Bendix

Aerospace Systems Division

POWER DISTRIBUTION UNIT (ARRAY E)	AL 310210
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PERFORMANCE/DESIGN AND PRODUCT CONFIGURATION REQUIREMENTS

POWER DISTRIBUTION UNIT (PDU) FOR DATA SUBSYSTEM ARRAY E

APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE SYSTEM

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1.0 Scope. - This specification establishes the requirements for performance, design, test, and qualification of the component identified as the power distribution unit (PDU) of the central station subsystem (specification AL 210 100) for the apollo lunar surface experiments package (ALSEP) array E. This component is used to:

a. Accept power from the power conditioning unit (PCU),

b. Route it on command to the various central station units and experiments.

c. Provide telemetry signals indicating the status of each load control, and the internal unit temperature, to the data processor (specification AL 310 910)

2.0 Applicable documents. - The following documents, of exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced here and other detail content of Section 3, the detail requirements of Section 3 shall prevail.

Specifications

Military.

MIL-E-5272C (1) (Section 3)	Environmental Testing, Aeronautical and Associated Equipment, General Specification for
MIL-W-6858	Welding
MIL-I-26600(2)	Interference Control Requirements, Aeronautical Equipment

Standards.

Military.

MIL-STD-130C	Identification Marking of US Military Property

MIL-STD-810B	Environmental Test Methods for Aerospace and Ground Equipment
MIL-STD-889	Metals, Definition of dissimilar

Other publications.

Bendix.

ATM-241	Acceptable Parts List
ATM-242	Approved Materials List
AL 210 100	Central Station Subsystem Specification
AL 230 000	Electrical Power Subsystem Specification
AL 310 810	Command Decoder Specification
AL 310 910	Data Processor Specification
AL 510 100	Array E PCU
AL 770 000	EMI specification
ARD 98	Diplexer and Switch for Data Subsystem
ARD 106	Command Receiver Specification
ARD 503	Transmitter for Data Subsystem

NASA

NHB 5300 4(3A)	Quality Requirements for Hand Soldering of Electrical Connections
MSC-ASPO-EMI-10A	NASA Addendum to Specification MIL-I-26600

NASA/MSC criteria and standards.

DS-1	System Accessibility for Maintenance
DS-4	Separation of Redundant paths
DS-5	Transistors - Selection of Types
DS-22	Flammability of Wire Bundles
DS-25	Wire Bundles - Protective Coatings
PS-5	Protection of Electrical/Electronic Assemblies from Moisture Damage
PS-6	Ultrasonic Cleaning Electrical and Electronic Assemblies
PS-8	Application of Previous Qualification Tests
PS-11	Direct Procurement of Parts

3.0 Requirements. - The power distribution unit (PDU) shall accept power from the power conditioning unit (PCU), (specification AL 510 100) a part of the power subsystem (Specification AL 230 000), and distribute this power to the other ALSEP component and subsystem loads.

The PDU shall generate status signals which indicate the position of all its load controls. The PDU shall also provide internal temperature monitor signals.

3.1 Load control. - The PDU shall, in response to signals from the command decoder (Specification AL 310 810), route power to the various experiments and redundant central station units. The PDU shall be designed to minimize quiescent power loss when no signals are applied. The use of latching controls and complementary symmetry is encouraged to achieve this goal.

3.1.1 Input signals shall be provided by the command decoder and may be provided by 5v TTL gates normally in the high state. The levels provided shall be as given in Table 1a.

TABLE 1 - Input Signal Pulses

Line	(1) State	(2) Applied emf	(3) Input current	(4) Duration
a	quiescent	+2.4 to +5 VDE	0	∞
b	active	0 to +0.3 VDE	600μ ADC min.	5 to 22 ms

The PDU shall present to these signals a load of: 10 K ohms minimum on each input line. 5.6 VDE maximum

3.1.2 Load control power dissipation. When no signal is being received (quiescent state), the power dissipated in the PDU shall not exceed 2.4 mW per quiescent command line. When a signal is being received (active state) to change the state of a load control, the power shall not exceed 4 W per active line. These powers shall not be construed to include the loss due to currents being supplied thru the PDU to the central station unit and experiment loads.

3.1.3 Load control signals shall be those listed in Table 2 Column 2. A single signal shall switch all the power lines listed in columns 3 and 4 opposite that command. Within 5 ms after the leading edge of the command pulse, all load switching actions listed in Table 2 shall be completed.

3.1.4 Load control relays, whose contacts handle the load current, shall have those contacts rated at at least 2 times the current of Table 2, Col. 5 for the expected number of operations of the relay. Where contacts are connected in parallel, this rating shall apply to each contact.

3.1.5 PCU isolation shall be incorporated in all PDU power lines so that no emf shall appear on the lines from that part of the PCU which is not supplying power to the system.

