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National Aeronautics and Space Administration

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W.C. Long EE4

Lyndon B. Johnson Space Center
Houston, Texas 77058

2. EXTRAVEHICULAR ACTIVITY/AIR TRAFFIC CONTROL (EVA/ATC) TEST SYSTEM ACCEPTANCE TEST REPORT

Job Order 14-4091

3. D. Tomaro

Prepared By

4. Lockheed Engineering and Management Services Company, Inc.
Houston, Texas

5. Contract NAS 9-15800

For

SPACECRAFT SYSTEMS TEST SECTION

TRACKING AND COMMUNICATIONS DEVELOPMENT DIVISION

6. February 1982

7. LEMSCO-17557
JSC-17917

EXTRAVEHICULAR ACTIVITY/AIR TRAFFIC CONTROL (EVA/ATC) TEST SYSTEM

ACCEPTANCE TEST REPORT

Job Order 14-409

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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HOUSTON, TEXAS

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16. Abstract

During extravehicular activity (EVA), communications between the EVA astronaut and the Space Shuttle Orbiter are maintained by means of a transceiver installed in the Environmental Support System backpack. Onboard the Orbiter, a transceiver Line Replaceable Unit and its associated equipment performs the task of providing a communications link to the astronaut in the extravehicular activity/air traffic control (EVA/ATC) mode.

In order to simulate and test the system, design, and fabrication of the EVA/ATC test system was required.

The acceptance test report outlined in this document resulted from tests that were performed on the test system designed and fabricated for EVA/ATC testing.

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The Spacecraft Systems Test Section of Lockheed Engineering and Management Services Company, Inc., designed the console and was responsible for the development of the equipment. The Transceiver Test Set was provided to the Tracking and Communications Development Division by the Spacecraft Systems Test Section.

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ACRONYMS

AGC	automatic gain control
ATC	air traffic control
AVC	automatic volume control
DVM	digital voltmeter
EVA	extravehicular activity
G RCV	guard receiver
G T/R	guard transceiver
LRU	Line Replaceable Unit
PTT	Push to Talk
RF	radio frequency
RMS	root mean square
SEN	shielded enclosure
SS	Space Shuttle
UHF	ultra high frequency
VHF	very high frequency

1. INTRODUCTION

During extravehicular activity (EVA), communications between the EVA astronaut and the Space Shuttle Orbiter are maintained by means of a transceiver installed in the Environmental Support System backpack. Onboard the Orbiter, a transceiver Line Replaceable Unit (LRU) and its associated equipment performs the task of providing a communications link to the astronaut in the extravehicular activity/air traffic control (EVA/ATC) mode. This transceiver also provides communications between the Orbiter and the ground and the chase planes.

In order to simulate and test the LRU's, the EVA/ATC test system was designed and fabricated (see figure 1). The acceptance test procedure, included as appendix A of this document, was used to substantiate the proper operation of this system for tests to be conducted in the Shielded Enclosure 1 (SEN-1). The following data is a tabulation of the test results obtained during the System Acceptance Test. These results indicated that the system was operating properly with the required parameters for SEN-1 use.

RF POWER LEVEL CARRIER ONLY

Frequency, MHz	Mode switch	Result, dBm	Comments
259.7	Amp off simplex	-6.0	-5 ± 1 dBm
296.8	Amp off simplex	-4.4	
296.8	Amp on simplex	11.5	16 dBm gain from power amp
296.8	Amp off simplex Guard transceiver	-4.6	-5 ± 1 dBm
296.8	Guard transceiver	-6.2	-5 ± 1 dBm
296.8	EVA	-4.6	-5 ± 1 dBm
296.8	EVA	-4.6	-5 ± 1 dBm
259.7	EVA	6.2	5 ± 1 dBm

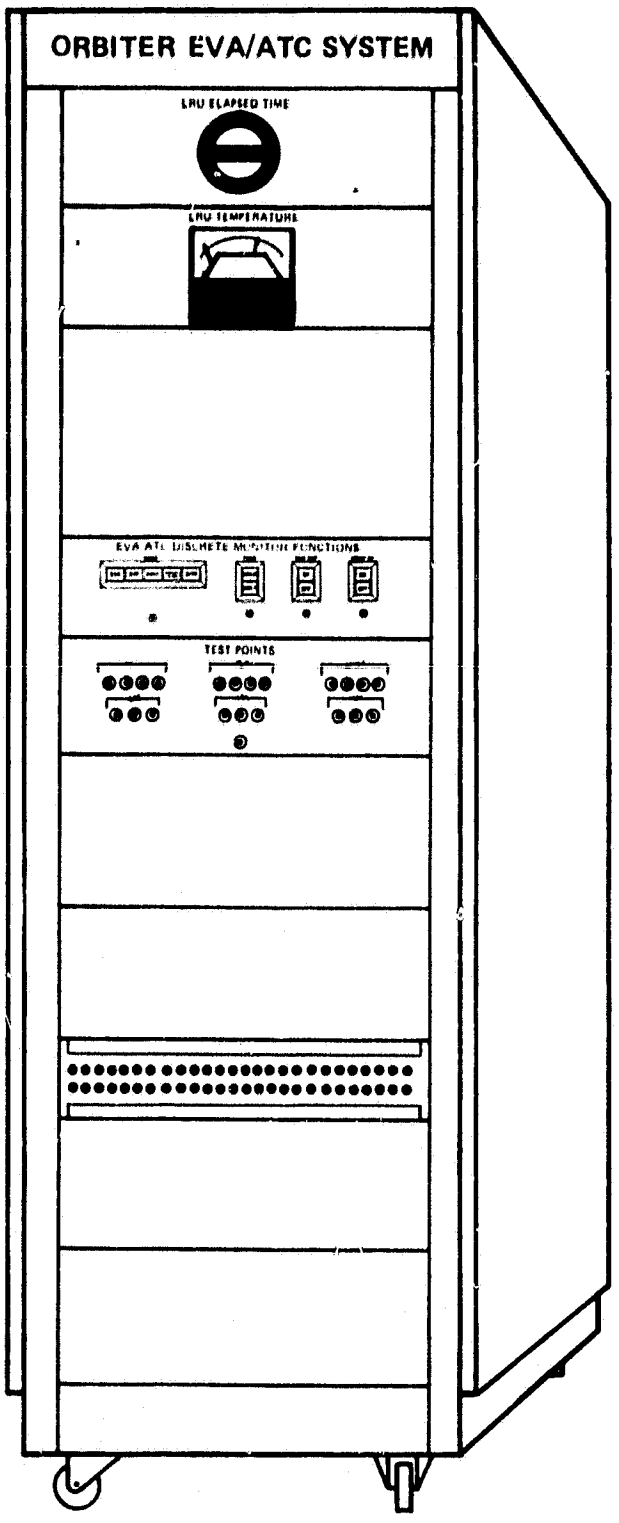

Figure 1.- Orbiter EVA/ATC test system.

