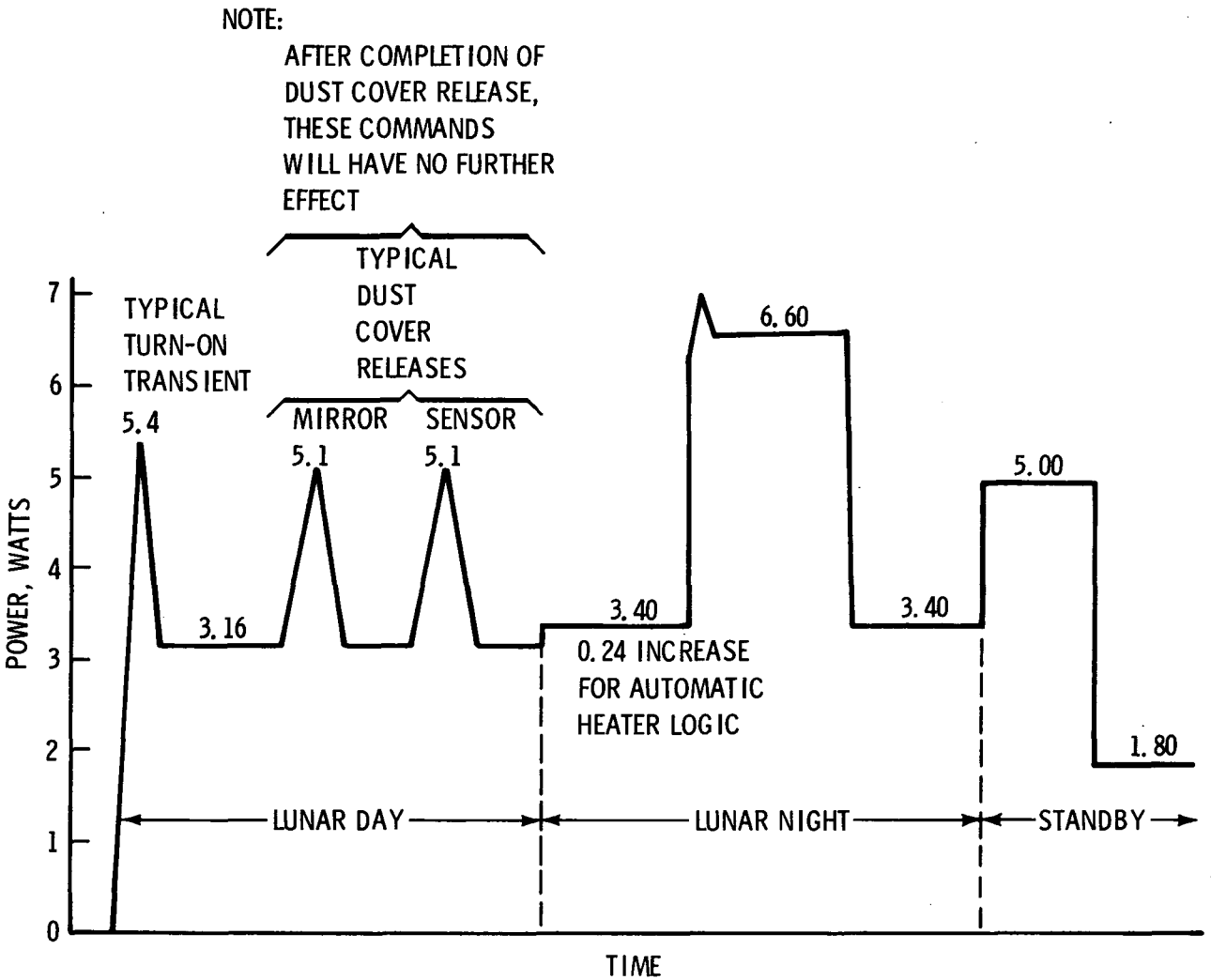
LEAM SQUIB AND TEMPERATURE CONTROL



NOTES:

- FIRST RELAY DRIVER OPERATES FOR DURATION OF THE CMD (20 MILLISEC)
- WHEN THE CMD PULSE ENDS, THE FALLING EDGE TRIGGERS THE SECOND RELAY WHICH IS HELD ON FOR APPROXIMATELY 35 MILLISEC BY A CAPACITOR DISCHARGE CIRCUIT
- FIRING OF EITHER SQUIB RELEASES COVER
- TM MONITORS INTEGRITY OF EACH SQUIB PAIR BY +5 VDC VIA THE SQUIBS
- ONCE FIRED, TM GOES TO ZERO AND RELAY POWER IS INHIBITED

LEAM POWER PROFILE



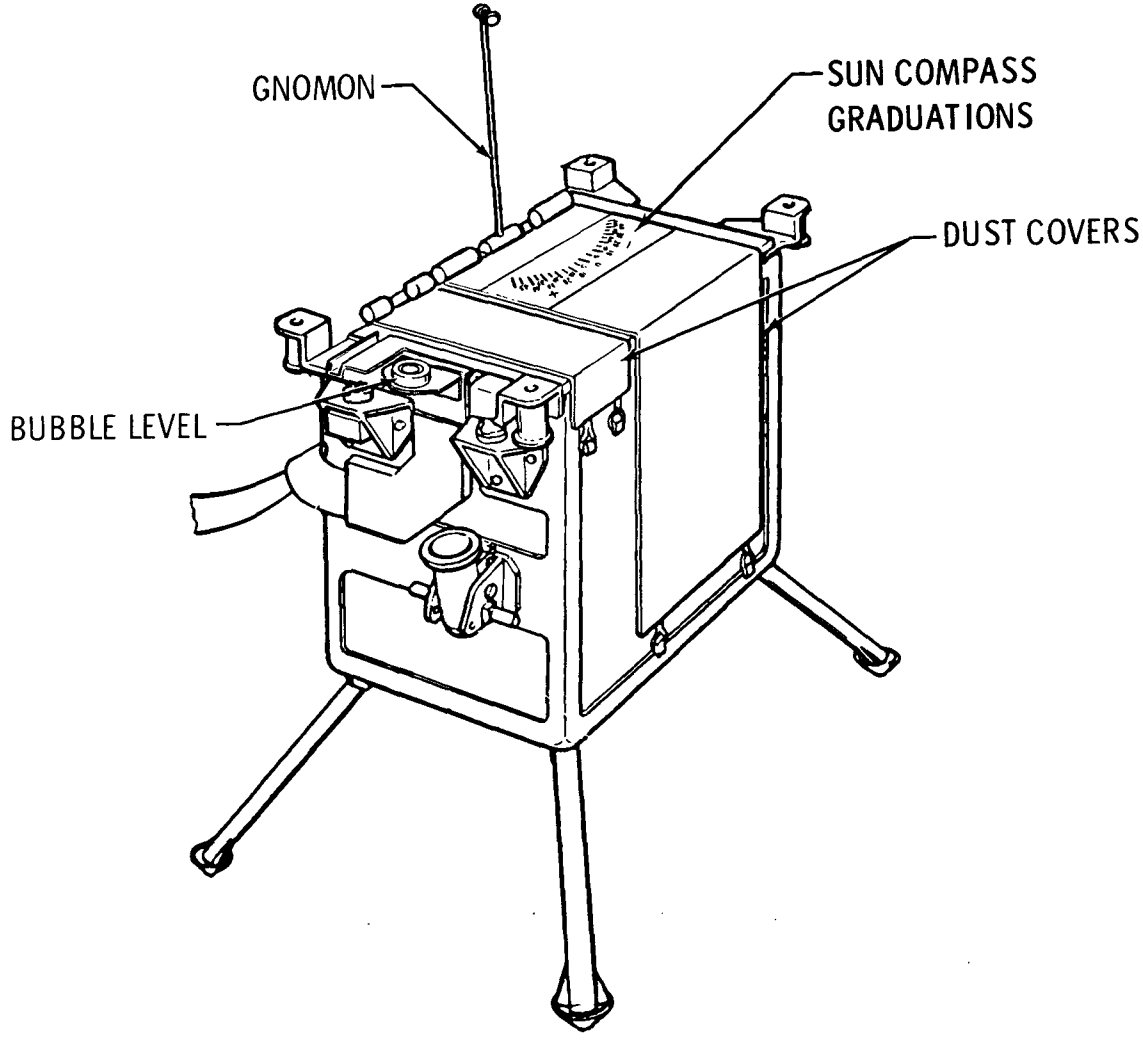
JULY 72 3270.6.20

LEAM EMPLACEMENT CRITERIA

LEAM EMPLACEMENT CRITERIA

PARAMETER	REQUIREMENT	PRIORITY	INDICATOR	COMMENTS
LOCATION	25 ±5 FT SOUTHEAST OF CENTRAL STATION ON A MOUND (LEVEL AREA ON TOP)		PACING, CABLE LENGTH, AND VISUAL	30-FT CABLE; AVOID CRATERS, SLOPES, AND ROCKY SURFACES (PACK SURFACE WITH BOOT).
LEVEL, WRT INDICATOR	WITHIN $\pm 5^0$		BUBBLE LEVEL	LEGS MAY PENETRATE SURFACE TO DIFFERENT DEPTHS TO ACHIEVE LEVELING
ALIGN, WRT INDICATOR	WITHIN $\pm 5^0$ OF PRESCRIBED SETTING		GNOMON AND SUN COMPASS GRADUATIONS	REPORT FINAL INDICATION AND TAKE PHOTOGRAPHS
NOTE: LEVEL IS WITHIN $\pm 5^0$ WHEN BUBBLE IS FREE FROM OUTER CASE EDGE.				

LEAM LEVEL AND ALIGNMENT FEATURES



JULY 72 3270.6.22

LEAM DEPLOYMENT OPERATIONS

SUBPACKAGE 2 IN VERTICAL POSITION

- RELEASE AND REMOVE SUBPALLET PULL PIN

SUBPACKAGE 2 IN HORIZONTAL POSITION

- RELEASE 2 BOYDBOLTS TO FREE THE LEAM SUBPALLET FROM SUBPACKAGE 2
- ENGAGE UHT IN SUBPALLET CARRY SOCKET REMOVE SUBPALLET FROM SUBPACKAGE, AND RELOCATE 10 FT SOUTHEAST OF CENTRAL STATION
- RELEASE ASTROMATE CONNECTOR PULL RING AND REMOVE PULL PIN TO FREE THE CONNECTOR FROM THE SUBPALLET
- WHILE SUPPORTING SUBPALLET ON UHT, REMOVE ASTROMATE CONNECTOR
- RETAIN CONNECTOR, AND MATE CONNECTOR WITH CENTRAL STATION (ENGAGE LOCK)
- RETAIN CONNECTOR, SET SUBPALLET ON SURFACE, REMOVE CONNECTOR DUST CAP (DISCARD), AND MATE CONNECTOR WITH CENTRAL STATION (ENGAGE LOCK)
- RELEASE 4 BOYDBOLTS TO FREE LEAM FROM SUBPALLET
- ENGAGE UHT IN LEAM SWIVEL SOCKET, REMOVE LEAM FROM SUBPALLET
- GRASP PULL RING ON DUST COVER BAG AND REMOVE BAG FROM LEAM
- CARRY TO FINAL LOCATION

AT FINAL LOCATION

- RELEASE SWIVEL SOCKET PULL RING, REMOVE PULL PIN, AND ROTATE LEAM UNTIL SWIVEL SOCKET LOCKS
- RELEASE LEG/GNOMON PULL RING AND PULL IN THE DIRECTION INDICATED BY STRIPE ON THE SIDE OF LEAM TO SEQUENTIALLY RELEASE LEGS AND GNOMON (DISCARD RING AND LANYARDS)
- PLACE LEAM ON SURFACE (USING UHT), LEVEL AND ALIGN, AND REMOVE UHT FROM SWIVEL SOCKET

LEAM COMMANDS

OCTAL CMD NUMBER

111 LEAM CAL

THIS IS A TWO-STATE CMD TO SELECT ALTERNATELY, UPON SUCCESSIVE TRANSMISSION, THE TWO LEAM CALIBRATION LEVELS CALLED MODE ONE AND MODE TWO*. EACH ACTIVATION OF THE CALIBRATION CIRCUITS PRODUCES A SINGLE INPUT PULSE TO THE LEAM SENSOR BUFFER AMPLIFIERS TO CALIBRATE THE OVERALL SENSOR ELECTRONICS AND DATA STORAGE SYSTEM. THE RESPONSE OF LEAM TO CMD 111 IS DELAYED UNTIL PREVIOUSLY RECORDED DATA HAS BEEN TRANSMITTED TO ALSEP.

MODE ONE PROVIDES SIGNAL PULSES TO EACH:
-FRONT FILM AMPLIFIERS 3 AND 4 (4)
-MAIN MICROPHONE AMPLIFIERS (3)
-SECONDARY MICROPHONE AMPLIFIER (1)
-REAR FILM AND ALL COLLECTOR AMPLIFIERS (28)**

MODE TWO PROVIDES SIGNAL PULSES TO EACH:
-FRONT FILM AMPLIFIERS 1 AND 2 (4)
-MAIN MICROPHONE AMPLIFIERS (3)
-ALL REAR FILM AMPLIFIERS (10)**

112 LEAM MIR CVR GO

THIS CMD ACTIVATES THE CIRCUITS OF A REDUNDANT FIRING MECHANISM TO RELEASE THE DUST COVER WHICH PROTECTS THE LEAM THERMAL CONTROL MIRROR. AFTER COVER RELEASE, CMD 112 HAS NO FURTHER EFFECT. REMOVAL OF THE MIRROR DUST COVER IS SCHEDULED AFTER LM ASCENT. PRIOR TO REMOVAL, THE EXTENT OF LEAM OPERATION IS CONSTRAINED BY THERMAL CONTROL LIMITATIONS.