TABLE 2 - LOADS SUPPLIED BY THE PDU

Line	(1) Controlled Function	(2) Commands	(3) Loads VDE	(4) Loads Destination	(5) Currents (mA) Expected	(6) Currents (mA) Trip	(7) Overload Protection Device	(8) Overload Protection Action	(9) Redund. Type
a.0	Experiments	OFF	0		-	-	-	-	-
a.1	(Exp)	STBY	+29	Experiments	545	1000	F	discon. load	1
a.2	(each of 6)	ON	+29	Experiments	560	606	CB	sw. to STBY	1
b.1	Uplink (Upl)	A ON	+12	Receiver A	58	150	CB	sw. to B ON	1
b.2	"	"	+12	Cmd Decod. A					
b.3	"	"	+5	" " A	78	350	CB	"	1
b.4	"	"	-12	" " A	4	150	CB	"	1
b.5	"	B ON	+12	Receiver B	58	150	CB	sw. to A ON	1
b.6	"	"	+12	Cmd Decod. B					
b.7	"	"	+5	" " B	78	350	CB	"	1
b.8	"	"	-12	" " B	4	150	CB	"	1
c.1	Digital data	A ON	+5	DDP A	150	270	CB	sw. to B ON	1
c.2	Processor (DDP)	B ON	+5	DDP B	150	270	CB	sw. to A ON	1
d.1	Analog data	A ON	+12	ADP A	13	150	CB	sw. to B ON	1
d.2	Processor (ADP)	"	+5	"	65	350	CB	"	1
d.3	"	"	-12	"	33	150	CB	"	1
d.4	"	B ON	+12	ADP B	13	150	CB	sw. to A ON	1
d.5	"	"	+5	"	65	350	CB	"	1
d.6	"	"	-12	"	33	150	CB	"	1

TABLE 2 - LOADS SUPPLIED BY THE PDU (CONT.)

Line	(1) Controlled Function	(2) Commands	(3) Loads VDE	(4) Loads Destination	(5) Currents (mA) Expected	(6) Currents (mA) Trip	(7) Overload Protection Device	(8) Overload Protection Action	(9) Redund. Type
e.1	Transmitter	A OFF	-	-	-	-	-	-	-
e.2	(Xmtr)	A ON	+29	Xmtr A	300	760	CB	sw. to A OFF	1
e.3	"	B OFF	-	-	-	-	-	-	-
e.4	"	B ON	+29	Xmtr B	300	760	CB	sw. to B OFF	1
e.5	"	"	+12	Diplexer	10	150	CB	-	1
f.1	Power dump	1 OFF	-	-	-	-	-	-	-
f.2	(PDM)	1 ON	+29	Pwr. dump mod.	321	600	F	Discon. load	1
f.3	"	2 OFF	-	-	-	-	-	-	-
f.4	"	2 ON	+29	Pwr. dump mod.	641	1000	F	Discon. load	1
g.1	Unswitched emf	none	+29	Data proc.	4.0	-	none		0
g.2	"	"	+12	Cmd. decod.	1	-	"		0
g.3	"	"	+12	Data proc.	83	-	"		0
g.4	"	"	+5	Cmd. decod.	40	-	"		0
g.5	"	"	+5	Data proc.	22	-	"		0
g.6	"	"	-12	Cmd. decod.	1	-	"		0
g.7	"	"	-12	Data proc.	2	-	"		0

3.1.6 Over current protection - The type of device used, nominal trip current, and action to be taken when over current occurs shall be as given in Table 2, columns 6 and 8.

3.1.6.1 Fuses ("F") shall conduct the trip current (column 6) for at least 4 hours. At 2 times the trip current, they shall break the circuit within 5 seconds.

3.1.6.2 Circuit breakers ("CB") - shall trip at a value within ±200 ppK (parts per thousand) of the column 6 value. Upon sensing an over current, the circuit breaker shall disconnect all power to the defective load within 10 ms. The column 8 action shall be completed within an additional 10 milliseconds by the affected PDU load control. The circuit breaker shall then be reset so that, upon receipt of a signal to switch back to the defective load, all emfs will be applied to that load if the over current condition has disappeared. Circuit breaker reset shall not occur until all power lines to the defective load have been switched per column 8.

3.1.7 Redundancy of each PDU power line shall be as coded in Table 2 Column 9. The various code numbers shall indicate:

3.1.7.1 "0" - No redundancy. Power shall be accepted from either PCU half.

3.1.7.2 "1" - Parallel load current paths shall be provided with a load control in each path. Power shall be accepted from either PCU half.

3.1.8 Special Requirements for the various power control circuits follow:

3.1.8.1 Experiment power control shall be commandable from any one of its modes (OFF, STBY, ON) to any other one, except that it shall not be possible to switch from OFF to STBY directly. Logic shall be incorporated to prevent both ON and STBY power lines to any experiment from being simultaneously energized.

3.1.8.2 Uplink Power Control shall insure that either uplink (receiver and command decoder units) A or uplink B receives power, but not both. In particular, precautions shall be taken to protect the +5v lines against welded power relay contacts which would cause this simultaneous output condition to exist. The RELAY RESET W CMD and the UPLINK AUTO TOGGLE X SIG shall be used to secure this protection.

TABLE 3 - PDU EMF DROPS

Line	(1) Power Control	(2) Output Line	(3) Current (mA)	(4) Drop (mV)
a.1	Experiment	+29 STBY	130	650-900
a.2	"	+29 OP	325	900-1300
b.1	Uplink	+12 Receiver A/B	58	700-1050
b.2	"	+12 Cmd. Decod. A/B	58	700-1050
b.3	"	+5 " " "	78	650-1050
b.4	"	-12 " " "	4	400-800
c	DDP	+5 DDP A/B	150	800-1200
d.1	ADP	+12 ADP A/B	13	500-850
d.2	"	+5 ADP "	65	650-1050
d.3	"	-12 " "	33	600-950
e.1	Transmitter	+29 Xmtr. A/B	300	800-1200
e.2	"	+12 Diplexer B	10	450-850
f.1	PDM	+29 #1	310	650-950
f.2	"	+29 #2	665	700-1000
g.1	Unswitched	+29 Data Proc.	4.0	450-700
g.2	"	+12 Cmd. Decod.	85	600-900
g.3	"	+12 Data Proc.	85	600-900
g.4	"	+5 Cmd. Decod.	62	600-850
g.5	"	+5 Data Proc.	62	600-850
g.6	"	-12 Cmd. Decod.	4	500-700
g.7	"	-12 Data Proc.	4	500-700

3.1.8.3 Digital data processor (DDP) power control shall incorporate circuitry to prevent +5V from being applied to both DDP's simultaneously.

