Bendix

Aerospace Systems Division

Command List (Array E)	ATM-930 / D
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This listing of command allocations is applicable to ALSEP Array E, with the following complement of experiments:

#1 Lunar Mass Spectrometer
#2 Lunar Ejecta and Meteorites
#3 Heat Flow
#4 Lunar Surface Gravimeter
#5 Lunar Seismic Profiling

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TABLE 1

Symbol	Command Nomenclature	Octal Command	Termination Point
CD-32	DP Formatting ON[1, 3]	005	Data Processor
CD-33	Normal Bit Rate[1, 3]	006	" "
CD-34	Slow Bit Rate[3]	007	" "
CD-38	LSP Formatting ON[3]	003	" "
CD-39	Transmitter A ON[2]	012	Power Dist. Unit
CD-40	Transmitter A OFF	013	" " "
CD-41	Transmitter B OFF[2]	014	" " "
CD-42	Transmitter B ON	015	" " "
CD-5	PDR #1 ON	017	" " "
CD-6	PDR #1 OFF[2]	021	" " "
CD-7	PDR #2 ON	022	" " "
CD-8	PDR #2 OFF[2]	023	" " "
CD-43	ADP X Select[2]	024	" " "
CD-44	ADP Y Select	025	" " "
CD-47	Ripple-off Reset[1]	032	Command Decoder
CD-11	DDP X Select[2]	034	Power Dist. Unit
CD-12	DDP Y Select	035	" " "
CD-13	Experiment 1 Power ON	036	" " "
CD-14	Experiment 1 Power Standby	037	" " "
CD-15	Experiment 1 Power OFF[2]	041	" " "
CD-16	Experiment 2 Power ON	042	" " "
CD-17	Experiment 2 Power Standby	043	" " "

[1] Automatically selected at turn-on.

[2] Lunar surface initial conditions preset by latching relays during final system checkout.

[3] Change occurs at end of ALSEP frame during which command is executed.

TABLE 1 (CONT)

Symbol	Command Nomenclature	Octal Command	Termination Point
CD-18	Experiment 2 Power OFF[2]	044	Power Dist. Unit
CD-19	Experiment 3 Power ON	045	" " "
CD-20	Experiment 3 Power Standby	046	" " "
CD-21	Experiment 3 Power OFF[2]	050	" " "
CD-22	Experiment 4 Power ON	052	" " "
CD-23	Experiment 4 Power Standby	053	" " "
CD-24	Experiment 4 Power OFF[2]	054	" " "
CD-25	Experiment 5 Power ON	055	" " "
CD-26	Experiment 5 Power STANDBY[2]	056	" " "
CD-27	Experiment 5 Power OFF	057	" " "
CD-36	Periodic Commands Enable[1]	104	Command Decoder
CD-37	Periodic Commands Inhibit	105	" "
CD-51	ADP Power Relay X Select	107	Power Dist. Unit
CD-50	Uplink/ADP Power Relay W Select[2]	110	" " "
CD-48	Switch Uplink[9]	122	Command Decoder
CD-49	Delay Uplink Switchover[5]	174	" "
CU-1	APM #1 ON[1]	027	Power Cond. Unit
CU-2	APM #1 OFF	031	" " "
CU-3	APM #2 ON[1]	115	" " "
CU-4	APM #2 OFF	113	" " "
CU-5	PC #1 Select[2]	060	" " "
CU-6	PC #2 Select	062	" " "
CU-7	PC Auto Select #1[2,6]	120	" " "
CU-8	PC Auto Select #2	121	" " "
CG-1	Slave Heater Power ON	63	Lunar Surface Gravimeter
CG-2	Slave Heater Power OFF	64	" " "
CG-3	Command Execute[4]	67	" " "
CG-4	Command Decoder Power ON[10]	70	" " "

[1,2] See Page 2. [4] See Page 7, Note 1. [5,6,9,10] See Page 4.