114 LEAM SEN CVR GO

THIS CMD ACTIVATES THE CIRCUITS OF A REDUNDANT FIRING MECHANISM TO RELEASE THE DUST COVERS WHICH PROTECT THE LEAM SENSORS. AFTER COVER RELEASE, CMD 114 HAS NO FURTHER EFFECT. REMOVAL OF THE SENSOR DUST COVERS ARE SCHEDULED AFTER LM ASCENT AND AFTER DETONATION OF THE LSP EXPLOSIVE PACKAGES, AND AFTER AT LEAST TWO DAYS OF BACKGROUND DATA.

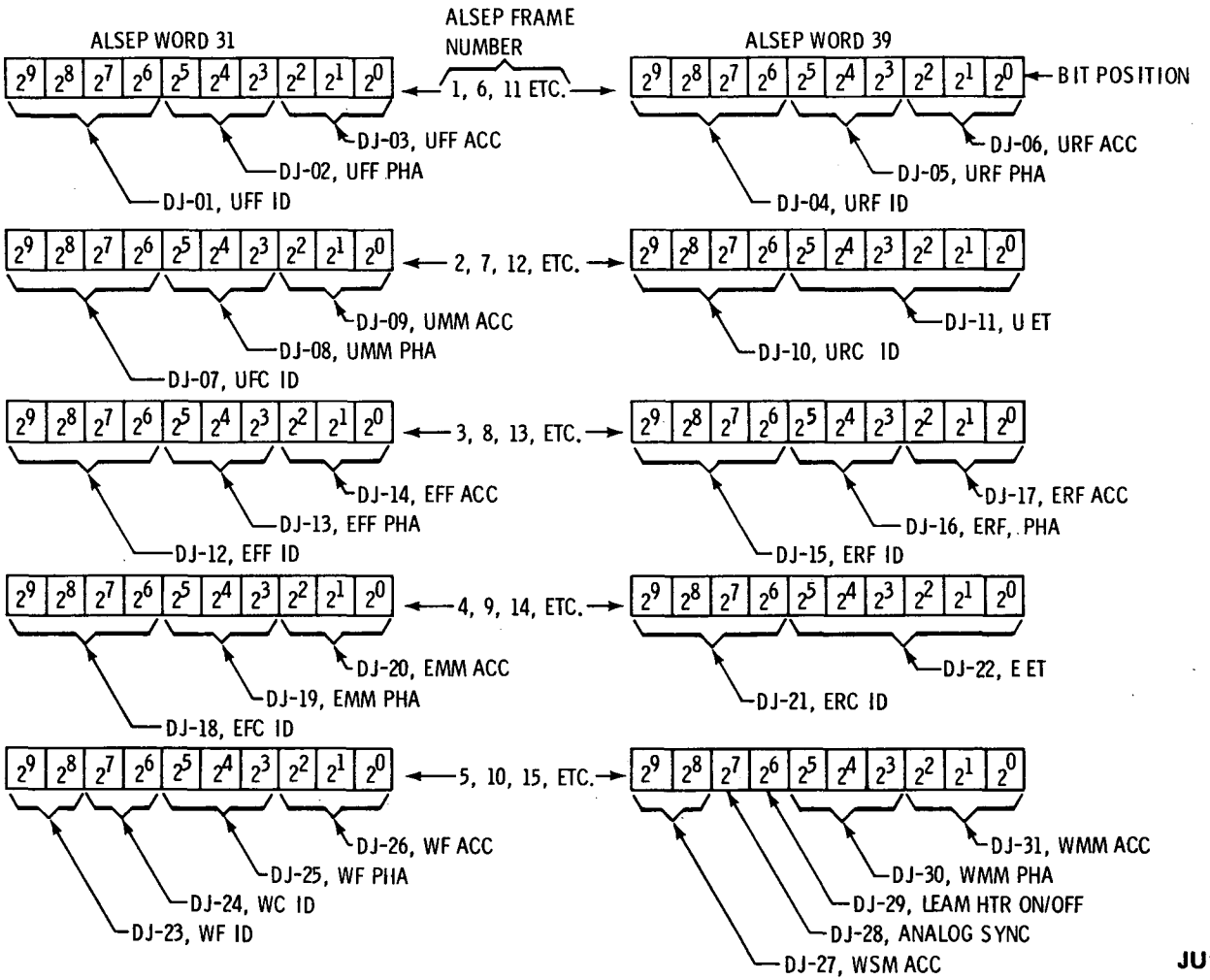
117 LEAM HTR STEP

THIS IS A THREE-STATE CMD WHICH, UPON SUCCESSIVE TRANSMISSION, STEPS REPETITIVELY THROUGH THREE LEAM HEATER CONTROL MODES: ON, OFF, AND AUTOMATIC. IN THE AUTOMATIC (NORMAL) MODE, A CIRCUIT CONTROLS THE HEATER OPERATION TO MAINTAIN LEAM ABOVE A MINIMUM TEMPERATURE. THE ON AND OFF MODES BYPASS THE AUTOMATIC CONTROL CIRCUIT AND CAUSE THE HEATER TO REMAIN ON OR OFF REGARDLESS OF TEMPERATURE. THE HEATER ON/OFF STATUS IS READ OUT IN THE TM, ALONG WITH TEMPERATURE DATA. APPLICATION OF OPERATIONAL POWER TO THE LEAM CAUSES INITIALIZATION IN THE AUTOMATIC MODE.

WHEN STANDBY (SURVIVAL) POWER IS APPLIED TO THE LEAM:
-THE AUTOMATIC CIRCUIT IS ENERGIZED AND CONTROLS OPERATION OF THE 3.2-WATT HEATER; THERE IS AN ADDITIONAL 1.6-WATT CONSTANT STANDBY HEATER
-CMD 117 HAS NO EFFECT
-TEMPERATURE IS READ OUT IN THE ALSEP CENTRAL STATION TM.

NOTES:
*THE CALIBRATION LEVEL OF MODE TWO IS HIGHER THAN MODE ONE
**REAR FILM SIGNALS ARE DELAYED TO VERIFY ELAPSED-TIME CIRCUITRY; DELAY IS LONGER IN MODE TWO.

LEAM DIGITAL DATA FORMAT



JULY 72 3270.6.25

LEAM ANALOG DATA

ALSEP WORD 33, CHANNEL 83, MULTIPLEXED 5 TIMES IN THE FOLLOWING SEQUENCE:

AJ-01, LEAM +5 VOLTS (MEASURED AT OUTPUT OF LEAM POWER SUPPLY)
AJ-02, SNSR CVR STATUS (INDICATES THAT SQUIBS HAVE OR HAVE NOT FIRED)
AJ-03, MIR CVR STATUS (INDICATES THAT SQUIBS HAVE OR HAVE NOT FIRED)
AJ-04, POWER SUPPLY MON (BASED ON COMBINED +12 VDC +5 VDC AND -5 VDC OUTPUT)
AJ-05, BIAS VOLTAGES MON (BASED ON COMBINED +24 VDC AND -7.5 VDC OUTPUT)

ALSEP WORD 33, CHANNEL 84, MULTIPLEXED 5 TIMES IN THE FOLLOWING SEQUENCE:

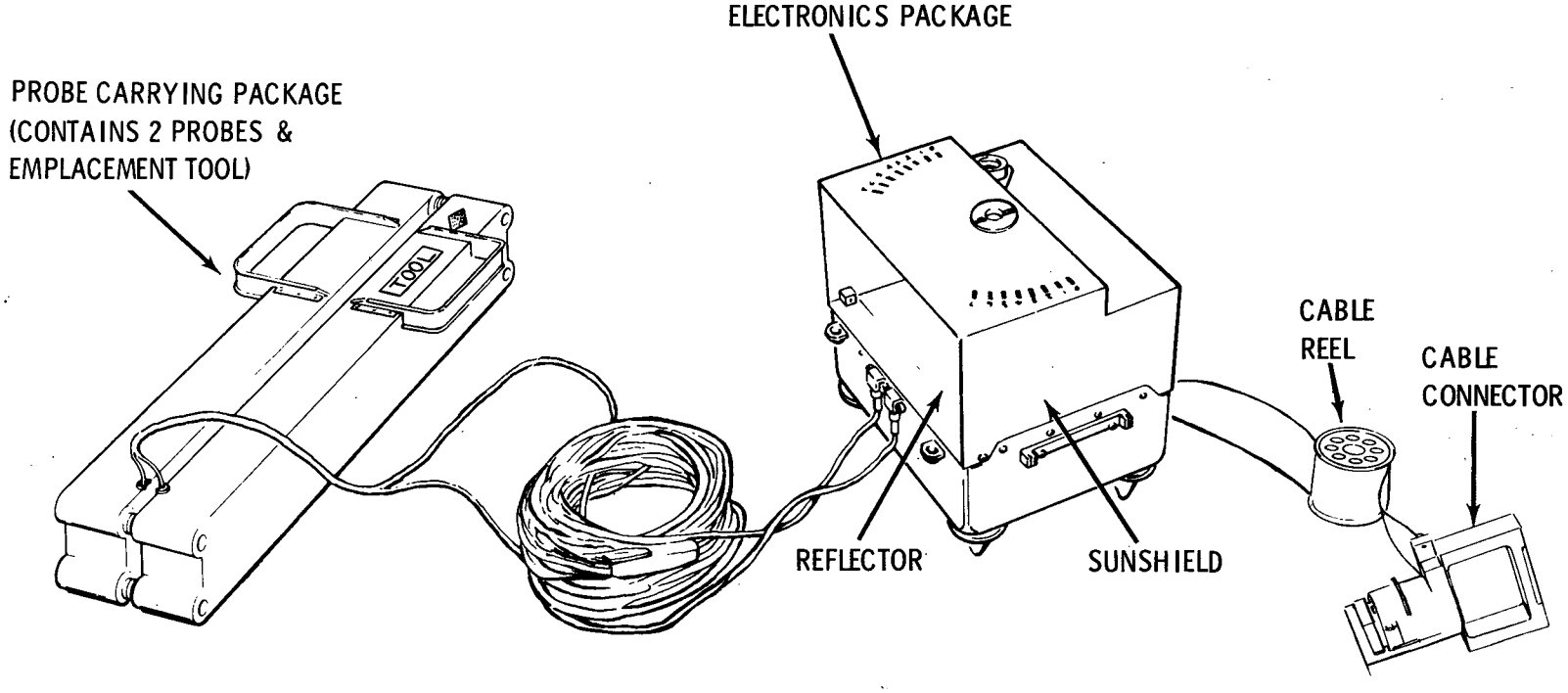
AJ-06, UP MAIN MIC TEMP (MEASURES UP SENSOR TEMP NEAR MICROPHONE)
AJ-07, EAST MAIN MIC TEMP (MEASURES EAST SENSOR TEMP NEAR MICROPHONE)
AJ-08, WEST MAIN MIC TEMP (MEASURES WEST SENSOR TEMP NEAR MAIN MICROPHONE)
AJ-09, CENT ELECT TEMP (MEASURES TEMP IN SENSOR CENTRAL ELECTRONICS)
AJ-10, LEAM -5 VOLTS (MEASURED AT OUTPUT OF LEAM POWER SUPPLY)

ALSEP WORD 33, CHANNEL 85:

AJ-11, LEAM ELECT TEMP (MEASURES INTERNAL STRUCTURE TEMP NEAR THERMAL PLATE; POWERED FROM ALSEP CENTRAL STATION TO READ INDEPENDENT OF LEAM ON/STANDBY/OFF STATUS)

HEAT FLOW EXPERIMENT
(HFE)

HEAT FLOW EXPERIMENT



	LENGTH	WIDTH	HEIGHT
ELECTRONICS PACKAGE	10	9.55	11
PROBE PACKAGE	25.5	4.5*	3.8

*EXCEPT HANDLES (8.5)

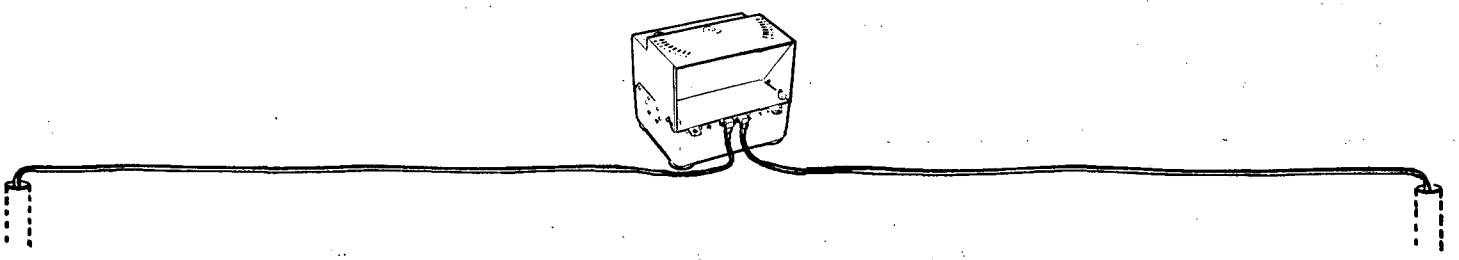
FEB 72 3270.7.2

HEAT FLOW
NASA No. S037

OBJECTIVE: INTERNAL TEMPERATURE & COMPOSITION OF THE MOON. FROM THIS, INFERENCES CAN BE MADE ON LUNAR EVOLUTION, BULK COMPOSITION, CHEMICAL SORTING, INTERNAL ENERGY (INCLUDING RADIOACTIVITY), & NEAR-SURFACE MATERIAL PROPERTIES