3.1.8.4 Analog data processor power control special requirements shall be identical to those of the uplink power control, except that the commands used to guard against +5V simultaneous outputs shall be the RELAY RESET W CMD and ADP RELAY RESET X CMD.

3.1.8.5 Unswitched power lines shall provide the output emfs indicated in Table 2 regardless of which PCU half is supplying power.

3.1.9 Stored power - The PDU shall not lose its ability to clear an over current condition even if that condition momentarily disables the PCU output(s). The PDU shall incorporate energy storage which shall supply power to those parts of the load controls which are needed to take the protective action required in Table 2, Column 8. The amount of usable energy stored shall be adequate for any one load control to clear its load.

3.1.10 Emf drops shall not exceed the values given in Table 3, Column 4, when the Column 3 currents are being taken by the load. Only the single output line being measured shall be drawing any load current.

3.1.11 Telemetry - The PDU shall monitor the position of each load control or of each group of load controls designed to act in unison. The PDU shall then condition and combine the signals as necessary, for use by the data processor unit. Specifically, the signals to be combined on each of the six output status telemetering channels are listed in Table 4.

TABLE 4 - PDU STATUS TELEMETERING CHANNELS

Line	(1) Monitored Mode	(2) Output Channel
a.1	Experiment 1 STBY	
a.2	" 1 OP	
a.3	" 2 STBY	Status: Exp 1 & 2
a.4	" 2 OP	
b.1	Experiment 3 STBY	
b.2	" 3 OP	
b.3	" 4 STBY	Status: Exp 3 & 4
b.4	" 4 OP	
c.1	Experiment 5 STBY	
c.2	" 5 OP	
c.3	" 6 STBY	Status: Exp 5 & 6
c.4	" 6 OP	
d.1	Uplink Toggle	Status: Uplink
d.2	" A	
e.1	ADP Toggle	Status: ADP
e.2	" A	
f.1	PDM #1	Status: Power Dumps
f.2	" #2	

If any of the mode signals of Table 4 Column 1 are higher than +10V, the related output channel(s) (Col. 2) shall be protected against the possibility of more than +10 V appearing on a PDU telemetering output caused by an open resistor.

3.1.11.1 Telemetry Codes - The emf generated by the various combinations of modes on each output channel shall be as given in Tables 5, 6 and 8, Columns 4 and 5. The W and X appearing in Table 6, Column 2 indicates the last command sent to the +5V anti-simultaneity circuit (see paragraph 3.1.8.2 and 3.1.8.4).

TABLE 5 - PDU TELEMETERING EMFS: EXPERIMENTS

	(1)	(2)	(4)	(5)
	Modes		Output emf(v)	
Line	Exp. 1, 3, or 5	Exp. 2, 4, or 6	Min.	Max.
0	OFF	OFF	0.000	0.128
1	STBY	OFF	0.148	0.443
2	ON	OFF	0.463	0.758
4	OFF	STBY	1.093	1.388
5	STBY	STBY	1.407	1.703
6	ON	STBY	1.722	2.018
8	OFF	ON	2.352	2.648
9	STBY	ON	2.667	2.963
10	ON	ON	2.982	3.278

TABLE 6 - PDU TELEMETERING EMFS: UPLINK OR ADP

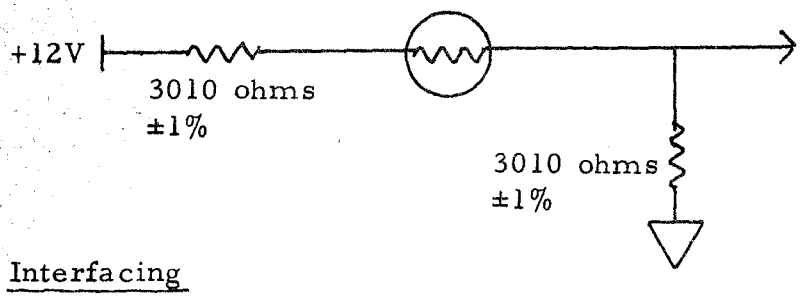
	(1)	(2) Modes	(3)	(4) Output emf(v)	(5)
Line	PCU In Use	Power Routing	Load	Min.	Max.
0.a	1	X	B	0.000	0.128
0.b	2	W	B	0.000	0.128
1.a	1	W	B	0.148	0.443
1.b	2	X	B	0.148	0.443
2.a	1	X	A	0.463	0.758
2.b	2	W	A	0.463	0.758
3.a	1	W	A	0.778	1.073
3.b	2	X	A	0.778	1.073

TABLE 8 - PDU TELEMETERING EMFS: PDM

	(1)	(2)	(4)	(5)
	Modes		Output emf(v)	
Line	Load 1	Load 2	Min.	Max.
0	OFF	OFF	0.0	0.6
4	ON	OFF	0.7	1.8
8	OFF	ON	1.9	3.1
12	ON	ON	3.2	6.0

3.1.12 Temperature sensing by means of two 15K ohm (@ +25C) thermistors (BxA 2335661-2) shall be included in the PDU. One shall monitor the PDU base plate temperature, and one shall be located as close as possible to the hottest spot in the unit.