RF POWER LEVEL CARRIER AND 1 KHZ AT 50 PERCENT MODULATION WITH 600 OHM LOAD

Frequency, MHz	Mode	Results, dBm
269.7	EVA	0
279.0	EVA	0
296.8	EVA transmit	0
279.0	EVA transmit	0

EVA LRU CARRIER FREQUENCY MEASUREMENT WITH A FREQUENCY COUNTER

Frequency, MHz	Mode	Results, MHz
259.7	Simplex	259.71
296.8	Simplex	296.80
296.8	Guard transceiver	243.01

SQUELCH AND AGC LEVEL VERIFICATION

Frequency, MHz	Mode	Results
243.0	Simplex and guard receive	AGC level 2.5 Vdc
243.0	Reduce RF level	Verify AGC reduction
243.0	Squelch on, set RF at 3 mV	AGC level 2.5 Vdc
243.0	Reduce RF level	Verify receiver squelches
296.8	Squelch off, set RF at 3 mV	AGC level 2.5 Vdc
296.8	Reduce RF level	Verify AGC reduction
259.7	EVA, 3 mV RF	AGC level 2.5 Vdc
259.7	Reduce RF level	Verify AGC reduction
279.0	Squelch off, set RF at 3 mV	AGC level 2.5 Vdc
279.0	Reduce RF level	Verify AGC reduces

1.1 ORBITER EVA/ATC SYSTEM COMPONENTS

1.1.1 EVA/ATC LINE REPLACEABLE UNIT (TRANSCEIVER)

The Extravehicular Communicator is a vendor-furnished, space-qualified transceiver unit installed in the Orbiter to enable communications between the EVA astronaut and the Space Shuttle (SS), the ground and SS, and the chase planes and SS. To allow support of in-house testing, the LRU is mounted on a heat sink in the inside rear of a test system cabinet (see figure 2).

1.1.2 ELAPSED TIME METER

This panel contains an elapsed time meter to measure the cumulative time that power is applied to the transceiver LRU (see figure 3).

1.1.3 LRU TEMPERATURE INDICATOR

This panel contains a temperature indicator and a thermocouple system which is used to measure the transceiver LRU temperature at the estimated highest temperature point (see figure 4).

1.1.4 DISCRETE MONITOR ASSEMBLY

Indicator lights on this panel (see figure 5) display the status of discrete signals as follows:

- EVA transceiver on
- EVA transceiver off
- Simplex operation
- Simplex and ground receiver
- Ground transmit/receiver
- 296.8 MHz on
- 259.7 MHz on
- Squelch off
- Squelch on

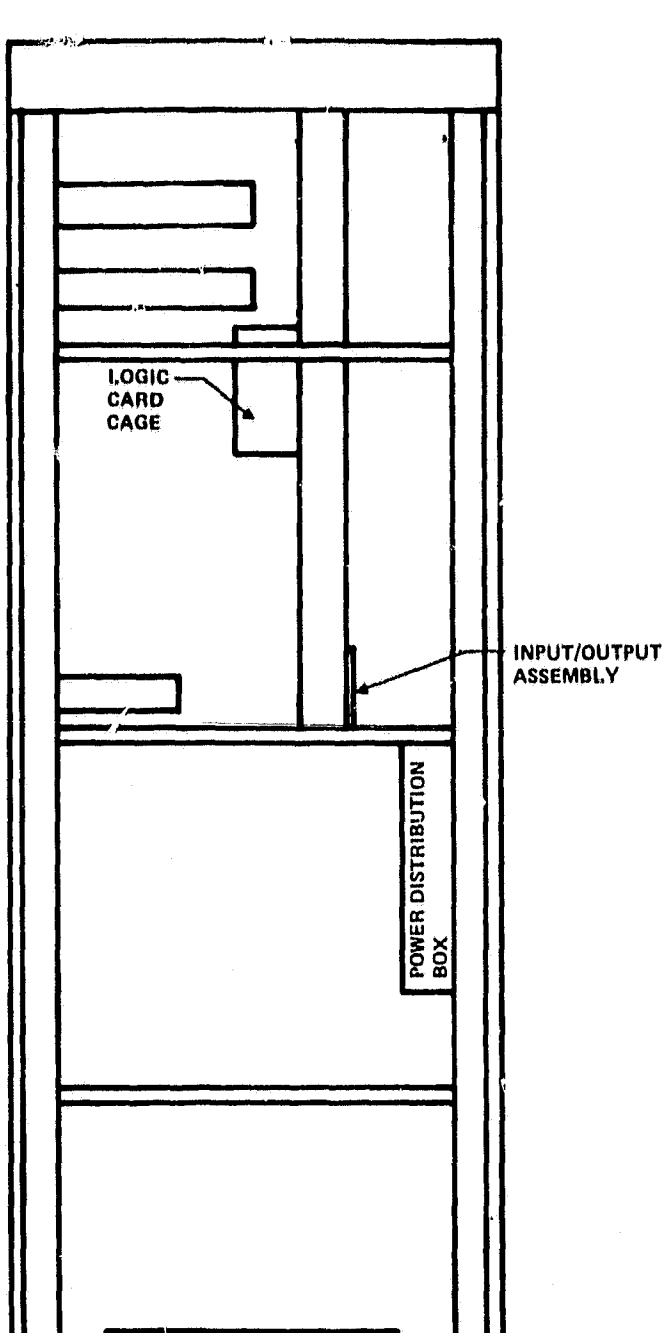

Figure 2.- EVA/ATC test system side view.