TABLE 1 (CONT)

Symbol	Command Nomenclature	Octal Command	Termination Point
CG-5	Command Decoder Power OFF	71	" " "
CG-6	Step Command Counter UP	72	" " "
CG-7	Step Command Counter DOWN	74	" " "
CJ-1[7]	LEAM Calibrate HIGH/LOW (Periodic Command)	111	LEAM
CJ-2	LEAM Mirror Cover Release	112	"
CJ-3	LEAM Sensor Cover Release	114	"
CJ-4	LEAM Heater ON/OFF/AUTO	117	"

[4] See NOTE 1, page 7, for details of encoded LSG commands.

[5] Automatic reset at turn-on ensures that CD-49 (Octal 174) is not effective until commanded.

[6] This violates normal operating requirements. CU-8 (Octal 121) will be transmitted after satisfactory PC#1 turn-on.

[7] Also generated automatically within ALSEP as a pair of commands 3.5 minutes apart, every 15.4 hours, unless inhibited by execution of CD-37 (Octal 105).

[9] Also generated automatically within ALSEP 7.6 hours after turn-on, then every 61.8 hours, unless each potential switch is inhibited by the prior transmission of CD-49 (Octal 174). It is not possible to permanently inhibit the automatic generation of CD-48 (Octal 122) except by the regular transmission of CD-49 at intervals not exceeding 61.8 hours.

[10] Transmission of command CG-4 will also clear the LSG command counter to 00000 (binary).

TABLE 1 (CONT)

Symbol	Command Nomenclature	Octal Command	Termination Point
CM-1[8]	LMS Load Command #1	123	LMS Experiment
CM-2	LMS Load Command #2	124	" "
CM-3	LMS Load Command #3	125	" "
CM-4	LMS Load Command #4	127	" "
CM-5	LMS Load Command #5	132	" "
CM-6	LMS Load Command #6	133	" "
CM-7	LMS Execute and Clear	134	" "
CH-1	Normal (Gradient) Mode Select[1]	135	Heat Flow Experiment
CH-2	Low Conductivity Mode Select (Ring Source)	136	" " "
CH-3	High Conductivity Mode Select (Heat Pulse)	140	" " "
CH-4	HF Full Sequence Select[1]	141	" " "
CH-5	HF Probe #1 Sequence Select	142	" " "
CH-6	HF Probe #2 Sequence Select	143	" " "
CH-7	HF Subsequence #1 } Command	144	" " "
CH-8	HF Subsequence #2 } Functions as shown	145	" " "
CH-9	HF Subsequence #3 } in Note 3	146	" " "

[8]Encoding of the CM series is described in Note 2, page 9.

TABLE 1 (CONT)

Symbol	Command Nomenclature	Octal Command	Termination Point
CH-10	HF Heater Advance (Steps through following 16-step sequence, one step per command) All heaters off — All heaters off Probe #1 heater #2 ON — Probe #2 heater #2 ON All heaters off — All heaters off Probe #1 heater #4 ON — Probe #2 heater #4 ON All heaters off — All heaters off Probe #1 heater #1 ON — Probe #2 heater #1 ON All heaters off — All heaters off Probe #1 heater #3 ON — Probe #2 heater #3 ON repeat	152	Heat Flow Experiment
CS-1	Transmitter Pulses ON	156	LSP Experiment
CS-2	Transmitter Pulses OFF	162	" "
CS-3	Amplifier Gain Normal	163	" "
CS-4	Amplifier Gain Low	164	" "
CS-5	Geophone Calibrate	170	" "

Note 1

LSG Commands

An expanded command capability is accomplished in the LSG experiment by decoding a 5-Stage, "Up-Down" Command Counter. Thirty of the possible thirty-two states of the counter are used to generate command functions. State of the Counter is read out through the telemetry link.

Three command lines are used to step the command counter (up or down) and to generate a command execute function.