The circuit used shall be:



3.2 Interfacing

3.2.1 Input signals shall be accepted by the PDU for setting the various power controls. The characteristics and functions of these commands and signals shall be as given in Tables 1 and 2 respectively.

They shall be expected to operate into a 5 M ohm min. load.

The specific signals sent out of the PDU shall be as described in paragraphs 3.1.11, 3.1.11.1, and 3.1.12.

3.2.2 Input Power - The PDU shall receive power from both halves of the PCU, only one half of which shall be energized at a time. The various emfs, together with the current ranges shall be as listed in Table 9.

TABLE 9 - PDU INPUT EMFS FROM THE PCU

	(1)	(2)	(3)	(4)	(5)	(6)
	Emf range (VDE)		Currents (mA)			Max. Ripple 0 to 50KHz
Line	Min.	Max.	Min.	Nom.	Max.	(mV p-p)
1	+29.4	+30.2	480	2000	2300	100
2	+12.4	+13.0	140	140	160	60
3	+ 5.4	+ 5.6	430	430	500	40
4	-12.3	-12.9	55	60	70	60

3.2.3 Output emf on each line from the PDU shall equal the input emf from the PCU listed in Table 9, Columns 1 and 2 less the drop of Table 3, Column 4.

3.2.4 Output signals from the PDU are routed to the data processor unit and LSP experiment. The signals' properties shall be:

1) Linear range: 0.00 to 5.00V

2) Damage free range: -0.02 to 10.0V

3) Source impedance: 5K ohms max.

3.2.5 Outside connector (J13) of the PDU shall mate with a Hughes WST 0132 F20 BVHO1 connector. The assignment of contacts shall be as listed in Table 10. Columns 1, 3, 5 and lines 18 through 26 are included for reference only.

3.2.6 Returns - The bulk of the PDU return current shall be conducted through the PDU's metal case to the central station thermal plate.

3.2.7 Heat dissipation - The PDU shall be designed so that the components will not operate at excessive temperatures if the only means of disposing of power losses is to be the Central Station thermal plate (held at -30 to +70 C) via the PCU/PDU case.

3.3 Operability

3.3.1 Reliability - Reliability shall be a prime consideration in design, development, and fabrication. Redundancy will be utilized in achieving the reliability goal. The design will provide maximum resistance to single point failures. As a design goal, the Power Distribution Unit shall have a 0.9992 probability of surviving launch, translunar flight, deployment, and lunar surface operation in the environment specified in paragraph 3.3.5 herein. The requirements of Document DS-4 shall apply.

3.3.2 Maintainability - Accessibility and interchangeability features shall be incorporated into the design to allow efficient servicing and maintenance. DS-1 shall apply.

3.3.3 Useful life - The Power Distribution Unit shall be capable of performing as specified herein for a period of two (2) years after a maximum earth storage period of three (3) years.

TABLE 10 - PDU CONNECTOR CONTACT ASSIGNMENTS

Line	(1) Code	(2) Function	(3) Solder Pad	(4) J13 Contact	(5) From
1	1P 29PA	+29VDE A input	16	1	Pwr Conv. Unit
2	2P 29PA	+29VDE A input	17	2	"
3	3P 29PA	+29VDE A input	23	3	"
4	1P 12PA	+12VDE A input	48	4	"
5	1P 05PA	+5VDE A input	18	6	"
6	2P 05PA	+5VDE A input	19	7	"
7	3P 05PA	+5VDE A input	20	8	"
8	1P 12NA	-12VDE A input	62	5	"
9	1P 29PB	+29VDE B input	58	23	"
10	2P 29PB	+29VDE B input	59	24	"
11	3P 29PB	+29VDE B input	60	25	"
12	1P 12PB	+12VDE B input	33	26	"
13	1P 05PB	+5VDE B input	93	28	"
14	2P 05PB	+5VDE B input	94	29	"
15	3P 05PB	+5VDE B input	95	30	"
16	1P 12NB	-12VDE B input	75	27	"
17	Return	Return	124	46	Thermal Plate
18		"	125	Frame	-
19		"	127	"	-
20		"	128	"	-
21		"	133	"	-
22		"	134	"	-
23		+29(Y)	24	Jumper	-
24		+29(YA)	15	Jumper	-
					-
					-

TABLE 10 - PDU CONNECTOR CONTACT ASSIGNMENTS (CONT.)