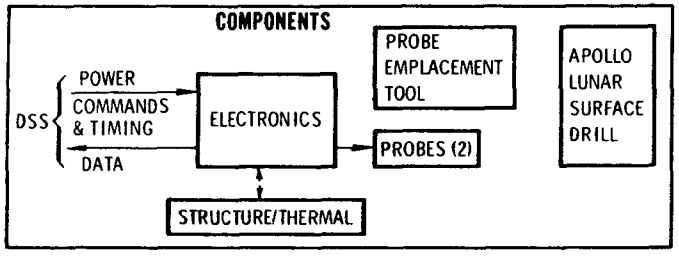
MEASUREMENT: TEMPERATURE GRADIENT & THERMAL CONDUCTIVITY TO DETERMINE AVERAGE OUTWARD HEAT FLUX AT THE SURFACE

EQUIPMENT: APOLLO LUNAR SURFACE DRILL; TWO PROBES, 1-IN. DIAM X 43 IN. LONG, WITH HEATING ELEMENTS & TEMPERATURE SENSORS; PROBES PLACED AT BOTTOM OF 8 - FT HOLES



HEAT FLOW CHARACTERISTICS

COMPONENTS



KEY FEATURES

SENSOR CALIBRATION ON EARTH REQUIRES SPECIAL FACILITY
AVOID DISTURBING LUNAR SURFACE REFLECTIVE PROPERTIES AROUND PROBES
REQUIRES RADIATIVE THERMAL COUPLING BETWEEN PROBE & HOLE PLUS
NO THERMAL SHORT-CIRCUIT TO SURFACE
"THERMOSTATICALLY" CONTROLLED HEATER IN ELECTRONICS PACKAGE

PHYSICAL PARAMETERS

(NOT INC DRILL)

SIZE, IN: ELECTRONICS 11 x 9.5 x 10
PROBES 25.5 x 3.8 x 8.5 (IN PACKAGE)

EARTH WT, LB: 12.2 LB (TOTAL)

POWER, W: 3.9 TO 10.7

OPERATIONS

DEPLOYMENT

- LOCATE ELECTRONICS 25-30 FT FROM CENTRAL STATION
- LEVEL ± 5°
- ALIGN ±5° WRT SHADOW (THERMAL)
- DRILL HOLES (2) 2.5 METERS DEEP & PLACE PROBES IN BOTTOM OF HOLES USING TOOL
- HOLES 30 FT APART & 18 FT FROM ELECTRONICS

APPROX TIME, 9 MIN, PLUS 30 MIN FOR DRILLING

POST DEPLOYMENT

- TURN ON (OPER) PRE-ASCENT
- READ GRADIENT DATA CONTINUOUSLY EXCEPT DURING CONDUCTIVITY TESTS
- MAKE CONDUCTIVITY TESTS – TIMES FOR UP TO 48 HRS EACH TIME

COMMUNICATIONS

COMMANDS:

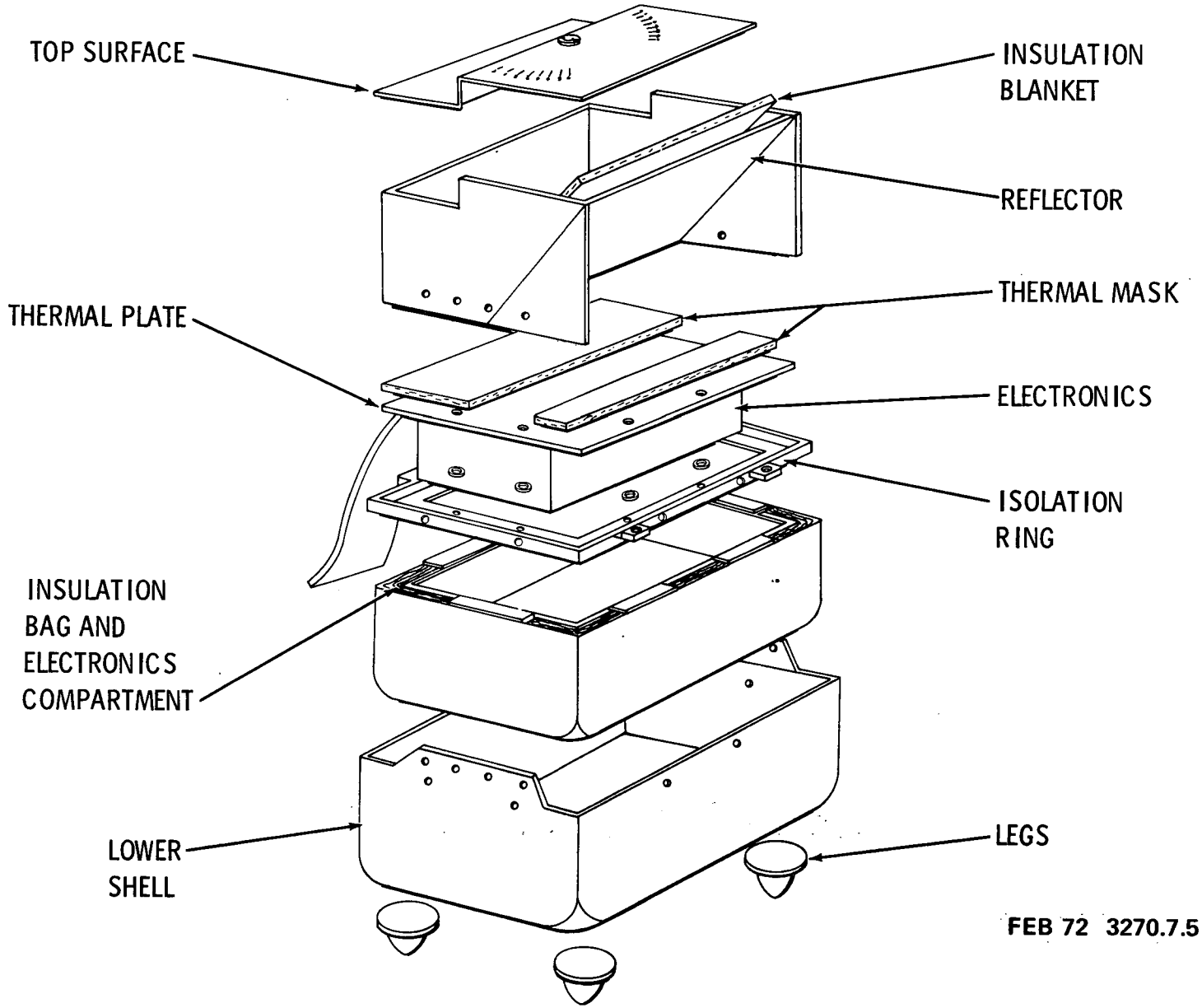
- POWER OPER/STBY/OFF
- 10 SPECIAL CMDS FOR:
  - SELECT GRADIENT, HI CONDUCTIVITY, OR LO CONDUCTIVITY MODES (3)
  - SELECT MEASUREMENT SEQUENCE (6)
  - SELECT & ACTIVATE CONDUCTIVITY HTRS (1)

DATA:

- 1 DIGITAL WORD PER ALSEP FRAME (FOR 16 OUT OF EVERY 90 FRAMES)
  3.0 BPS (APPROX)
  65% SCIENCE, 35% HK
  435 SEC REP RATE (FULL SEQUENCE)
- 6 ANALOG ENG PARAMETERS SAMPLED ONCE PER 54 SEC ALSEP SEQUENCE

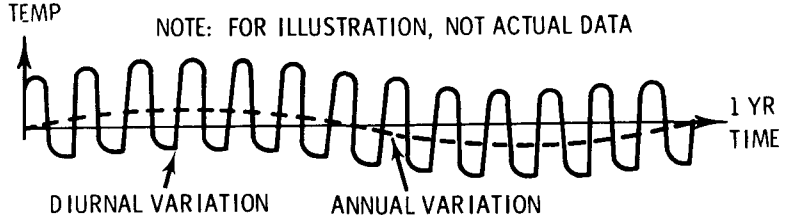
DISPLAY: PRINT (REQUIRES DATA ANALYSIS)

HFE STRUCTURE/THERMAL DETAILS



FEB 72 3270.7.5

HEAT FLOW SENSORS

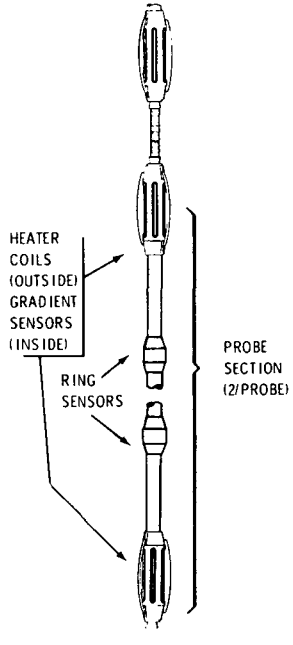


- PROBLEM: TO FIND THE SMALL DC COMPONENT IN A POSSIBLY LARGE AC WAVE

MODES OF OPERATION: MODE/G, MODE/LK, & MODE/HK PLUS MANY MEASUREMENT SEQUENCES

BASIC DATA WORD: 13-BIT OUTPUT OF ADC IN 2 ALSEP WORDS (PLUS ID)