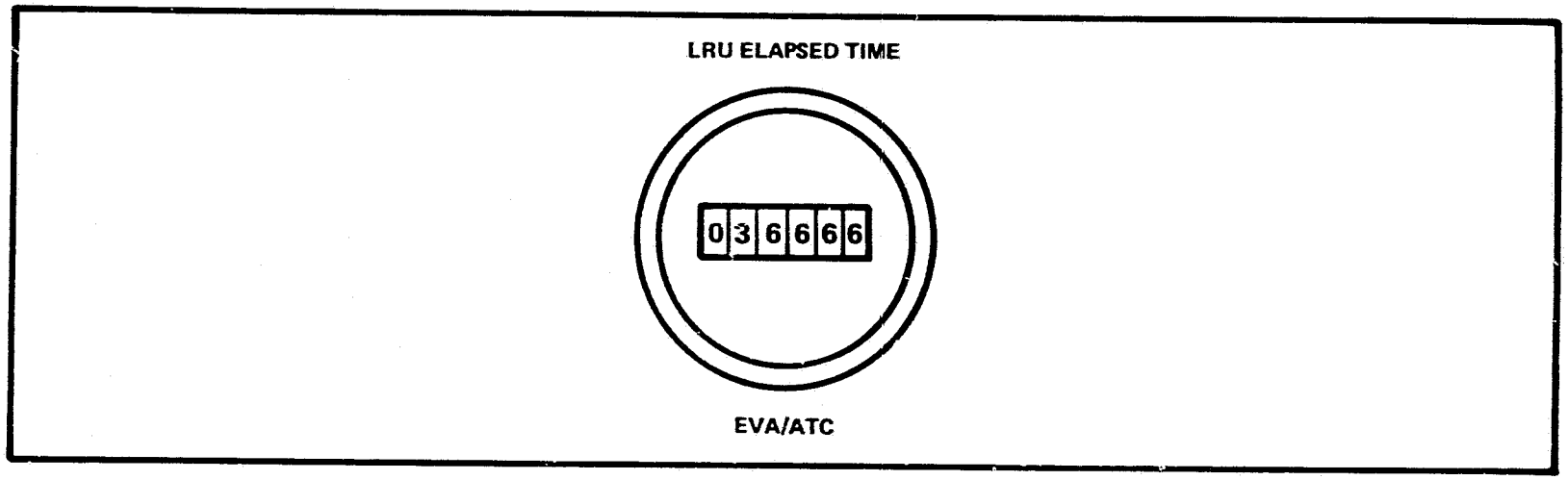

Figure 3.- Elapsed time meter panel.

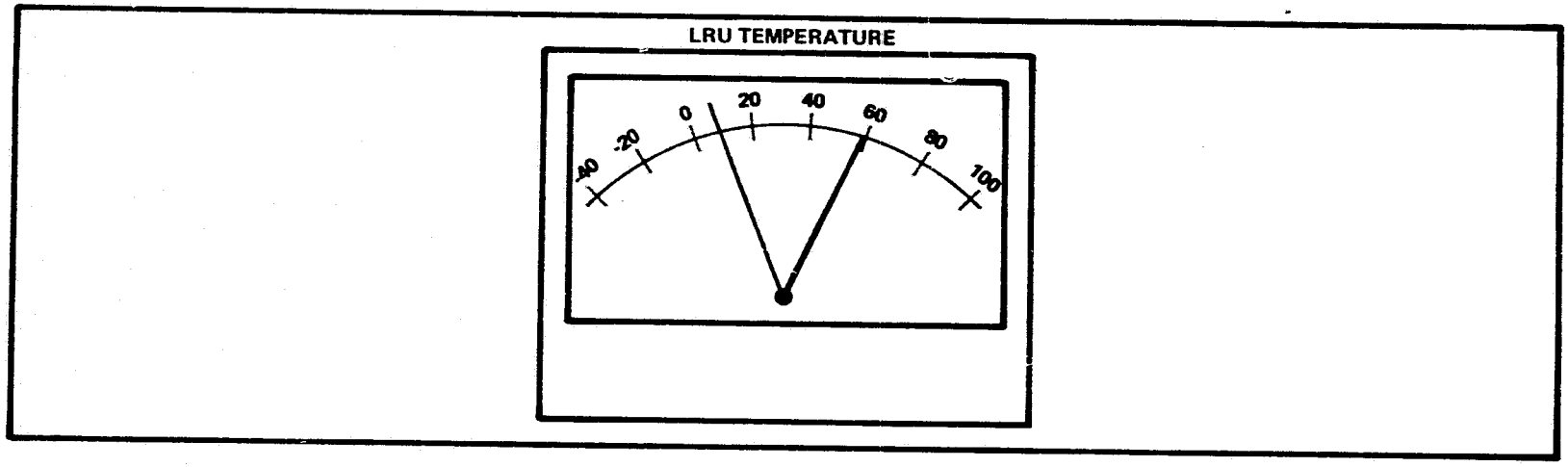

Figure 4.- LRU temperature monitor panel.

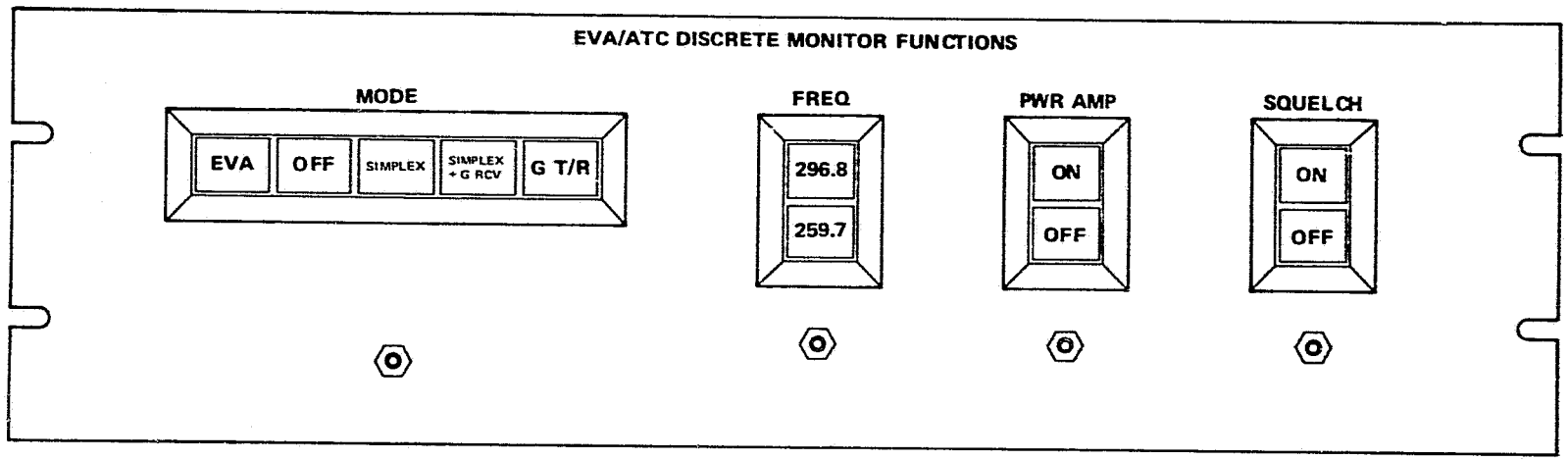

Figure 5.- Discrete monitor functions panel.