(1) Line	(2) Code	Function	(3) Solder Pad	(4) J13 Contact	(5) From
27	CL036ZN	Exp #1 power on cmd.	22	98	Command Decoder
28	CL037ZN	Exp #1 power standby "	36	97	" "
29	CL041ZN	Exp #1 power off "	44	96	" "
30	CL042ZN	Exp #2 power on "	85	116	" "
31	CL043ZN	Exp #2 power standby "	78	117	" "
32	CL044ZN	Exp #2 power off "	64	118	" "
33	CL045ZN	Exp #3 power on "	126	119	" "
34	CL046ZN	Exp #3 power standby "	100	120	" "
35	CL050ZN	Exp #3 power off "	92	121	" "
36	CL052ZN	Exp #4 power on "	131	122	" "
37	CL053ZN	Exp #4 power standby "	132	123	" "
38	CL054ZN	Exp #4 power off "	77	124	" "
39	CL055ZN	Exp #5 power on "	65	125	" "
40	CL056ZN	Exp #5 power standby "	57	126	" "
41	CL057ZN	Exp #5 power off "	4	104	" "
42	CL TBD	Exp #6 power on "	51	105	" "
43	CL TBD	Exp #6 power standby "	50	127	" "
44	CL TBD	Exp #6 power off "	110	128	" "
45	UPLAN	Select uplink A sig.	6	66	" "
46	UPLBN	Select uplink B sig.	1	65	" "
47	CL110ZN	UPL/ADP relay reset W cmd.	56	103	" "
48	UPSZN	Uplink auto togle X sig.	5	84	" "
49	CL034ZN	Select DDP A cmd.	115	64	" "
50	CL035ZN	Select DDP B cmd.	116	63	" "
51	CL024ZN	Select ADP A cmd.	10	62	" "
52	CL025ZN	Select ADP B cmd.	14	78	" "
53	CL107ZN	ADP relay set X sig.	13	102	" "

TABLE 10 - PDU CONNECTOR CONTACT ASSIGNMENTS (CONT.)

(1) Line	(2) Code	Function	(3) Solder Pad	(4) J13 Contact	(5) From
54	CL012ZN	Transmitter A on cmd.	12	79	Command Decoder
55	CL013ZN	Transmitter A off "	2	80	" "
56	CL015ZN	Transmitter B on "	70	81	" "
57	CL014ZN	Transmitter B off "	41	82	" "
58	CL017ZN	Power dump 1 on cmd.	63	83	" "
59	CL021ZN	Power dump 1 off "	40	101	" "
60	CL022ZN	Power dump 2 on "	7	100	" "
61	CL023ZN	Power dump 2 off "	27	99	" "
	Output				To
62	E1 POJK	Exp 1 operate +29V power	43	59	Experiment 1
63	E1 PSJK	Exp 1 standby +29V power	123	60	"
64	E2 POJK	Exp 2 operate +29V power	71	75	Experiment 2
65	E2 PSJK	Exp 2 standby +29V power	122	76	"
66	E3 POJK	Exp 3 operate +29V power	99	93	Experiment 3
67	E3 PSJK	Exp 3 standby +29V power	117	94	"
68	E4 POJK	Exp 4 operate +29V power	129	111	Experiment 4
69	E4 PSJK	Exp 4 standby +29V power	120	112	"
70	E5 POJK	Exp 5 operate +29V power	3	113	Experiment 5
71	E5 PSJK	Exp 5 standby +29V power	108	114	"
72	E6 POJK	Exp 6 operate +29V power	121	41	Experiment 6
73	E6 PSJK	Exp 6 standby +29V power	114	42	"
74	RX 12PA	Uplink A +12V power	47	21	Receiver
75	CD 12PA	Uplink A +12V power	54	19	Command Decoder
76	CD 05PA	Uplink A +5V power	68	39	" "
77	CD 12NA	Uplink A -12V power	84	40	" "

TABLE 10 - PDU CONNECTOR CONTACT ASSIGNMENTS (CONT.)

(1) Line	(2) Code	Function	(3) Solder Pad	(4) J13 Contact	(5) To
78	RX 12PB	Uplink B +12V power	76	22	Receiver
79	CD 12PB	Uplink B +12V power	83	38	Command Decoder
80	CD 05PB	Uplink B +5V power	53	58	" "
81	CD 12NB	Uplink B -12V power	69	37	" "
82	PD 05PX	DDP A +5V power	109	56	Data Processor
83	PD 05PY	DDP B +5V power	102	55	" "
84	PA 12PX	ADP A +12V power	49	73	Data Processor
85	PA 05PX	ADP A +5V power	82	71	" "
86	PA 12NX	ADP A -12V power	98	72	" "
87	PA 12 PY	ADP B +12V power	91	92	Data Processor
88	PA 05PY	ADP B +5V power	55	90	" "
89	PA 12NY	ADP B -12V power	67	91	" "
90	XA 29PA	Transmitter A +29V power	26	69	Transmitter A
91	XB 29PB	Transmitter B +29V power	25	68	Transmitter B
92	XB 12PB	Transmitter B +12V power	11	34	Diplexer
93	DM 1 PWR	Power dump load #1 +29V	130	132	Pwr. Dump Mod.
94	DM 2 PWR	Power dump load #2 +29V	113	131	" " "
95	DP 29PZ	Unswitched +29V	101	89	Data Processor
96	CD 12PZ	Unswitched +12V	31	52	Command Decoder
97	DP 12PZ	Unswitched +12V	32	54	Data Processor
98	CD 02PZ	Unswitched +5V	38	53	Command Decoder
99	DP 05PZ	Unswitched +5V	39	57	Data Processor
100	CD 12NZ	Unswitched -12V	45	70	Command Decoder
101	DP 12NZ	Unswitched -12V	46	74	Data Processor

TABLE 10 - PDU CONNECTOR CONTACT ASSIGNMENTS (CONT.)