A list of all LSG experiment command counter states and the associated functional command assignments is provided below:

Command Symbol	Binary Count	Command Function
CG-8	00001	Read Shaft Encoder
CG-9	00010	Mass Change Motor ON
CG-10	00011	Bias In
CG-11	00100	Bias Out
CG-12	00101	Integrator, Normal Mode
CG-13	00110	Integrator, Short Mode

LSG ELECTRONICS COMMAND ASSIGNMENT (CONT)

Symbol	Binary Count	Command Function
CG-14	00111	Seismic Low Gain
CG-15	01000	Seismic High Gain
CG-16	01001	Sensor Beam Caged
CG-17	01010	Sensor Beam Uncaged
CG-18	01011	Coarse Screw Servo ON
CG-19	01100	Tilt, Mass Chg., Screw Servo & Press Trans. OF
CG-20	01101	Pressure Tranducer ON
CG-21	01110	Mass Change Increment
CG-22	01111	Gross Slew Up/ Tilt Increment Up
CG-23	10000	Gross Slew Down/ Tilt Incr. Down
CG-24	10001	Vernier Slew Up
CG-25	10010	Vernier Slew Down
CG-26	10011	Fine Screw Servo ON
CG-27	10100	North/ South Tilt Servo ON
CG-28	10101	East/ West Tilt Servo ON
CG-29	10110	Temperature Relay #1
CG-30	10111	Temperature Relay #2
CG-31	11000	Temperature Relay #3
CG-32	11001	Temperature Relay #4
CG-33	11010	Temperature Relay #5
CG-34	11011	Temperature Relay #6
CG-35	11100	Temperature Reset
CG-36	11101	Post Amp. Gain Increment
CG-37	11110	Post Amp. Gain Reset

Note 2

Mass Spectrometer Command Structure

Octal commands 123 through 125, 127, and 132 through 134 inclusive, are encoded in specific sequences to provide 15 discrete commands for the Mass Spectrometer Experiment, as follows:

Symbol	Function	Sequence						
		123	124	125	127	132	133	134
CA-1	Step Mult, Sweep HV ON & Back-up Htr OFF	X	X					X
CA-2	Lock (Sweep Hold) & J-Plate Voltage Step	X		X				X
CA-3	One-Step (Sweep Advance)	X			X			X
CA-4	*Emission/Filaments OFF	X				X		X
CA-5	Filament #1 ON[3]	X					X	X
CA-6	Filament #2 ON[3]		X	X				X
CA-7	Mult High & Back-up Htr ON		X		X			X
CA-8	*Mult Low		X			X		X
CA-9	Disc High & J-Plate Voltage Step Enable		X				X	X
CA-10	*Disc Low & J-Plate Voltage Step Inhibit			X	X			X
CA-11	Bakeout Enable[2]			X		X		X
CA-12	*Bakeout Disable			X			X	X
CA-13	Dust Cover Removal				X	X		X
CA-14	Ion Pump ON[1]				X		X	X
CA-15	*Ion Pump, Mult, and Sweep HV OFF					X	X	X

* Preset Turn-On Operating Mode.

1 This command is inhibited if CA-1 is on, and CA-15 command must precede CA-14 in this case. CA-1 is not inhibited if CA-14 is on.

2 After this command the LMS must be commanded to standby to perform bakeout.

3 Mutually inhibited. CA-4 must be sent to switch filaments.

Entry Into the Cyclic Mode in which the filament bias is cycled through -70, -25, -20 and -18 Volt D. C; send the command sequence:

CA -4; CA -9; CA -10; CA -5 or CA--6; CA -1.

CA -4 is only necessary if the filaments are initially ON.

Note 3

Heat Flow Command Structure

Octal commands 144 through 146 are used to select subsets of the full heat flow measurement sequence as follows:

Command 144 selects a subset consisting of the four high sensitivity gradient measurements only.

Command 144 followed by command 145 selects a subset consisting of the four low sensitivity gradient measurements only.

Command 144 followed by command 146 selects a subset consisting of probe ambient temperature measurements only.

Command 145 followed by command 146 selects a subset consisting of thermocouple measurements only.

Command Availability and Usage, and Test Commands

Command usage is summarized in Table 2, and is also displayed for all the 128 potential commands, which could be derived from the seven bit command word, in Table 3. The command functions shown in Table 3 are determined by the Command Decoder design; 104 commands are physically decoded, of which 79 are currently used to control the system.

All 25 spare command outputs are available at the Command Decoder connectors and 19 of these spares could be used without restriction. The remaining six spares have the following limitations:

(a) Unless inhibited, Octal Commands 065 and 131 are pulsed automatically once every 15.4 hours, in addition to any ground transmissions. (See Octal Command 111, Page 4.)