- Power amplifier on
- Power amplifier off

1.1.5 TEST POINT PANEL

The test points located on this unit allow measurements to be taken of functions available from the transceiver LRU's (see figure 6). These functions are:

- Automatic gain control (AGC) for receivers R1, R2, R3, and R4
- Squelch for these receivers
- Video
- Automatic volume control (AVC) for transmitters T1, T2, and T4
- Clipper for the audio of transmitters T1, T2, and T4
- Audio level measurements for transmitters T1, T2, and T4

1.1.6 LOGIC CARD CAGE ASSEMBLY

The logic card cage is located at panel A9 inside the cabinet (see figure 2). It contains the printed circuit board assembly required for the control and operation of the test system, as well as the status signals for the discrete monitor panel indicators and discrete signals for the display boards in the test control center.

1.1.7 INPUT/OUTPUT ASSEMBLY

The input/output assembly, located at panel A5 inside the rear of the cabinet, contains the connectors required to interface the test system with the external interface system (see figure 2).

1.1.8 POWER DISTRIBUTION BOX

Power for the test system is made available to the power distribution box at distribution panels A6 and A7 from an external power rack and distributed to the various components in the test system from connections in the distribution box (see figure 2).

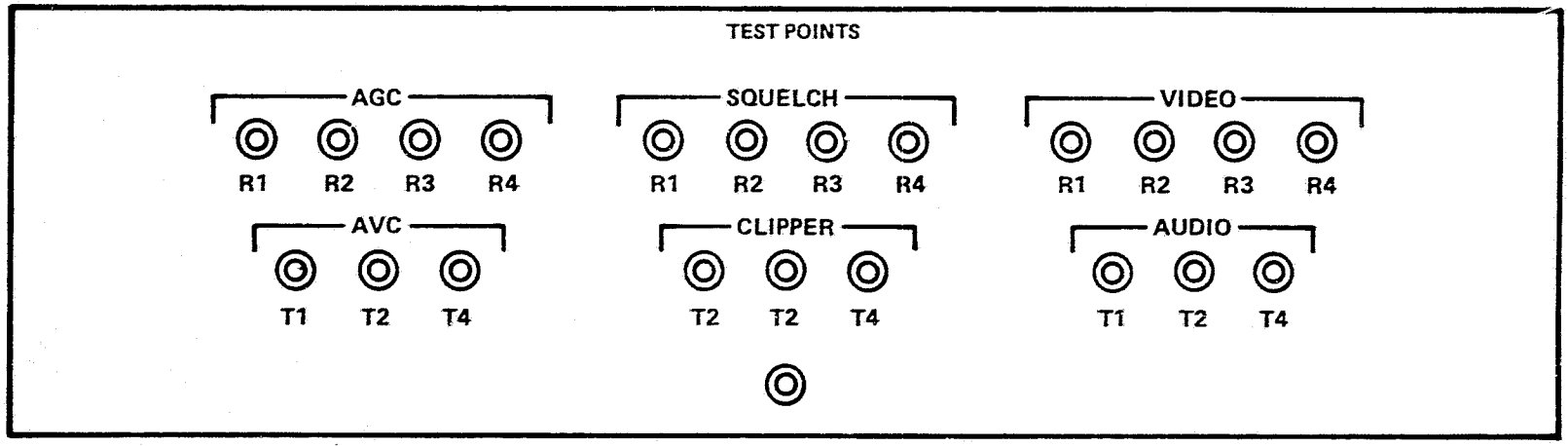

Figure 6.- Test point panel.

1.1.9 PATCH PANEL

The patch panel contains 26 sockets in an over/under configuration to enable monitoring and patching of signals as follows:

- Transmit audio
- Receiver audio
- Electrocardiogram input 1
- Electrocardiogram input 2
- Push to Talk (PTT)

1.1.10 MODE CONTROL PANEL

The mode control panel, located in the audio test system, selects the frequencies of operation (296.8 or 259.7 MHz), power amplifier status, and squelch (see figure 7). A mode selection list follows:

- EVA
- Simplex (both transceivers on the same frequency)
- Simplex and guard receiver (G RCV)
- Guard transceiver (G T/R) duplex operation of the transceiver and the G T/R

1.2 PERIPHERAL EQUIPMENT

The functions of the peripheral equipment (see appendix B) are discussed in sections 1.2.1 through 1.2.4.

1.2.1 SEN-1 WALL PANEL

The SEN-1 wall panel allows signal transfer between SEN-3 and SEN-1 without breaking the integrity of the shielded enclosure. Radio frequency (RF) and analog signals are distributed to the RF path test system and the logic card cage from the wall panel.