TYPICAL BRIDGE READING (8 ALSEP WORDS)
(1) + EXCITATION
(2) + OUTPUT
(3) - EXCITATION
(4) - OUTPUT

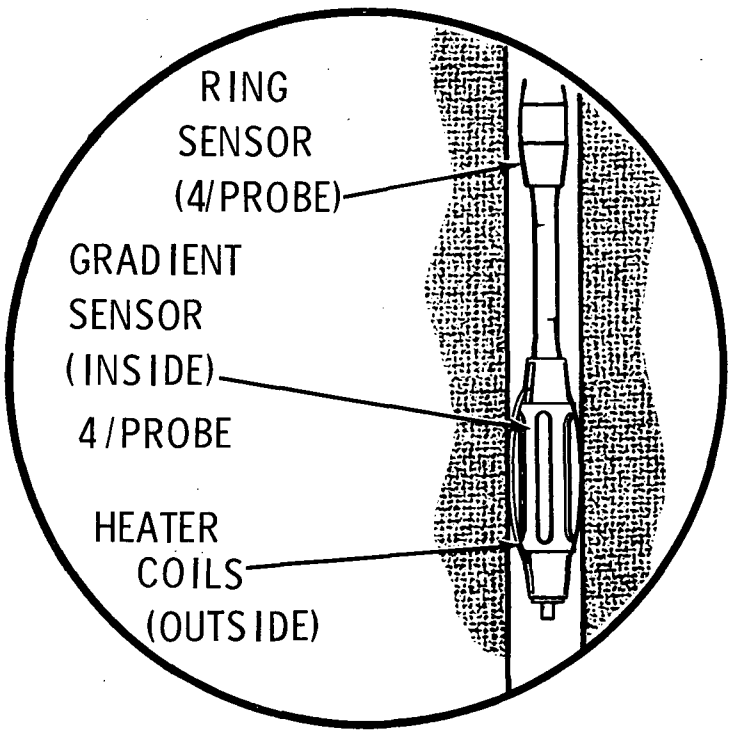


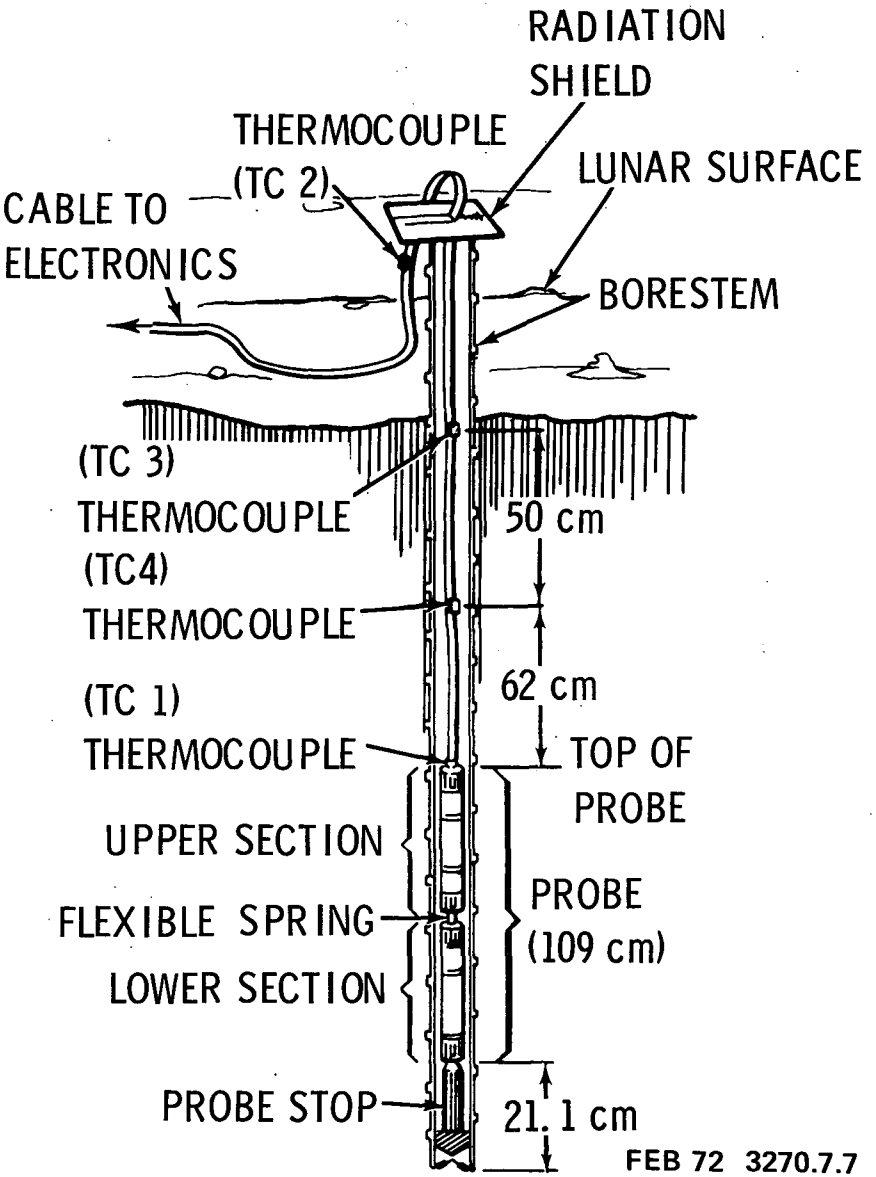
SENSOR TYPE: PLATINUM RESISTOR

SENSOR CIRCUITS:
- SETS OF FOUR SENSORS
- TWO COMBINATIONS (DIFFERENCE & AMBIENT) SELECTED BY INTERNAL LOGIC

DYNAMIC RANGE:
- TEMP DIFFERENCE (BRIDGE)
  HI SENSITIVITY ± 2° K (200° K TO 250° K)
  LO SENSITIVITY ±20° K (200° K TO 250° K)
- AMBIENT TEMP (RESISTANCE)
  200°K TO 250°K
- CABLE THERMOCOUPLES (ALONG PROBE CABLES)
  90°K TO 350°K (ACCURACY 0.3°C)
- THERMOCOUPLE REF JUNCTION (IN ELECTRONICS)
  -20° C TO +60° C (ACCURACY 0.1°C)
- CONDUCTIVITY RANGE: 5×10^{-6} TO 1×10^{-3} CAL/CM-SEC-°C

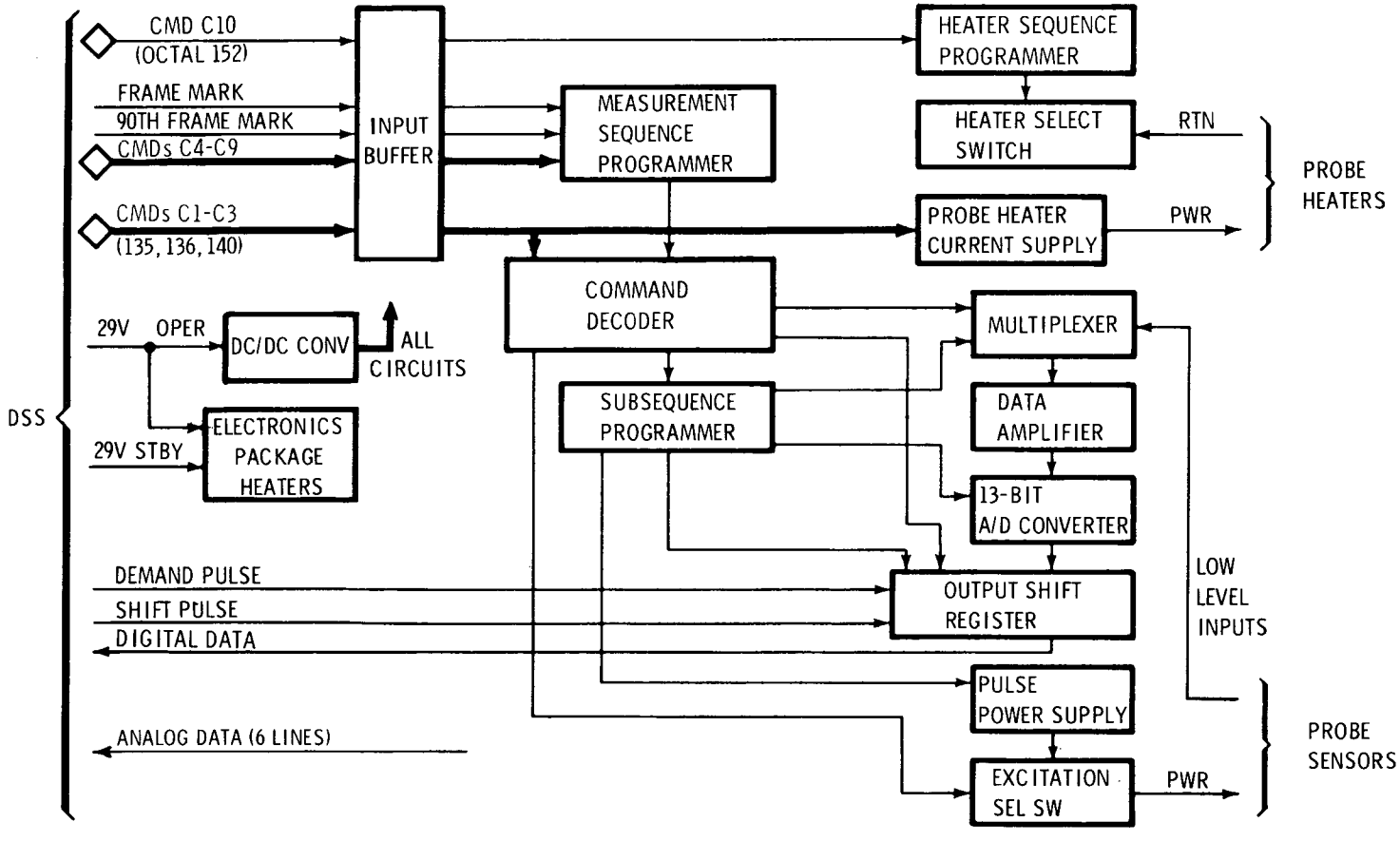
HFE PROBE DETAILS





FEB 72 3270.7.7

HFE FUNCTIONAL DIAGRAM



FEB 72 3270.7.8

HFE MODES OF OPERATION

	MODE: G, NORMAL GRADIENT (MODE 1)	LK, LOW CONDUCTIVITY (MODE 2)	HK, HIGH CONDUCTIVITY (MODE 3)
MEASUREMENT SEQUENCES	A. FULL (ALL MEAS)	SAME AS GRADIENT	DIFFERENTIAL & AMBIENT TEMP FOR ONE BRIDGE (DEPENDING ON SELECTED HEATER)
	B. PROBE 1 PROBE 2		
	C.* DIFFERENTIAL TEMP (HI EXCITATION) DIFFERENTIAL TEMP (LO EXCITATION) AMBIENT TEMP REF JUNCTION TEMP & CABLE THERMOCOUPLES		
	D. COMBINATIONS OF B & C		
BRIDGE SENSORS	GRADIENT	GRADIENT	RING (OR "REMOTE")
HEATERS	NONE	0.002W	0.5W

*THESE MODES USED PRIMARILY FOR TESTS

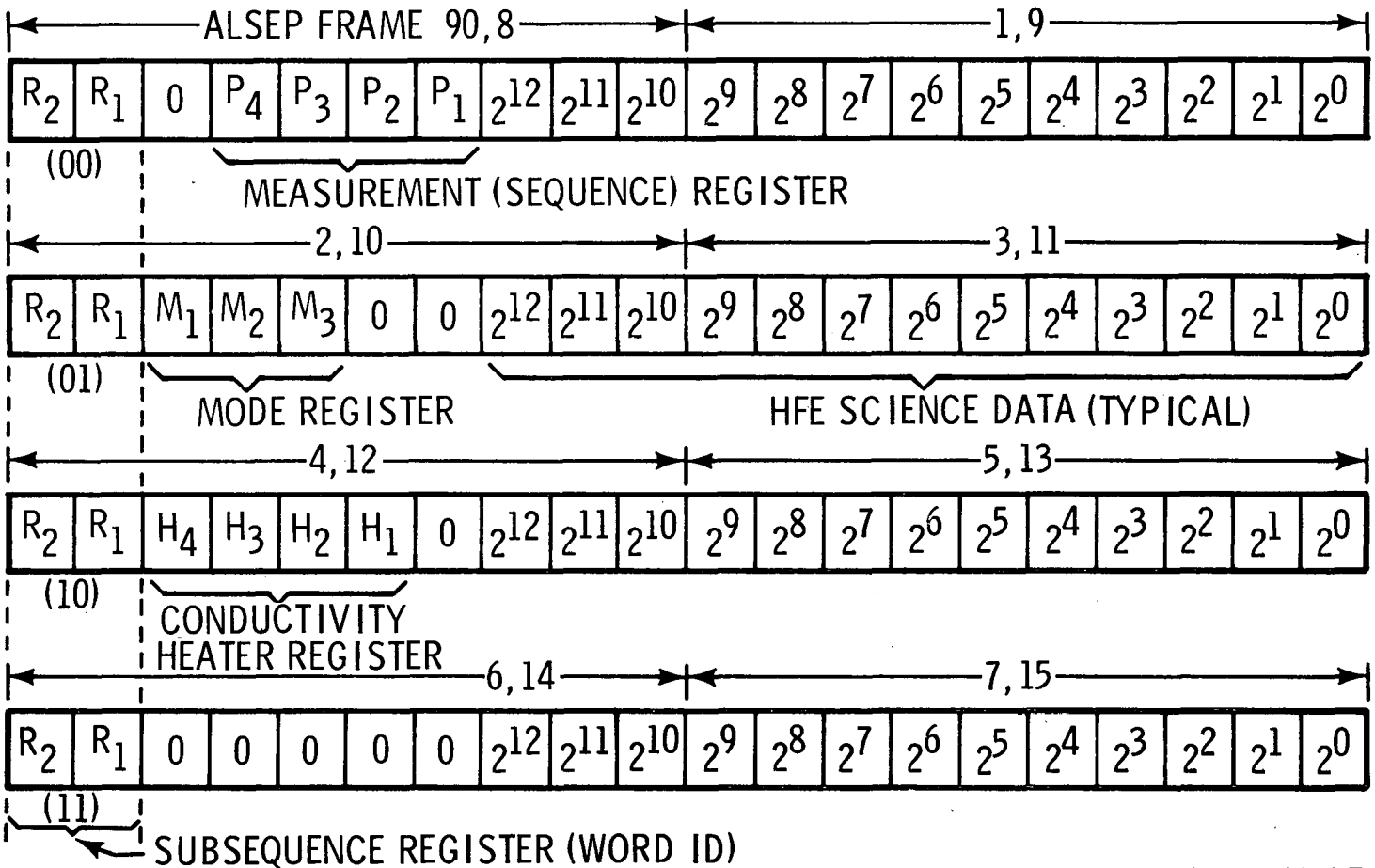
FEB 72 3270.7.9

HFE COMMAND SUMMARY

CMD NUMBERS			
HFE	OCTAL		
C1	135	HFE MODE/G SEL *	INITIALIZED TO THESE CONDITIONS AT POWER TURN-ON
C2	136	HFE MODE/LK SEL	
C3	140	HFE MODE/HK SEL	
C4	141	HFE SEQ/FUL SEL *	
C5	142	HFE SEQ/P1 SEL	
C6	143	HFE SEQ/P2 SEL	
C7	144	HFE LOAD 1	MEASUREMENT SELECT (ENCODED)
C8	145	HFE LOAD 2	
C9	146	HFE LOAD 3	
C10	152	HFE HTR STEPS	

INPUT BUFFER HOLDS COMMANDS FOR EXECUTION AT 90-FRAME MARK

HFE DIGITAL DATA FORMAT



FEB 72 3270.7.11

HFE MODE REGISTER

THE MODE REGISTER IS PART OF THE HFE CMD DECODER AND RESPONDS TO CMDs 135, 136 AND 140. THE STATE OF THIS REGISTER IS READ OUT VIA TM