(1) Line	(2) Code	Function	(3) Solder Pad	(4) J13 Contact	(5) To
102	HK-62	Temperature: PDU A	42	109	Data Processor
103	HK-63	Temperature: PDU B	35	110	" "
104	HK-12	Status: Exp 1 & 2	103	17	" "
105	HK-14	Status: Exp 3 & 4	118	16	" "
106	HK-73	Status: Exp 5 & 6	112	15	" "
107	HK-26	Status: Uplink	97	12	" "
108	HK-80	Status: Power dumps	111	107	" "
109	HK-90	Status: ADP togle	96	86	" "
110	HK-12	Status: Exp 1 & 2	104	14	LSP Experiment
111	HK-14	Status: Exp 3 & 4	119	13	" "

3.3.4 Safety - The design shall preclude, either through elimination of causes, or the incorporation of protective methods or devices, the possibility of physical harm or injury from the hazardous effects of sharp edges and corners, the discharge of electrical energy, the stored energy of compressed gases, springs and other devices, the effects of chemical processes utilized within the equipment, the effects of radiated energy or the transfer of heat to the external surroundings, or from accidental contact with voltages in excess of 30 volts, root mean square or direct current, during normal operation test or maintenance of the equipment.

3.3.5 Environmental requirements - The worst case environmental conditions to which the PDU shall be subjected to in its operational and non-operational duty cycle are as specified in Tables 11 and 12. Additional details on vibration, shock acceleration and EMI are provided in the following paragraphs.

The PDU shall operate according to its specification under all or any combination of these environmental conditions.

3.3.5.1 Non-operational vibration, shock and acceleration

Vibration - Sinusoidal

X-axis:	5-20 Hz	5.0 mm (0.20 in) d.a.
	20-34	40 m/s^2 (4.0g) peak
	34-50	1.8 mm (0.07 in) d.a.
	50-65	90 m/s^2 (9.0g) peak
	65-100	40 m/s^2 (4.0g) peak

TABLE 11 - System environments

Environmental parameter	ALSEP Mission Phase: Storage package	Checkout	Movement to the pad	Launch pad environment	Flight	Lunar operations
Relative humidity	15 - 90%	Max. 50%	15-100% rel.	Max. 50%	N/A	N/A
Sand & dust	N/A	N/A	N/A	N/A	N/A	N/A
E.M.I.	N/A	AL770000	N/A	AL770000	N/A	AL770000
Acceleration	LED520-1	N/A	LED520-1	N/A	Para 3.6.5.1	N/A
Vibration	LED520-1	N/A	LED520-1	N/A	Para 3.6.5.1	Para 6.3.5.2
Shock	LED520-1	N/A	LED520-1	N/A	LIS-360-22302	30 cm (12 in.) free fall onto a hard surface under lunar gravity
Temperature	-55 C to +55 C	+10 to +37 C	+10 to +37 C	+10 to +37 C	LIS-360-22303 LIS-360-22402	LED520-1
Nuclear radiation	N/A	Negligible	N/A	Negligible	Less than lunar oper.	LED520-1

TABLE 11 (cont.)

ALSEP Mission Phase

Environmental parameter	Storage package	Checkout	Movement to the pad	Launch pad environment	Flight	Lunar operations
Solar radiation	N/A	N/A	N/A	N/A	N/A	LED520-1
Meteoroids	N/A	N/A	N/A	N/A	N/A	DS-21
Pressure	LED520-1	Ambient	Ambient	Ambient	1×10^{-8} mm Hg	LED520-1
Acoustics	N/A	N/A	N/A	N/A	LED520-1	N/A

TABLE 12 Environmental duty cycles

Environment considered	Storage unpackaged	Storage packaged	Movement to pad	Factory & KSC checkout	Launch pad environment	Flight	Lunar operations
Humidity	3 days	90 days	1 day	180 days	13 days	N/A	N/A
Acceleration	N/A	N/A	N/A	N/A	N/A	Approx* 25 min	N/A
Vibration	N/A	1 day	1 day	N/A	N/A	25 min*	N/A
Shock	Single shock	Single shock	N/A	N/A	N/A	One shock	N/A
Temperature	3 days	90 days	1 day	180 days	13 days	3.5 days	365 high days 365 low days
Radiation	N/A	N/A	N/A	Negligible	Negligible	3.5 day	730 days
Solar radiation	6 hr/day 3 days	N/A	N/A	N/A	N/A	N/A	365 days
Meteoroids	N/A	N/A	N/A	N/A	N/A	N/A	730 days
Pressure	90 days		1 day	180 days	13 days	3.5 days	730 days
Acoustics	N/A	N/A	N/A	N/A	N/A	5 min	N/A

*includes lunar descent

Y & Z - axis:	5-17 Hz	5.0 mm (0.20 in) d.a.
	17-54	30 m/s^2 (3.0 g) peak
	54-80	0.5 mm (0.02 in) d.a.
	80-100	65 m/s^2 (6.5 g) peak
Sweep	5-100-5 Hz	
Sweep rate:	3 oct/min	
Tolerances:	± 10% (g & d.a.)	
	± 5 Hz at step discontinuities	

L&B Random

X-axis:	20-40 Hz	+6 db/oct
	40-150	7.6 m^2/s^4 Hz (0.08 g^2/Hz)
	150-270	-6 db/oct
	270-2000	2.4 m^2/s^2 Hz (0.025 g^2/Hz)
Y-axis:	20-60	+6 db/oct
	60-200	5.8 m^2/s^4 Hz (0.06g^6/Hz)
	200-285	-6 db/oct
	285-2000	2.9 m^2/s^4 Hz (0.03 g^2/Hz)
Z-axis:	20-50	+9 db/oct
	50-150	3.4 m^2/s^4 Hz (0.035 g^2/Hz)
	150-210	-3 db/oct
	210-2000	2.4 m^2/s^4 Hz (0.025 g^2/Hz)
Duration:	60 s/axis	
Tolerances:	± 3 db (PSD)	
	± 10% (G_{rms})	