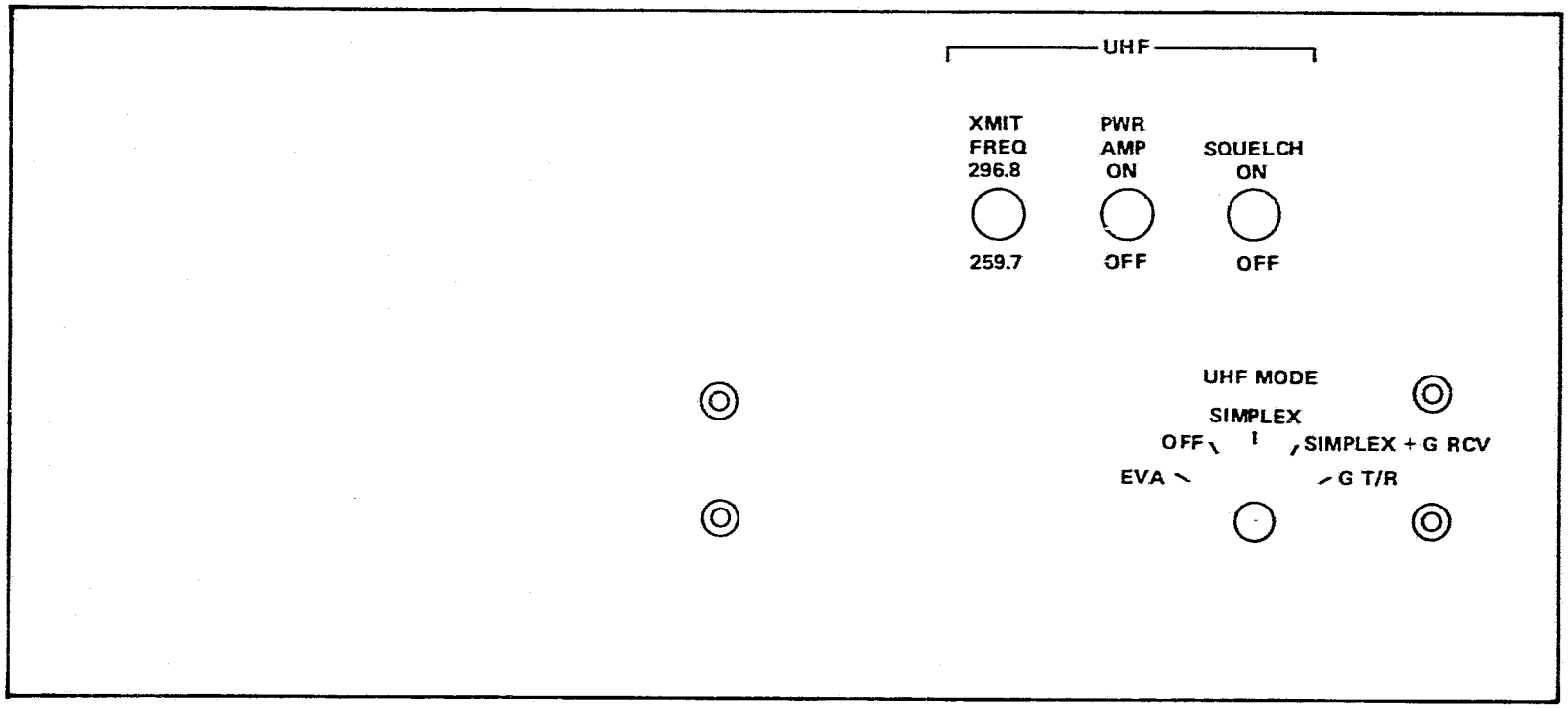

Figure 7.- UHF mode control panel.

1.2.2 RF PATH TEST SYSTEM

Utilizing RF circulators and appropriate plumbing, the S-band and Ku-band signals are routed through the RF path drawer and fed to the input/output panel to permit the desired mode of operation to be selected.

1.2.3 STATUS BOARD INTERFACE UNIT

Located outside of the EVA/ATC test system, this unit permits the interface of the test center status boards with the signals from the logic card at panel A9 in the EVA/ATC test system.

2. PRETEST REQUIREMENTS

The pretest requirements for the EVA/ATC system requires the following procedures.

1. Determine that the LRU is installed and the coolant system is functioning.
2. Obtain a calibrated RF signal generator capable of generating the 259.7 and 296.8 MHz signals required by the system.
3. Obtain a calibrated RF type power meter equipped with a 30 dBm attenuator.
4. Obtain a calibrated oscilloscope, counter, and digital multimeter.

NOTE: The Test Preparation Sheets are located in appendix A.

3. TEST PROCEDURES

The test procedures for the EVA/ATC system requires the following procedures.

1. The power required for operation of the EVA/ATC system is provided by the power supply console located in SEN-1. Activate this power supply to furnish the required voltages for this acceptance test.
2. Connect a Hewlett Packard 435 RF power meter with a 30 dB attenuator in series with the input lead to A10J1.
3. On the ultra high frequency (UHF) mode panel, set the selector switch to Simplex. Key the transmitter at A7J11 and note the RF power reading (approximately -6 dBm).
4. Unkey the transmitter and select the 296.8 MHz channel on the UHF mode panel. Key the transmitter and note the RF power reading (approximately -4.5 dBm). Unkey the transmitter.
5. Turn on the power amplifier on the UHF mode panel and key the transmitter. Note that the RF power meter reads approximately 11 to 12 dBm. Unkey the transmitter. Turn off the power amplifier.
6. On the UHF mode panel, set the selector switch to the Simplex + G RCV position and key the transmitter. The power meter reading should be approximately -4 to -5 dBm. Unkey the transmitter.
7. On the UHF mode panel, set the selector switch to G T/R and key the transmitter. The power meter reading should be approximately -6.8 dBm.
8. On the UHF mode panel, set the selector switch to the EVA mode and key the transmitter. The power meter should read approximately -4 to -5 dBm. Unkey the transmitter.
9. On the UHF mode panel, set the PWR AMP switch to the ON position. Key the transmitter and note that the power meter reads approximately -4.6 dBm. Unkey the transmitter.
10. On the UHF mode panel, set the frequency select switch to 259.7 MHz and key the transmitter. The power meter should read approximately -6.2 dBm. Unkey the transmitter and remove the power meter.

11. This phase of the test requires the use of an RF signal generator and an oscilloscope. Adjust the signal generator at 269.7 MHz, modulated at 50 percent with a 1 kHz signal for an RF output of 3 mV. Connect the signal generator to A7J5.

12. Connect the oscilloscope to A7J5 and verify the presence of the 1 kHz sine wave. Remove the oscilloscope and connect a root mean square (RMS) type voltmeter in its place with a 600 ohm load attached. The level of reading should be approximately 0 dBm.

13. On the very high frequency (VHF) mode control panel, set the selector switch to EVA. The meter reading should be 0 dBm. Set the frequency switch to 279.0 MHz. Set the signal generator to 279.0 MHz and note that the meter should read approximately 0 dBm.

14. Adjust the RF signal generator to 295.8 MHz. Select 295.8 MHz on the UHF mode control panel. The meter should read approximately 0 dBm.

15. Adjust the RF signal generator to 279.0 MHz. The meter reading should be approximately 0 dBm. Remove the RF signal generator and connect a counter through a 30 dBm load to connector A10J1.

16. On the UHF mode control panel, select Simplex and the 259.7 MHz transmitter frequency. Key the transmitter and note the counter frequency, which should be 259.7 MHz. Unkey the transmitter.

17. Select the 296.8 MHz transmit channel and key the transmitter. The counter frequency should read 296.8 MHz. Unkey the transmitter.