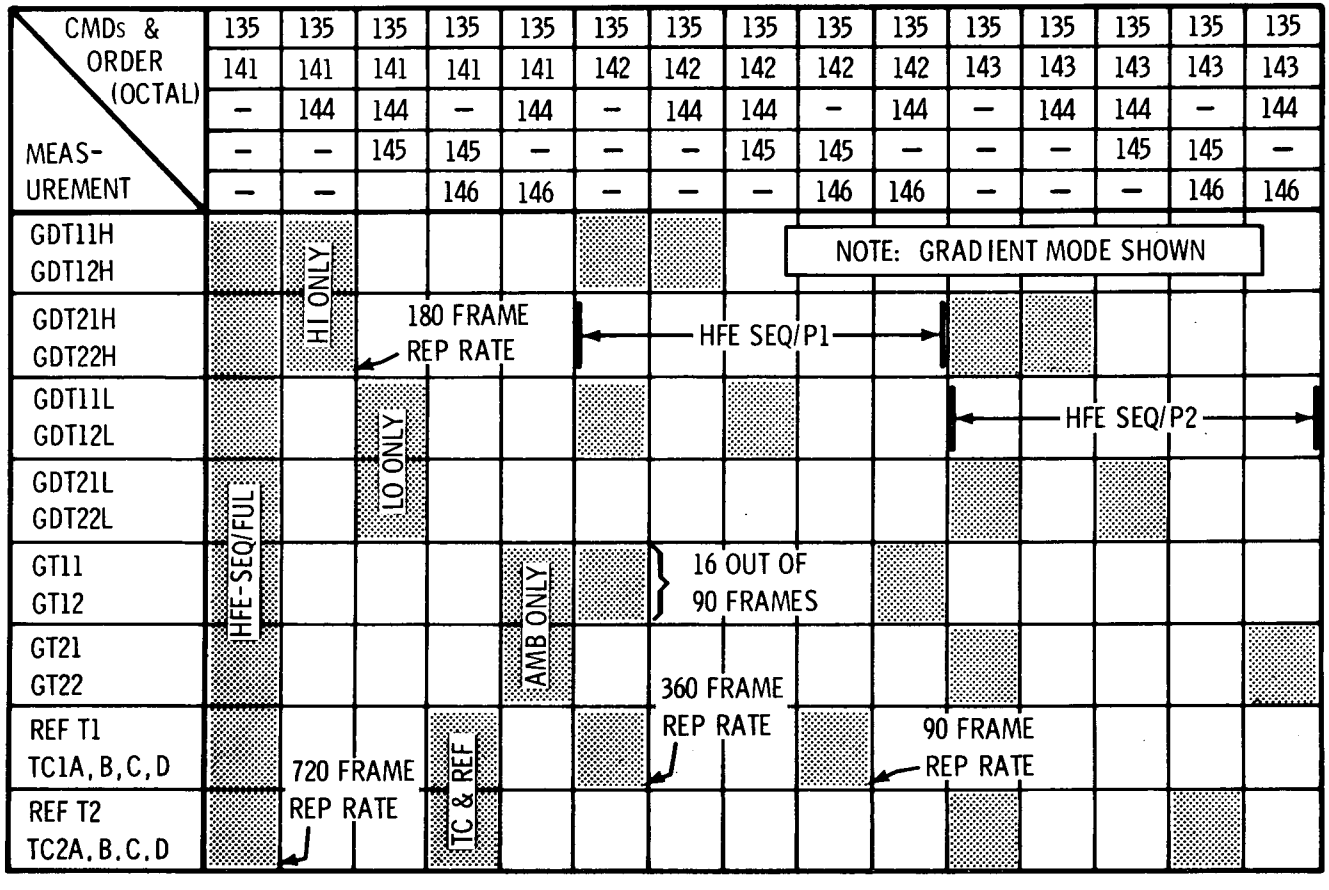
OCTAL	ABBR	HFE	MODE	TM ($M_1M_2M_3$)
135	MODE/G	MODE 1	NORMAL GRADIENT	100
136	MODE/LK	MODE 2	LOW CONDUCTIVITY	010
140	MODE/HK	MODE 3	HIGH CONDUCTIVITY	001

THE MODE SELECTED BY CMD AFFECTS THE DATA AS FOLLOWS:

MODE/G AND MODE/LK HAVE IDENTICAL TM (FORMATTED BY THE MEASUREMENT SEQUENCE PROGRAMMER AND SUBSEQUENCE PROGRAMMER) BUT IN MODE/LK THE PROBE HEATER CURRENT SUPPLY IS TURNED ON AND HEATERS RESPOND TO CMD 152.

MODE/HK BYPASSES THE MEASUREMENT SEQUENCE PROGRAMMER AND PRODUCES A SPECIAL TM OUTPUT FORMATTED BY THE SUBSEQUENCE PROGRAMMER AND HEATER SEQUENCE PROGRAMMER.

HFE GRADIENT MEASUREMENT OPTIONS



FEB 72 3270.7.13

HFE MEASUREMENT SEQUENCE PROGRAMMER

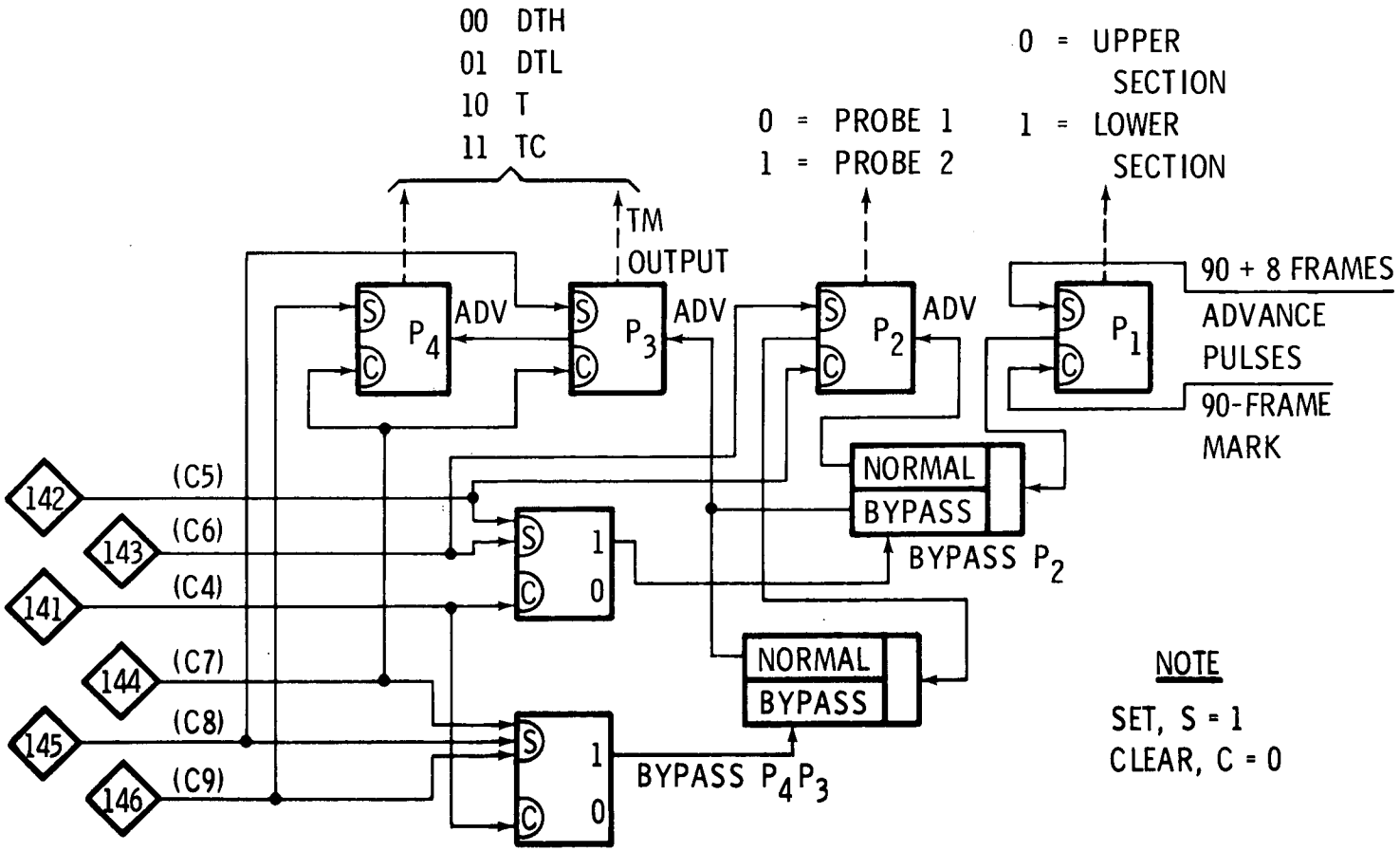
THE MEASUREMENT SEQUENCE PROGRAMMER (MSP) IS A 16-STATE BINARY COUNTER USING 4 FLIP-FLOPS. ITS OPERATION CAN BE MODIFIED BY CMD TO PERFORM 8-STATE, 4-STATE, AND 2-STATE PROGRAMS. THE FLIP-FLOPS HAVE DUAL FUNCTIONS:

- FORMAT HFE DATA BY CONTROLLING GATES TO THE OUTPUT REGISTER
- SUPPLY MSP STATUS DATA FOR TM (P-BITS)

NOTE THAT EXECUTION OF A MEASUREMENT CMD (141 THROUGH 146) DOES NOT RESET MSP. OPERATION CONTINUES FROM PREVIOUS STATE.

IN DIAGRAM, THE SET (S) AND CLEAR (C) POSITIONS OF THE FLIP-FLOPS CORRESPOND TO ONE AND ZERO IN THE TM.

HFE MSP DIAGRAM



FEB 72 3270.7.15

HFE SUBSEQUENCE PROGRAMMER

THE SUBSEQUENCE PROGRAMMER IS A 4-STATE COUNTER HAVING DUAL FUNCTIONS:

- CONTROLS GATING OF DATA, WITHIN A SUBSET, TO THE OUTPUT REGISTER (WHERE THE TYPE OF SUBSET IS CONTROLLED BY THE MSP)
- SUPPLIES SUBSEQUENCE REGISTER STATUS DATA FOR TM (R-BITS)

THE STATE OF R_2R_1 CHANGES EVERY OTHER ALSEP FRAME (ONE 10-BIT WORD OF HFE DATA IN EACH ALSEP FRAME) STARTING WITH A RESET AT THE 90-FRAME MARK

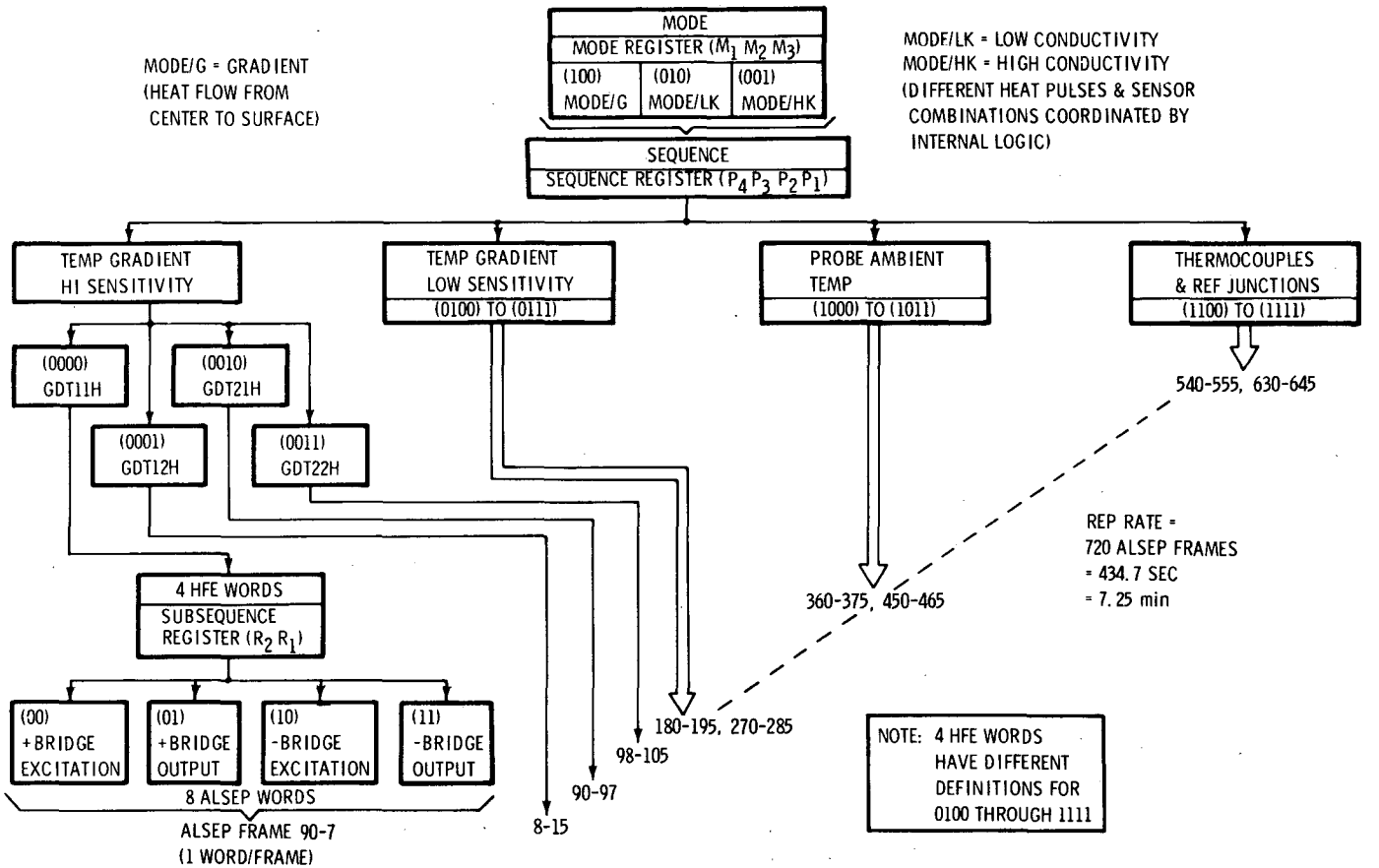
THE TRANSITION FROM 11 TO 00 BETWEEN 7 AND 8 MARKS THE 90 + 8 FRAME. THIS ADVANCES P_1 FROM ZERO TO ONE