(b) Octal Commands 157, 167, 173 and 176 are primarily intended to be test commands (see below). They will not be used for system control until all other spares have been used.

All the spare outputs, except those for Octal Commands 011, 033 and 106, are rise- and fall-time controlled to between 2 microseconds and 10 microseconds.

Test commands are the fourteen Octal numbers which in their binary equivalents have only one '1' or one '0', in all the possible positions. They can be transmitted, as required, to diagnose possible faults in the parity check and CVW circuits. Since most of the test commands are not physically decoded, and the four that are decoded are not used, there is no possibility of a test command in normal fault-free operation causing a system status change.

TABLE 2

COMMAND SUMMARY

Termination Point	Number of Commands
Power Distribution Unit (Power Switching)	29
Power Conditioning Unit	8
Command Decoder	5
Data Processor	4
Lunar Surface Gravimeter Experiment	7
Mass Spectrometer Experiment	7
Heat Flow Experiment	10
Seismic Profiling Experiment	5
Lunar Ejecta and Meteoroid Experiment	4
Total	79

Function	Octal Code	Number
Test Commands	1, 2, 4, 10, 20, 40, 100, 77, 137, 157[1], 167[1], 173[1], 175, 176[1]	14
ALSEP Addresses	130, 30, 116, 16, 151[2], 25[3], 65[4], 62[3], 144[3]	9
Address Complements	47, 147, 61, 161, 26, 152[3], 112[3], 115[3], 33[4]	9
Never used as command	0, 177	2
Commands Assigned to Array E		79
Commands Exclusively Reserved for Other Usage or not Decoded		24
Available Commands Not Assigned in Array E		25
Total Available Encodings of 7-Bits		128

[1] 157, 167, 173 and 176 are also spare commands.

[2] Address for Array E is 151. (Only one address is used on Array E)

[3] These ALSEP Addresses and Address complements are also used as assigned Array E commands.

[4] 33 and 65 are also decoded spare commands, not currently assigned.

TABLE 3

CROSS REFERENCE OF COMMAND NUMBER TO COMMAND FUNCTION

Octal Command	Array E Command Symbol	Test Cmds.	ALSEP Address	ALSEP Address Complement	Not Physically Decoded as Command	Decoded but Not Assigned i.e. Spare
1		X			X	
2		X			X	
3	CD-38					
4		X			X	
5	CD-32					
6	CD-33					
7	CD-34					
10		X			X	
11						X
12	CD-39					
13	CD-40					
14	CD-41					
15	CD-42					
16			X		X	
17	CD-5					
20		X			X	
21	CD-6					
22	CD-7					
23	CD-8					
24	CD-43					
25	CD-44		X			
26				X	X	

TABLE 3 (CONT)

Octal Command	Array E Command Symbol	Test Cmds.	ALSEP Address	ALSEP Address Complement	Not Physically Decoded as Command	Decoded but not Assigned i.e. Spare
27	CU-1					
30			X		X	
31	CU-2					
32	CD-47					
33				X		X
34	CD-11					
35	CD-12					
36	CD-13					
37	CD-14					
40		X			X	
41	CD-15					
42	CD-16					
43	CD-17					
44	CD-18					
45	CD-19					
46	CD-20					
47				X	X	
50	CD-21					
51					X	
52	CD-22					
53	CD-23					
54	CD-24					
55	CD-25					
56	CD-26					

TABLE 3 (CONT)

Octal Command	Array E Command Symbol	Test Cmds.	ALSEP Address	ALSEP Address Complement	Not Physically Decoded as Command	Decoded but Not Assigned i.e. Spare
57	CD-27					
60	CU-5					
61				X	X	
62	CU-6		X			
63	CG-1					
64	CG-2					
65			X			X
66						X
67	CG-3					
70	CG-4					
71	CG-5					
72	CG-6					
73						X
74	CG-7					
75						X
76						X
77		X			X	
100		X			X	
101						X
102						X
103						X
104	CD-36					

TABLE 3 (CONT)