18. Select the G T/R mode and key the transmitter. The counter frequency should read 243.0 MHz. Unkey the transmitter.

19. Turn the selector switch on the UHF mode panel to OFF. Connect the digital voltmeter to A5J4. Set the Squelch switch to the OFF position. Adjust the RF signal generator to 243 MHz unmodulated, 3 mV RF level. Remove the counter and connect the RF signal generator to A10J1.

20. On the UHF mode panel, set the selector switch to the Simplex + G RCV position and note the reading (approximately 1.37 Vdc) on the digital voltmeter (DVM). Reduce the RF level on the signal generator and note that the AGC reading reduces accordingly. Reset the RF level to 3 mV.

21. Connect the oscilloscope to A7J5. Set the Squelch switch on the UHF mode panel to N. Reduce the RF level and verify that the receiver squelches. Turn the Squelch OFF.

22. Reset the RF signal generator to 296.8 MHz at 3 mV. Note that the DVM AGC reading is approximately 4.3 V. Reduce the RF level and verify that the AGC voltage reduces accordingly.

23. On the UHF mode panel, set the selector switch to EVA. Set the RF signal generator to 259.7 MHz at 3 mV. Note that the DVM reads approximately 4.3 V. Reduce the RF level and verify that the AGC level reduces accordingly. Switch the selector switch to the OFF position and remove the test equipment.

4. APPLICABLE DRAWINGS

The following drawings are applicable to the EVA/ATC test system. Copies may be obtained from Document Control.

SID36122570	Console Interface Diagram
SID36122609	Wiring Diagram, Elapsed Time Meter
SID36122607	Wiring Diagram, Temperature Monitor
SID36122608	Schematic, Discrete Monitor
SID36122583	Wiring Diagram, Test Points Panel
SID36122550	Card Cage, Wire List
SID36122573	Card Cage, Wiring Diagram
SID36122546	Schematic, Mode Control A25
SID36122548	Wire Wrap Board, Discrete and Analog

APPENDIX A

ACCEPTANCE TEST PROCEDURE

TEST PREPARATION SHEET

NASA – LYNDON B. JOHNSON SPACE CENTER

1. TYPE: A CONFIGURATION CHANGE — PERM / TEMP; B NON CONFIGURATION CHANGE X
2. TPS NO. 3112003l
3. ORGAN
4. PAGE 1 OF 67
5. NEED DATE N/A
6. MOD SHEET(S) NUMBER(S)
7. CONTRACT NO./JOB NO.
8. PART/MODEL NO. 8379452-503
9. APPLICABLE DOCUMENTATION
10. SERIAL NUMBER 1002
11. TIME/CYCLE DATA UPDATE REQUIRED — YES / (NO)
12. SYSTEM EVA/ATC Console #810
13. SHORT TITLE OF TPS Verification Test

OPER SEQ NO.	14. OPERATIONS (Print, Type or Write Legible)	15. VERIFICATION TECH	16. CONT	17. NASA
1	Contact QA	3-18-81		
2	Receive from RCA Rm 276 an EVA/ATC Transceiver NOTE: Item is Class 3	RJD 3/18/81		
DE3.9	Move EVA/ATC console to Rm 244 RTM#34590HRS.RJ3	RJD 3/18/81		
4	Install the EVA/ATC and perform the following:			
5	On the UHF Control Panel position the XMIT FREQ to 259.7			
6	PUR AMP OFF			
7	Squelch OFF			
8	UHF MODE to OFF			
9	Connect RCA Power Supply Console to the EVA/ATC Console	RJD		
10	Activate the RCA Power Supply Console	RJD		

18. ORIGINATOR	DATE	19. FINAL ACCEPTANCE STAMP AND DATE	
		3-19-81	
20. CONTRACTOR	**DATE**	**21. NASA**	**DATE**
R. Evans	3/17/81	[illegible]	3/17/81
		[illegible]	3-19-81
		[illegible]	3/17/81

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TEST PREPARATION SHEET
CONTINUATION SHEET
NASA – LYNDON B. JOHNSON SPACE CENTER

TPS. NO. 2112003J
MOD. NO.
ORGAN

OPER. SEQ. NO.	OPERATIONS (Print, Type or Write Legible)	TECH.	VERIFICATION CONT.	VERIFICATION NASA
11	Connect HP430A RF Power Meter to A10J1 thru 30db of attenuation	3/18/61		
12	Select UHF MODE to SIMPLEX			
13	KEY Xmitter at A7J11			
14	Record RF power – 6 DBM			
15	Unkey Xmitter			
16	Select Xmitt freq 296.8 MHz			
17	Key Xmitter			
18	Record RF power – 4.4 DBM			
19	Unkey Xmitter			
20	Select PWR AMP ON			
21	Key Xmitter			
22	Record RF power +11.5 DBM			
23	Unkey Xmitter			
24	Select PWR AMP OFF			
25	Select SIMPLEX + G RCV			
26	Key Xmitter	RTO		

TEST PREPARATION SHEET
CONTINUATION SHEET
NASA – LYNDON B. JOHNSON SPACE CENTER

TPS. NO. 31120031
MOD. NO.
ORGAN

OPER. SEQ. NO.	OPERATIONS (Print, Type or Write Legible)	TECH.	VERIFICATION CONT.	VERIFICATION NASA
27	Record RF power -4.6 DBM	RTO 5/12/81		
28	Unkey Xmitter			
29	Select G T/R			
30	Key Xmitter			
31	Record RF power -6.8 DBM			
32	Select EVA			
33	Key Xmitter			
34	Record RF power -4.6 DBM			
35	Unkey Xmitter			
36	Select PWR AMP ON			
37	Key Xmitter			
38	Record RF power -4.6 DBM			
39	Unkey Xmitter			
40	Select Xmitt freq 259.7 MHz			
41	Key Xmitter			
42	Record RF Power -6.2 DBM			
43	Unkey Xmitter	RTO		