R_2 R_1	ALSEP FRAME NO	
00	90, 1	8, 9
01	2, 3	10, 11
10	4, 5	12, 13
11	6, 7	14, 15

R_2R_1 READ OUT AS FIRST TWO BITS IN EVEN NUMBERED ALSEP FRAME

FROM ALSEP FRAME 16 TO 89 THERE IS NO HFE DATA AND REGISTER CHANGES ARE INHIBITED

HFE TIMING FUNCTIONS



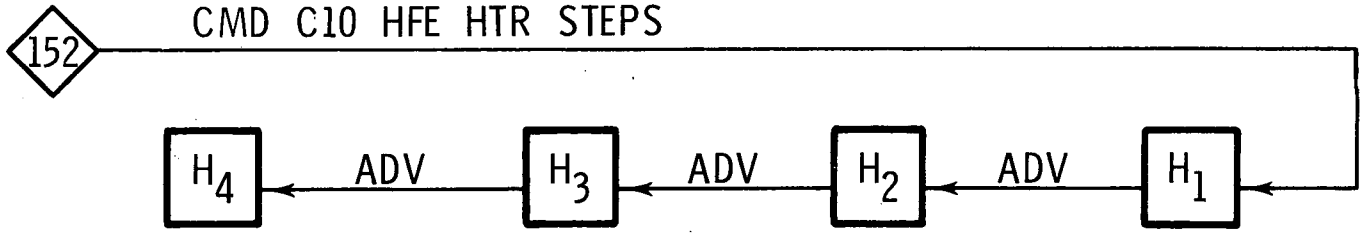
FEB 72 3270.7.17

HFE GRADIENT MEASUREMENT INDEX

SYMBOL	ABBR	P-BITS	DATA SOURCE	PROBE/ BRIDGE	EXCITATION (SENSITIVITY)	(R_2R_1) SUBSET DATA
DH-01	GDT 11H	0000	DIFFERENTIAL BRIDGE (GRADIENT SENSORS)	1/UPPER	HIGH VOLTAGE	(00) + BRIDGE EXCITATION
DH-02	GDT 12H	0001		1/LOWER		(01) + BRIDGE OUTPUT
DH-03	GDT 21H	0010		2/UPPER		(10) - BRIDGE EXCITATION
DH-04	GDT 22H	0011		2/LOWER		(11) - BRIDGE OUTPUT
DH-05	GDT 11L	0100		1/UPPER	LOW VOLTAGE	(00) + BRIDGE CURRENT
DH-06	GDT 12L	0101		1/LOWER		(01) + BRIDGE OUTPUT
DH-07	GDT 21L	0110		2/UPPER		(10) - BRIDGE CURRENT
DH-08	GDT 22L	0111		2/LOWER		(11) - BRIDGE OUTPUT
DH-09	GT 11	1000	(RESISTANCE)	1/UPPER	HIGH VOLTAGE	(00) + BRIDGE EXCITATION
DH-10	GT 12	1001		1/LOWER		(01) + BRIDGE CURRENT
DH-11	GT 21	1010		2/UPPER		(10) - BRIDGE EXCITATION
DH-12	GT 22	1011		2/LOWER		(11) - BRIDGE CURRENT
DH-13	REF T1	1100	REF JUNCTION BR		HV	SAME AS DH-01 TO DH-04
DH-14	TC1 GROUP	1101	THERMOCOUPLES IN CABLE OF PROBE 1 WRT REF T1			(00) REF T1-TC1 (1)
DH-24						(01) TC1 (1)-TC1 (2)
DH-34						(10) TC1 (1)-TC1 (3)
DH-44						(11) TC1 (1)-TC1 (4)
DH-15	REF T2	1110	SAME AS DH-13		HV	SAME AS DH-01 TO DH-04
DH-16	TC2 GROUP	1111	THERMOCOUPLES IN CABLE OF PROBE 2 WRT REF T2			(00) REF T2-TC2 (1)
DH-26						(01) TC2 (1)-TC2 (2)
DH-36						(10) TC2 (1)-TC2 (3)
DH-46						(11) TC2 (1)-TC2 (4)

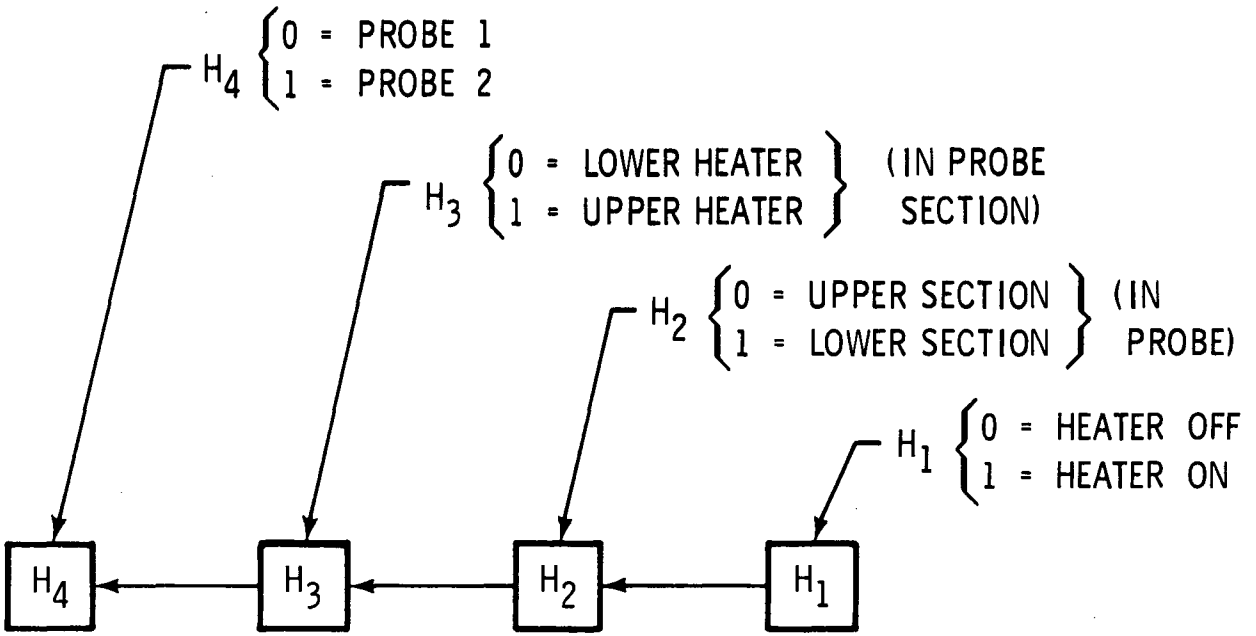
FEB 72 3270.7.18

HFE HEATER SEQUENCE PROGRAMMER



- 16-STATE BINARY COUNTER USING 4 FLIP-FLOPS
- STATUS TRANSMITTED IN TM AS H-BITS (ALL 3 MODES)
- EFFECT ON OPERATION AND DATA:
  - MODE/G – NO EFFECT (CAN BE ADVANCED VIA CMD 152 BUT PROBE HEATER CURRENT SUPPLY IS OFF)
  - MODE/LK – CONTROLS ON/OFF STATUS OF 8 HEATERS (4/PROBE) IN LOW MODE OF PROBE HEATER CURRENT SUPPLY
  - MODE/HK – CONTROLS DATA OUTPUT AND ON/OFF STATUS OF 8 HEATERS IN HIGH MODE OF PROBE HEATER CURRENT SUPPLY
- PROBE HEATER ON/OFF STATUS IN ANALOG TM (ALSEP WORD 33)

HFE HEATER SELECT CODE



H_3 H_2	HTR NUMBER
00	2
01	4 (BOTTOM)
10	1 (TOP)
11	3

EXAMPLE: WHEN H-BITS = 1011, HEATER H24 IS ON (WHERE H24 INDICATES FOURTH HEATER IN PROBE 2)

NOTE: THIS CODE APPLIES TO HEATER CONTROL IN BOTH MODE/LK AND MODE/HK

FEB 72 3270.7.20

HFE MEASUREMENTS IN MODE/HK

SYMBOL	ABBR	PROBE	BRIDGE	$H_4 H_3 H_2 H_1$	SYMBOL	ABBR	PROBE	BRIDGE	$H_4 H_3 H_2 H_1$
DH-50	RDT 11	1	1	0000	DH-70	RDT 21	2	1	1000
DH-51	RT 11	1	1	0000	DH-71	RT 21	2	1	1000
DH-52	RDT 11	1	1	0001	DH-72	RDT 21	2	1	1001
DH-53	RT 11	1	1	0001	DH-73	RT 21	2	1	1001
DH-60	RDT 12	1	2	0010	DH-80	RDT 22	2	2	1010
DH-61	RT 12	1	2	0010	DH-81	RT 22	2	2	1010
DH-62	RDT 12	1	2	0011	DH-82	RDT 22	2	2	1011
DH-63	RT 12	1	2	0011	DH-83	RT 22	2	2	1011
DH-56	RDT 11	1	1	0100	DH-76	RDT 21	2	1	1100
DH-57	RT 11	1	1	0100	DH-77	RT 21	2	1	1100
DH-58	RDT 11	1	1	0101	DH-78	RDT 21	2	1	1101
DH-59	RT 11	1	1	0101	DH-79	RT 21	2	1	1101
DH-66	RDT 12	1	2	0110	DH-86	RDT 22	2	2	1110
DH-67	RT 12	1	2	0110	DH-87	RT 22	2	2	1110
DH-68	RDT 12	1	2	0111	DH-88	RDT 22	2	2	1111
DH-69	RT 12	1	2	0111	DH-89	RT 22	2	2	1111

- DATA ALTERNATES BETWEEN DIFFERENCE (BRIDGE) AND AMBIENT (RESISTANCE) MEASUREMENTS FOR THE SET OF RING SENSORS NEAREST THE SELECTED HEATER

ALSEP FRAMES	P_1 (a)	MEAS TYPE (b)	ABBR (c)
90 TO 7	0	DIFFERENCE	RDTNN
8 TO 15	1	AMBIENT	RTNN

- NOTES
  - (a) P-BITS, OTHER THAN P_1, ARE MEANINGLESS IN MODE/HK
  - (b) MEASUREMENT CONTENT:

$R_2 R_1$	DIFFERENCE	AMBIENT
00	+ BRIDGE EXCITATION VOLTS	
01	+ BRIDGE OUTPUT	+ BRIDGE CURRENT
10	- BRIDGE EXCITATION VOLTS	
11	- BRIDGE OUTPUT	- BRIDGE CURRENT

  - (c) NN IDENTIFIES SENSOR (BRIDGE) LOCATION

HFE COMMAND DETAILS

OCTAL CMD NUMBER

135 HFE MODE/G SEL

THIS CMD (C1) IS A 1-STATE CMD. IT PLACES THE HFE IN THE GRADIENT, OR NORMAL, MODE OF OPERATION IN WHICH MEASUREMENTS ARE OBTAINED FROM THE GRADIENT SENSORS AND CABLE THERMOCOUPLES UNDER THE CONTROL OF THE MSP. CMD 135 ALSO TURNS OFF THE PROBE HEATER CURRENT SUPPLY. DIFFERENT MEASUREMENT SEQUENCES IN MODE/G MAY BE SELECTED BY TRANSMITTING SUBSEQUENT CMDs. AT POWER TURN-ON, THE HFE INITIALIZES IN MODE/G. IF THE HFE IS IN MODE/G, TRANSMISSION OF CMD 135 HAS NO EFFECT.

NOTE THAT THE HFE INPUT BUFFER HOLDS CMDs FOR EXECUTION AT THE 90-FRAME MARK; THUS, SEQUENTIAL CMDs MUST BE TRANSMITTED AT LEAST 54 SEC APART.

136 HFE MODE/LK SEL

THIS CMD (C2) IS A 1-STATE CMD. IT PLACES THE HFE IN THE LOW CONDUCTIVITY, OR RING SOURCE, MODE OF OPERATION IN WHICH MEASUREMENTS, AND SEQUENCES, ARE IDENTICAL TO MODE/G. IT ALSO TURNS ON THE PROBE HEATER CURRENT SUPPLY IN THE LOW (RING SOURCE) MODE ALLOWING HEATERS TO BE ACTIVATED BY CMD 152. IF THE HFE IS IN MODE/LK, TRANSMISSION OF CMD 136 HAS NO EFFECT.