Vibration: Lunar Descent

X-axis:	20-40 Hz	+6 db/oct
	40-60	9.6 m^2/s^4 Hz (0.10 g^2/Hz)
	60-135	-6 db/oct
	135-2000	1.9 m^2/s^4 Hz (0.02 g^2/Hz)

Y-axis:	20-90 Hz	+3 db/oct
	90-100	7.6 m^2/s^4 Hz(0.08 g^2/Hz)
	100-175	-9 db/oct
	175-2000	1.5 m^2/s^4 Hz (0.03 g^2/Hz)
Z-axis:	20-70	+3 db/oct
	70-120	6.7 m^2/s^4 Hz (0.07 g^2/Hz)
	120-380	-6 db/oct
	380-2000	0.67 m^2s^4 Hz (0.007 g^2/Hz)
Duration:	12-1/2 min/axis	
Tolerances:	±3 db (PSD)	
	±10% (G_{rms})	

Shock — 200 m/s^2 (20 g) for 11 ms
Sawtooth waveform
Procedure I (± X, ± Y, ± Z ALSEP axes)

Acceleration — 137 ±10 m/s^2 (14 ±1g) for 60 s
(+X ALSEP axis only).

3.3.5.2 Operating vibration

Vibration — Random for 300 s, X, Y, Z axis (Figure 1)

3.4 EMI Control

3.4.1 Electromagnetic interference (EMI) and magnetic field cleanliness - The PDU shall not be a source of interference which might adversely affect the operation of other lunar surface equipment. The PDU shall satisfy Specification MIL-I-26600 (as amended by MSC-ASPO-EMI-10, Addendum to MIL-I-26600) and Specification AL 770000 at the subsystem level.

3.4.2 Operation - The PDU shall perform as specified herein when operating either independently or in conjunction with other equipment with which there are electrical connections, or which may be installed nearby. This requires that the