TEST PREPARATION SHEET
CONTINUATION SHEET
NASA – LYNDON B. JOHNSON SPACE CENTER

TPS. NO. 3112003J
MOD. NO.
ORGAN

OPER. SEQ. NO.	OPERATIONS (Print, Type or Write Legible)	TECH.	VERIFICATION CONT.	VERIFICATION NASA
44	Remove RF power meter	P.S.D 3/12/81		
45	Set up Rhode & Swartz RF Signal Generator for 259.7 MHz, modulated 50% at 1 KHz, for an RF output of 3 mV			
	Delete (USE GND STATION)			
46	Connect RF signal generator to A10J1 P.S.D 3/12/81			
47	Connect oscilloscope to A7J5			
48	Verify presence of 1 KHz sinewave ~~[illegible]~~ V ~~[illegible]~~ OK			
49	Replace oscilloscope with HP 3400 RMS Voltmeter with 600 Ω load			
50	Record level as read on HP 3400 ~~[illegible]~~ 0 DBM			
51	Select EVA			
52	Record level as read on HP 3400 ~~[illegible]~~ 0 DBM			
53	Select 279.0 MHz			
54	Set RF signal generator for 279 MHz			
55	Record level as read on HP 3400 0 DBM			
56	Set RF signal generator for 296.8 MHz			
57	Select 296.8 MHz Xmitt freq			
58	Record level as read on HP 3400 0 DBM			
59	Set RF signal generator for 279 MHz	P.S.D		

JSC Form 1225 A (Rev Sep 76)

TEST PREPARATION SHEET
CONTINUATION SHEET
NASA – LYNDON B. JOHNSON SPACE CENTER

TPS. NO. 3112003J
MOD. NO.
ORGAN

OPER. SEQ. NO.	OPERATIONS (Print, Type or Write Legible)	TECH.	VERIFICATION CONF.	N/A
60	Record level as read on HP 3400 .0022M	RJO 3/10/81		
61	Remove RF signal generator			
62	Connect HP 5345A counter to A10J1, thru 30db			
63	Select SIMPLEX Mode			
64	Select 259.7 MHz Xmitt freq 259.7 MHz			
65	Key Xmitter			
66	Record frequency from Counter 259.71 MHz			
67	Unkey Xmitter			
68	Select 296.8 MHz Xmitt freq			
69	Key Xmitter			
70	Record frequency from Counter 296.80 MHz			
71	Unkey Xmitter			
72	Select G T/R Mode			
73	Key Xmitter			
74	Record frequency from counter 243.01 MHz			
75	Unkey Xmitter			
76	Select OFF on Mode System	RJO		

JSC Form 1225 A (Rev Sep 70)

TEST PREPARATION SHEET
CONTINUATION SHEET
NASA – LYNDON B. JOHNSON SPACE CENTER

TPS. NO. 31120031
MOD. NO.
ORGAN

OPER. SEQ. NO.	OPERATIONS (Print, Type or Write Legible)	TECH.	VERIFICATION CONT.	NASA
77	Connect Hp 3455 DVM to ~~A6~~ A5J4 · RJD 3/18/81	RJD 3/18/81		
78	Set SQUELCH TO OFF			
	RJD 3/18/81			
79	Set ~~Radio Simulator~~ GND STATION 2 RF signal generator to 243 MHz unmodulated,			
	3 mv RF level			
	DELETE 3/18/81 RJD			
80	Remove counter and connect RF signal generator to A10J1			
81	Set MODE switch to Simplex + G Rev.			
82	Record AGC level 2.56 VDC			
	INCREASES RJD 3/18/81			
83	Reduce RF level and verify AGC level ~~reduces~~ accordingly			
84	Reset RF level to 3 mV. Connect s'scope to A7J5			
85	Set Squelch ON			
86	Reduce RF level and verify that receiver squelches OK			
87	Set Squelch OFF			
88	Change RF Signal Generator to 296.8 Mhz at 3 mV			
89	Record AGC level 2.51 VDC			
	INCREASES RJD 3/18/81			
90	Reduce RF level and verify AGC level ~~reduces~~ accordingly			
91	Set MODE switch to EVA	RJD		

JSC Form 1229 A (Rev Sep 76)

TEST PREPARATION SHEET

CONTINUATION SHEET

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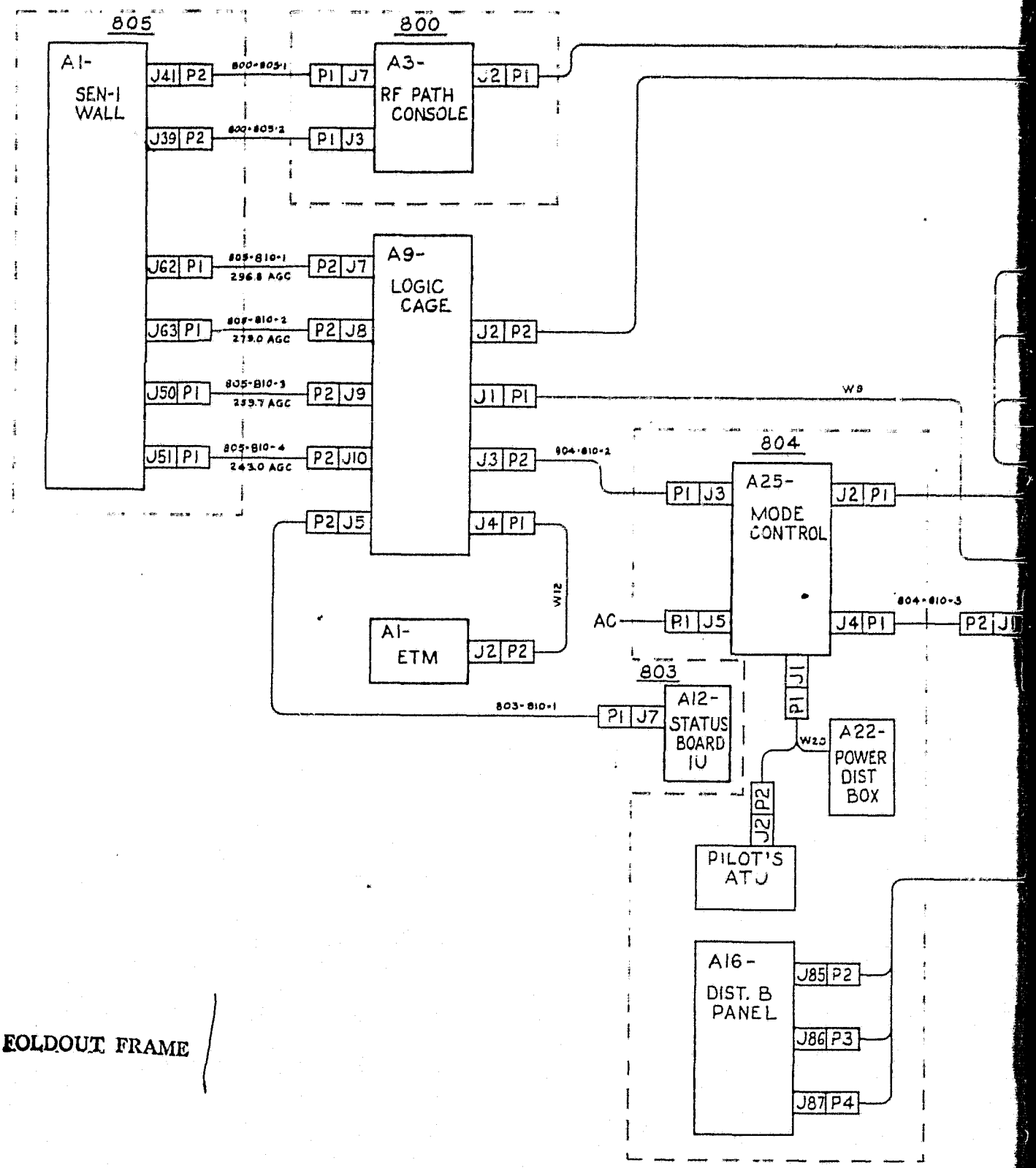
MOD. NO.
ORGAN