140 HFE MODE/HK SEL

THIS CMD (C3) IS A 1-STATE CMD. IT PLACES THE HFE IN THE HIGH CONDUCTIVITY, OR HEAT PULSE, MODE OF OPERATION IN WHICH MEASUREMENTS ARE OBTAINED FROM THE RING (OR REMOTE) SENSORS UNDER THE CONTROL OF THE HEATER SEQUENCE PROGRAMMER. NOTE THAT CMD 144 (C7) MUST ALSO BE TRANSMITTED BEFORE VALID DATA WILL BE OBTAINED IN MODE/HK. EITHER CMD MAY BE TRANSMITTED FIRST. CMD 140 ALSO TURNS ON THE PROBE HEATER CURRENT SUPPLY IN THE HIGH, OR HEAT PULSE, MODE ALLOWING HEATERS TO BE ACTIVATED BY CMD 152. IF THE HFE IS IN MODE/HK, TRANSMISSION OF CMD 140 HAS NO EFFECT.

141 HFE SEQ/FUL SEL

THIS CMD (C4) IS A 1-STATE CMD. IT CANCELS THE EFFECT OF CMDs 142 THROUGH 146 CAUSING THE MSP TO PERFORM ITS FULL 16-STATE CYCLE OF OPERATION IN MODE/G OR MODE/LK. IF TRANSMITTED DURING MODE/HK OPERATION, THIS CMD WILL CAUSE INVALID OPERATION UNTIL CMD 144 IS EXECUTED. AT POWER TURN-ON, THE HFE INITIALIZES IN SEQ/FUL. IF THE HFE IS IN MODE/G OR MODE/LK AND IN SEQ/FUL, TRANSMISSION OF CMD 141 HAS NO EFFECT.

142 HFE SEQ/P1 SEL

THIS CMD (C5) IS A 1-STATE CMD AND ALTERNATES WITH CMD 143 TO SELECT ONLY ONE PROBE FOR MEASUREMENT. IN MODE/HK THIS CMD IS MEANINGLESS. IN MODE/G AND MODE/LK IT CAUSES THE MSP TO LOCK FLIP-FLOP P_2 IN THE CLEAR STATE AND BYPASS P_2. THUS THE MSP ACTS AS AN 8-STATE COUNTER IF CMD 141 WAS PREVIOUSLY EXECUTED, OR AS A 2-STATE COUNTER IF CMD 144, 145 OR 146 WAS PREVIOUSLY EXECUTED. SEQ/P1 IS CLEARED BY SUBSEQUENT EXECUTION OF CMD 141.

143 HFE SEQ/P2 SEL

THIS CMD (C6) IS A 1-STATE CMD AND ALTERNATES WITH CMD 142 TO SELECT ONLY ONE PROBE FOR MEASUREMENT. IT HAS THE SAME CHARACTERISTICS AS CMD 142 EXCEPT THAT FLIP-FLOP P_2 IS LOCKED IN THE SET STATE.

144 HFE LOAD 1

THIS CMD (C7) IS A 1-STATE CMD AND IS USED ALONE OR IN COMBINATION WITH CMD 145 OR 146 TO POSITION AND LOCK TWO FLIP-FLOPS (P_4 P_3) OF THE MSP. CMD 144 PLACES P_4P_3 IN THE CLEAR POSITION (00) AND BYPASSES THOSE STEPS. THE MSP THEN ACTS AS A 4-STATE COUNTER IF CMD 141 WAS PREVIOUSLY EXECUTED AND AS A 2-STATE COUNTER IF CMD 142 OR 143 WAS PREVIOUSLY EXECUTED. THIS APPLIES TO MODE/G AND MODE/LK. IN MODE/HK CMD 144 MUST BE EXECUTED TO OBTAIN VALID DATA. CMDs 145 OR 146 MAY BE USED IN MODE/G OR MODE/LK, FOLLOWING CMD 144, TO LOCK P_4 P_3 IN THE 10 OR 01 STATE RESPECTIVELY. THE EFFECT OF CMD 144 IS CLEARED BY SUBSEQUENT EXECUTION OF CMD 141. NOTE: WHEN IN MODE/G OR MODE/LK 00 STATE PROVIDES HIGH EXCITATION DIFFERENTIAL TEMPERATURE DATA ONLY.

145 HFE LOAD 2

THIS CMD (C8) IS A 1-STATE CMD AND IS USED IN COMBINATION WITH EITHER CMD 144 (PRECEDING 145) OR CMD 146 (PRECEDING OR FOLLOWING 145) TO POSITION AND LOCK P_4 P_3 (SEE CMD 144). CMD 145 POSITIONS FLIP-FLOP P_3 IN THE SET STATE. THEREFORE, 144-145 YIELDS 01 (LOW EXCITATION DIFFERENTIAL TEMPERATURE DATA ONLY) WHILE 145-146 YIELDS 11 (CABLE THERMOCOUPLE DATA ONLY). EXECUTION OF THIS CMD IN MODE/HK CAUSES INVALID DATA UNTIL CMD 144 IS EXECUTED. THE EFFECT OF CMD 145 IS CLEARED BY SUBSEQUENT EXECUTION OF CMD 141.

146 HFE LOAD 3

THIS CMD (C9) IS A 1-STATE CMD OPERATING ESSENTIALLY THE SAME AS CMD 145 EXCEPT THAT IT POSITIONS FLIP-FLOP P_4 IN THE SET STATE. WHEN PRECEDED BY CMD 144 IT YIELDS 10 FOR P_4 P_3 (AMBIENT TEMPERATURE DATA ONLY). EXECUTION OF THIS CMD IN MODE/HK CAUSES INVALID DATA UNTIL CMD 144 IS EXECUTED.

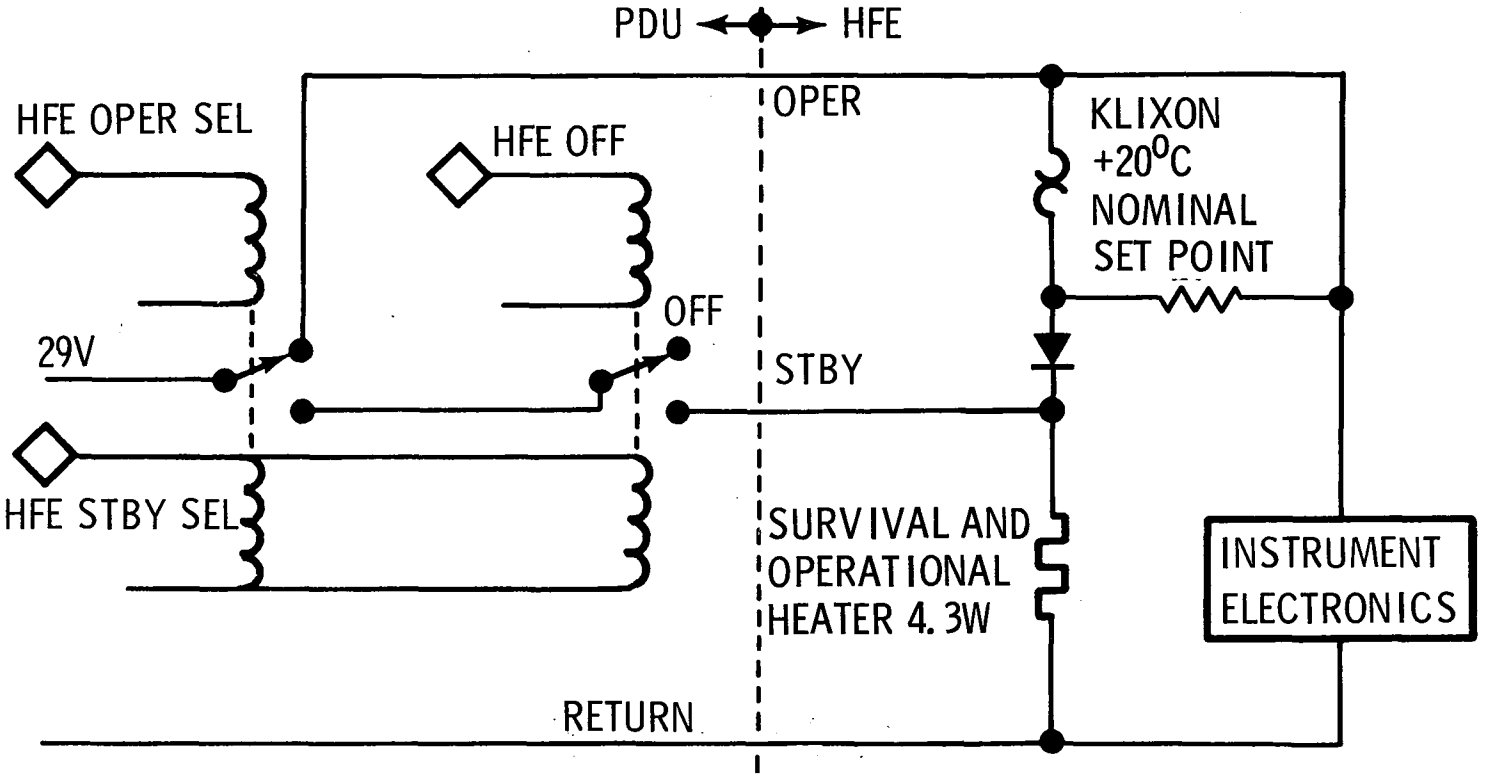
152 HFE HTR STEPS

THIS CMD (C10) IS A 16-STATE CMD WHICH ADVANCES THE HEATER EXCITATION PROGRAMMER (H_4 H_3 H_2 H_1) EACH TIME THE CMD IS EXECUTED. IN MODE/G THE PROGRAMMER ADVANCES BUTH THERE IS NO OTHER EFFECT SINCE THE PROBE HEATER CURRENT SUPPLY IS OFF. IN MODE/LK THE EXECUTION OF CMD 152 ALTERNATES THE HEATER STATUS BETWEEN ON AND OFF, SIMULTANEOUSLY STEPPING THROUGH THE 8 HEATERS (CURRENT SUPPLY IS ON FULL TIME AND HEATER ELEMENTS ARE SWITCHED IN AND OUT OF CIRCUIT). IN MODE/HK THE HEATER EXCITATION PROGRAMMER (ADVANCED BY CMD 152) ALSO SELECTS THE DATA TO BE SAMPLED.

HFE ANALOG DATA

AH-01	HFE +5V SUPPLY	EACH SAMPLED ONCE EVERY 54 SEC ALSEP SEQUENCE
AH-02	HFE -5V SUPPLY	
AH-03	HFE +15V SUPPLY	
AH-04	HFE -15V SUPPLY	
AH-05	(DELETED)	
AH-06	HFE HTR/HK ON/OFF	
AH-07	HFE HTR/LK ON/OFF	

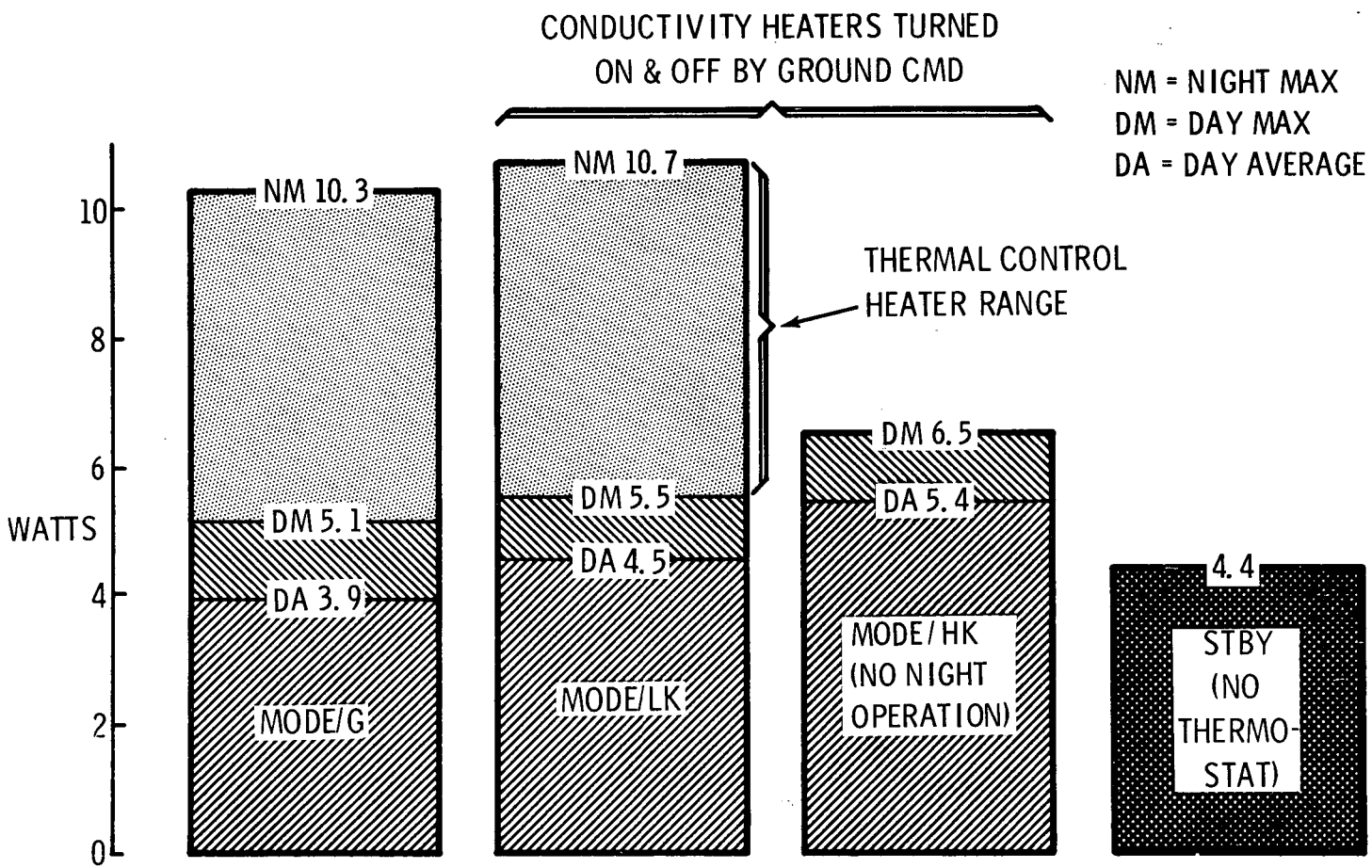
HFE THERMAL CONTROL



NOTE: ADDITIONAL THERMOSTAT TURNS A PORTION OF INSTRUMENT ELECTRONICS OFF DURING FRAMES 16 THROUGH 89 WHEN TEMP. IS ABOVE 30°C NOMINAL