Octal Command	Array E Command Symbol	ALSEP Address	ALSEP Address Complements	Not Physically Decoded as Command	Decoded but Not Assigned i.e. Spare
105	CD-37				
106					X
107	CD-51				
110	CD-50				
111	CJ-1				
112	CJ-2		X		
113	CU-4				
114	CJ-3				
115	CU-3		X		
116		X		X	
117	CJ-4				
120	CD-7				
121	CD-8				
122	CD-48				
123	CM-1				
124	CM-2				
125	CM-3				
126				X	
127	CM-4				
130		X		X	
131					X
132	CM-5				

TABLE 3 (CONT)

Octal Command	Array E Command Symbol	Test Cmds.	ALSEP Address	ALSEP Address Complements	Not Physically Decoded as Command	Decoded but Not Assigned i.e. Spare
133	CM-6					
134	CM-7					
135	CH-1					
136	CH-2					
137		X			X	
140	CH-3					
141	CH-4					
142	CH-5					
143	CH-6					
144	CH-7		X			
145	CH-8					
146	CH-9					
147				X	X	
150						X
151			X		X	
152	CH-10			X		
153						X
154						X
155						X
156	CS-1					
157		X				X
160						X

TABLE 3 (CONT)

Octal Command	Array E Command Symbol	Test Cmds.	ALSEP Address	ALSEP Address Complement	Not Physically Decoded as Command	Decoded but Not Assigned i.e. Spare
161				X	X	
162	CS-2					
163	CS-3					
164	CS-4					
165						X
166						X
167		X				X
170	CS-5					
171						X
172						X
173		X				X
174	CD-49					
175		X			X	
176		X				X
177					X	
000					X	
	Totals 79	14	9	9	24	25

Command Verification Word Generation

In the Data Processor Formatting Mode, with a few exceptions, bits 8 thru 14 following the Array E address will always be transmitted via the downlink as a CVW. This applies even if the contents of the command register are not capable of being decoded to give an Array E command. The parity bit downlinked as part of the CVW (i.e. Message Acceptance Pulse, MAP) simply shows that bits 1 thru 7 following the address were the complement of bits 8 thru 14. It is no way dependent upon whether the command word is physically decoded or has executed to cause a system change.

The exceptions to the normal CVW rule are as follows:

	Octal Command		
1.	003	LSP Formatting ON	CVW will <u>never</u> be transmitted.
2.	005 006 007	DP Formatting ON Normal Bit Rate Slow Bit Rate	CVW are <u>always</u> transmitted but will not be observed unless the ground system is already in lock i.e., the system is already in the required mode or bit rate.
3.	012 013 014 015	Transmitter A ON Transmitter A OFF Transmitter B OFF Transmitter B ON	Any change from "RF carrier" to "no RF carrier", or vice versa, will not give a CVW. If A is ON, and B is switched ON or OFF, then a CVW will be received if the ground system can ride over the random RF carrier phase change. If B is ON, then a CVW should always be received for A ON or A OFF.
4.	Power switching commands, in particular PDR, APM and Experiment power commands.		Power transients in excess of approximately 10 watts may sometimes cause a loss of CVW, particularly if the Reserve Power is very high or very low. Under normal timeline and operating rules it is possible that no CVW will be lost. Most likely, but not the only candidates are: 022 PDR #2 ON 023 PDR #2 OFF 036, 037, 041 LMS Power Commands

4.			027, 031, 115, 113 — APM ON/OFF Commands — Not Normal Operation Tendency to CVW loss tends to increase at low temperatures.
5.	034 035	DDP X Select DDP Y Select	If the DDP is already in the required state, then a CVW will always be received. If a DDP changeover actually takes place, then it may be assumed that a CVW will not be received, since the probability of a DDP change without sync loss is almost certainly less than 1 in 1500.
6.	122	Switch Uplink	If the uplink actually switches than a CVW will not be received. If the uplink does not switch, then a CVW will be received.
7.	060 062	PC #1 Select PC #2 Select	Although it is theoretically possible for a CVW to be received under certain conditions, a PC changeover will normally not give a CVW. The most likely reason for receiving a CVW is that the system is already in the required state.

No CVW will be transmitted for any command while the ALSEP System is in LSPE Formatting Mode.