OPER. SEQ. NO.	OPERATIONS (Print, Type or Write Legible)	TECH.	VERIFICATION CONT.	VERIFICATION NASA
92	Set RF Signal Generator to 259.7 MHz at 3 mV	RJD 3/12/91		
93	Record AGC level 2.56 VDC			
94	Reduce RF level and verify AGC level ~~reduces~~ increases accordingly RJD 3/12/91			
95	Set RF Signal Generator to 279 MHz at 3 mV			
96	Record AGC level 2.56 VDC			
97	Reduce RF level and verify AGC level ~~reduces~~ increases accordingly			
98	MODE switch to OFF			
99	Remove all test equipment			
100	~~Move~~ RJD 3/12/91 Move console to Rm 126 and interface per SID36122570			
101	~~Remove~~ RJD 3/12/91 Install grounding cable	RJD		
102	Seal console	3-12-91		
	RTM 3478.0			

APPENDIX B
CONSOLE INTERFACE DIAGRAM



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LTR	ZONE	REVISION	DATE	APPROVED

RELEASED Date 1-7-80 by VC per AS

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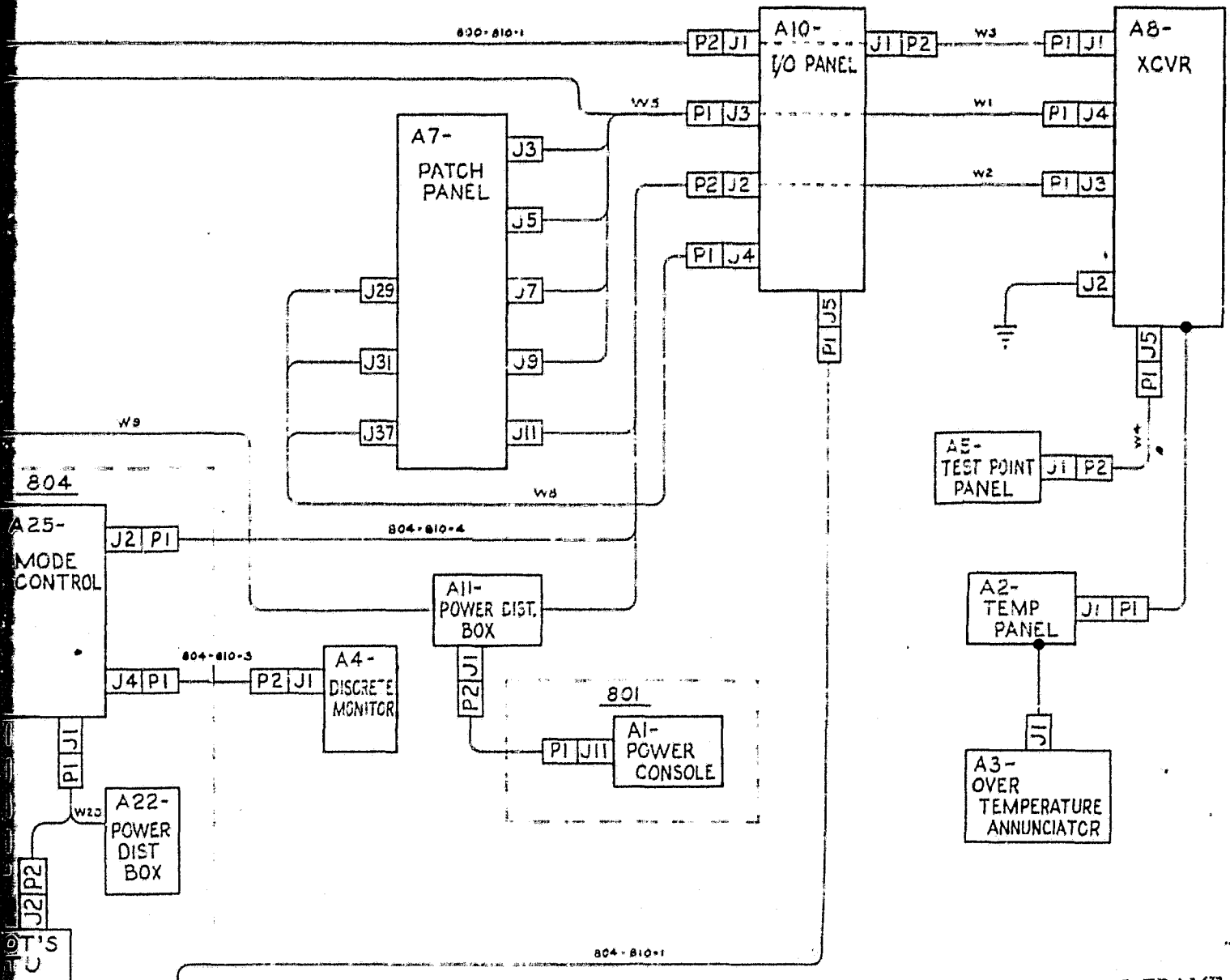

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SIGNATURES	DATE
DR	
ENG	
CH	
APP	2-1-81
AUTH	2-2-81

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LYNDON B JOHNSON SPACE CENTER • HOUSTON, TEXAS

DIAGRAM-
CONSOLE INTERFACE-
ORBITER EVA/ATC SYSTEM

CODE IDENT NO	SIZE	DWG NO.
21356	D	SID36122570

SCALE ~ SHEET 1 of 1