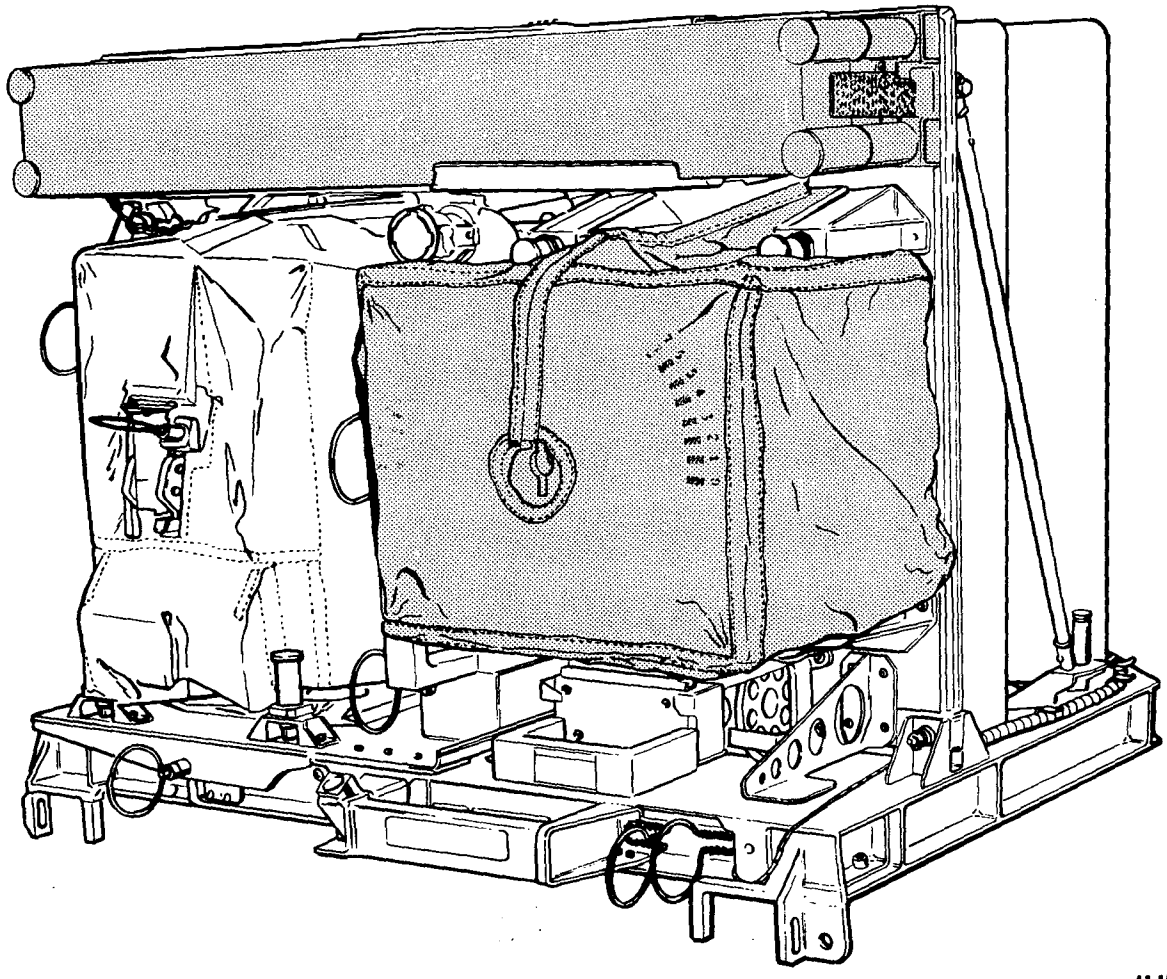
FEB 72 3270.7.24

HFE POWER PROFILE



FEB 72 3270.7.25

HFE TIEDOWN

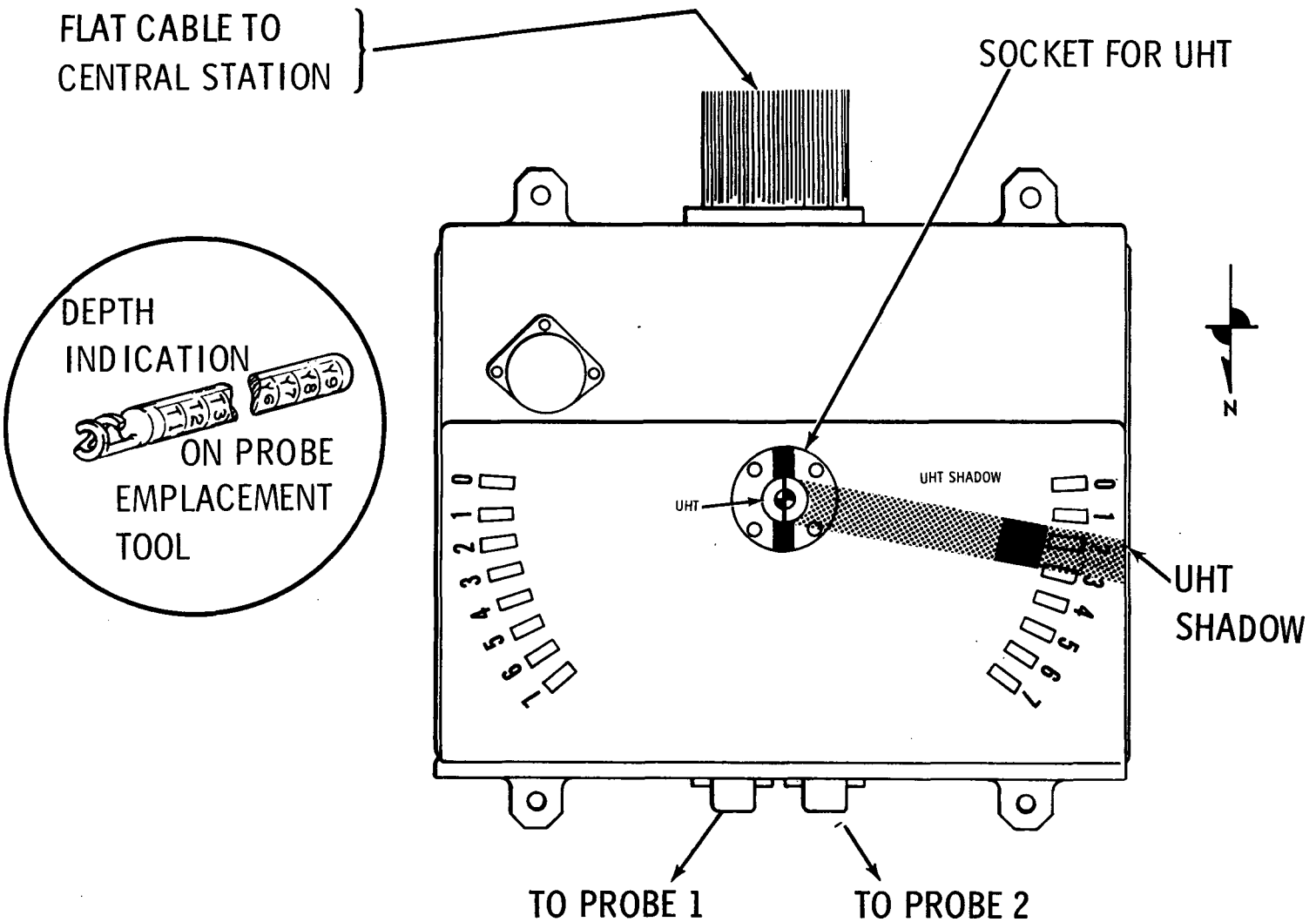


JUNE 72 3270-7-26

HFE EMPLACEMENT CRITERIA

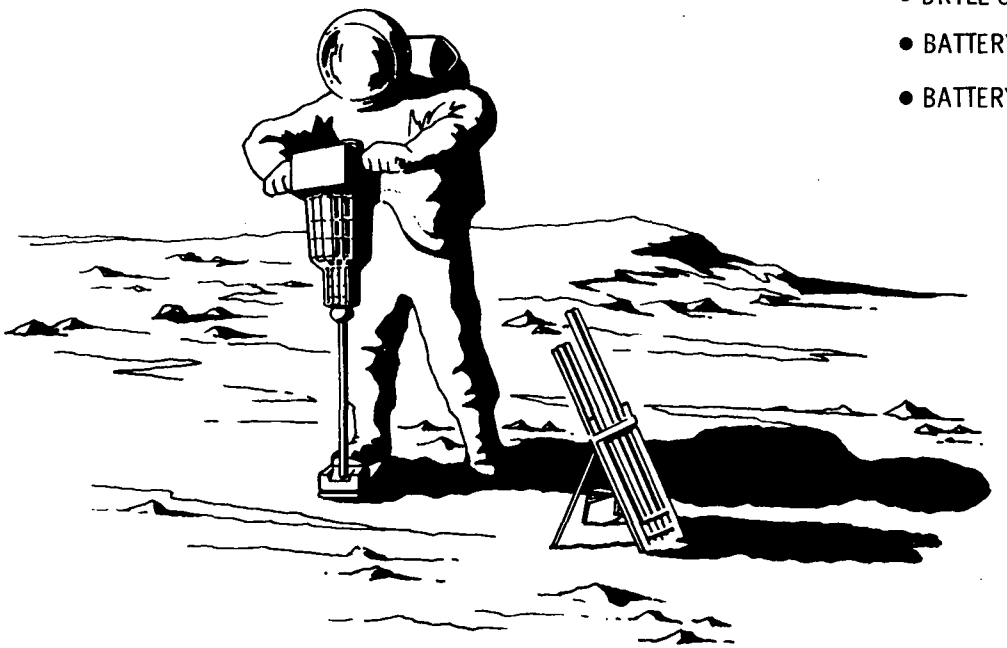
	PARAMETER	REQUIREMENT	PRIORITY	INDICATOR	COMMENTS
ELECTRONICS PACKAGE	DISTANCE FROM SUBPACKAGE 1	25-30 FT (30 ft CABLE)	2	PACED OFF	TO OBTAIN PROBE SEPARATION FROM RTG*
	DIRECTION FROM SUBPACKAGE 1	NORTH	2	VISUAL	GREATER THAN 80^{0} FROM RTG
	LEVEL	$\pm 5^{0}$ OF VERTICAL	2	BUBBLE	INTERACTS WITH ALIGNMENT
	ALIGN WITH UHT SHADOW AT DECAL	$\pm 5^{0}$ OF E-W	2	ARROW AND SHADOWS	THERMAL REQ FOR SUN SHIELD SHADOWS TO ALIGN WITH PLATE EDGES
PROBES (2)	DISTANCE FROM ELECTRONICS	$\underline{18} \pm 1$ ft (16 FT CABLE MARKS)	1	PACED OFF (CABLE MARKED FOR DEPTH)	TO OBTAIN 30 ft SEPARATION BETWEEN PROBES (REQUIREMENT)
	DIRECTION FROM ELECTRONICS	140^{0} APART	1		PROBE AND RTG SEPARATION* AVOID SHADOWS OR ANY OTHER DISTURBANCE FROM ALL SUBSYSTEMS
	VERTICAL ALIGNMENT	WITHIN $\pm 15^{0}$	2	VISUAL	OBJECTIVE FOR DRILLING
EXPERIMENT INTERRELATION		*SEPARATION DISTANCE FROM RTG: 40 ft MINIMUM, AVOID MAJOR DISTURBANCES (TRAMPLING, ETC.) AND SHADOWS IN 17 ft CIRCLE AROUND PROBE.			

HFE ALIGNMENT MARKINGS



FEB 72 3270.7.28

APOLLO LUNAR SURFACE DRILL



- EARTH WEIGHT, LB: 29.54 (TOTAL)
- STOWED SIZE, IN.: 22.7 X 9.6 X 7 (NOT INC DRILL STRING & CAPS)
- DRILL OPERATED BY SELF-CONTAINED BATTERY
- BATTERY INSTALLED 5 DAYS PRELAUNCH
- BATTERY SHELF LIFE { DRY: 2 YR / ACTIVATED: 30 DAYS
- DRILLING PRINCIPLE: ROTARY – PERCUSSION
- TORQUE REACTION SYSTEM: NONE (MINIMAL VERTICAL & ROTARY REACTION, EVEN IN ROCK)
- DRILLING TIME: 5 TO 15 MIN/HOLE (DEPENDING ON MATERIAL)

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