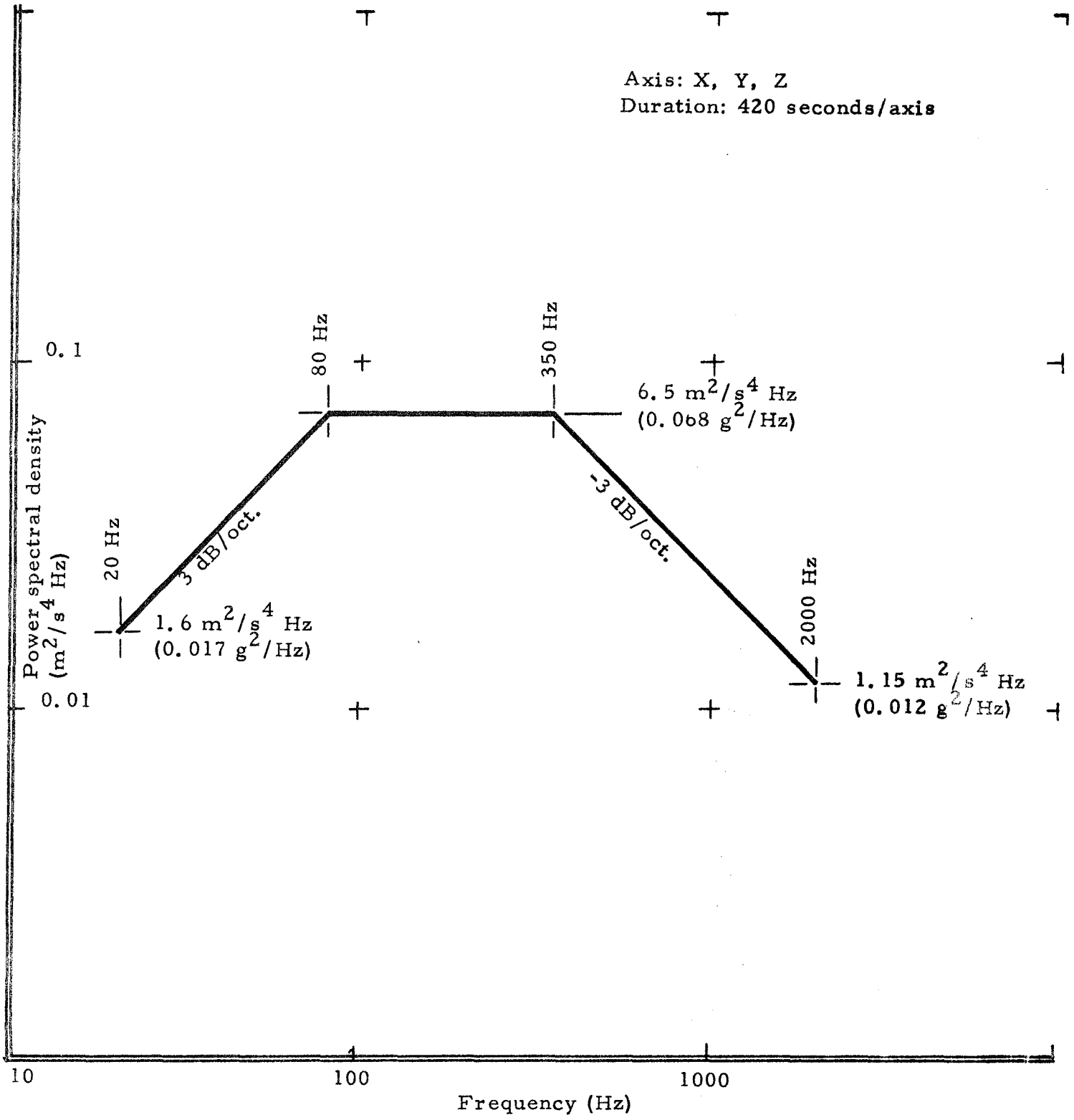


Figure 1 Operating random vibration spectrum

operation of such equipment shall not be adversely affected by interference voltages and fields reaching it from external sources and also requires that such equipment shall not, in itself, be a source of interference which might adversely affect the operation of other equipments. These general criteria ensure that the system will meet the requirements of the overall system acceptance criteria, and electromagnetic compatibility as specified in the performance specifications. In addition to these general requirements, the system shall satisfy the requirements of paragraph 3.1.2.4 and Specification MIL-I-26600, and NASA Addendum MSC-ASPO-EMI-10A.

3.4.3 Transient interference. Transient or short duration interference resulting from the operation of electrical or electromechanical devices shall not compromise the performance requirements as specified herein.

3.4.4 Interference-free design. Interference control shall be considered in the basic design of all subsystem electronic and electrical equipment and specialized equipment such as simulation sources and GSE. The design shall be such that before interference control components are applied, the amount of interference internally generated and propagated shall be the minimum achievable. The application of interference control components (e.g., filtering, shielding, bonding) shall conform to good engineering practice and, whenever practical, shall be an integral part of the subsystem or component.

3.4.5 Filtering. Filters shall be provided at each component or subsystem, as required, to prevent internally generated electrical interference signals being conducted out of the component or subsystem.

3.5 Mechanical design and construction

3.5.1 Size and mass - The PDU shall be housed in the same case as the PCU. Therefore, the size and mass restrictions of the PCU and PDU together shall be as given in the PCU specification AL 510100.

3.5.2 Parts and materials - Materials shall be selected from the ALSEP Approved Materials List -ATM-242. Parts shall be selected from the Acceptable Parts List - ATM-241. All parts and materials shall be compatible with the intended use and environment requirements specified in 3.3.5 through 3.3.5.2 herein.

3.5.2.1 Materials - Materials used in the fabrication of all components shall be of the highest quality compatible with design requirements specified herein. In general, the following types of materials shall not be used without prior written approval of NASA:

(a) Flammable materials

(b) Toxic materials

(c) Unstable materials

(d) Plastic - (only epoxy resin-based compounds, teflon, and polyester shall be used)

(e) Dissimilar metals in direct contact which tend toward active electrolytic or galvanic corrosion.

3.5.2.2 Standard processes -

3.5.2.2.1 Protective treatment - All materials used which are not inherently corrosive-resistant shall be treated to resist any corrosive effects resulting from environmental conditions specified herein. Protective coatings shall not crack, chip, peel, or scale with age when subject to the environmental extremes specified. The requirements of PS-5 shall apply prior to protective treatment. DS-25 shall apply.

3.5.2.2.2 Soldering - NASA Publication NHB 5300.4(3A) shall apply for hand soldering of all electrical connections.

3.5.2.2.3 Welding - Resistance welding (spot and seam) shall conform to Specification MIL-W-6858.

3.5.2.2.4 Ultrasonic cleaning - The requirements of PS-6 shall apply.

3.5.3 Standard Parts Mechanical - NASA Standard, Air Force-Navy (AN), Military Standards (MS), or joint Air Force-Navy (JAN) mechanical parts shall be used where applicable.

3.5.3.1 Standardization - Maximum economic standardixation of parts and components shall be provided. Where identical or similar functions are performed in more than one application within the system, effort shall be made to use only one item design for all system applications.

3.5.3.2 Parts procurement - The requirements of PS-8 and PS-11 (excluding part C) shall apply. Bendix shall be capable of identifying at any time the manufacturer's lot from which parts have been procured.

3.5.3.3 Semiconductors - Semiconductors used in the PDU shall operate at junction temperature less than +100 C.

3.5.4 Moisture and fungus resistance - Materials which are not nutrients for fungus shall be used whenever possible. The use of materials which are nutrients for fungus shall not be prohibited in hermetically sealed assemblies and in other accepted and qualified uses such as paper capacitors and treated transformers. If it is necessary to use fungus nutrient materials in other than such qualified application, these materials shall be treated with a process which will render the resulting exposed surface fungus resistant.

3.5.5 Corrosion of metal parts - Metals shall be corrosion-resistant type or suitably treated to resist corrosive conditions likely to be met in storage or normal service. Unless suitably protected against electrolytic corrosion, dissimilar metals, as defined in MIL-STD-889, shall not be used in direct physical contact.

3.5.6 Workmanship - The Power Distribution Unit shall be constructed, finished, and assembled in accordance with BSX 1000.

3.5.7 Electromagnetic Interference (EMI) - All items furnished shall have as a design goal the intent of meeting the requirements of EMI specification AL 770000.

3.5.8 Identification and marking - The Power Distribution Unit shall be marked for identification in accordance with Standard MIL-STD-130.

3.5.8.1 Identification and marking data - The identification and marking shall include but not be limited to the following data:

(a) Item nomenclature

(b) Item part number

(c) Item serial number

(d) Item identification number