ORBITER S-BAND FM SYSTEM

CONSOLE TEST PROCEDURE

Job Order 14-409

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Prepared By

Lockheed Electronics Company, Inc.
Systems and Services Division
Houston, Texas

Contract NAS 9-15200

For

SPACECRAFT SYSTEMS TEST
TRACKING AND COMMUNICATIONS DEVELOPMENT DIVISION

National Aeronautics and Space Administration

LYNDON B. JOHNSON SPACE CENTER

Houston, Texas

February 1978

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SHUTTLE

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16. Abstract

This document describes the S-band frequency modulated system console and gives the step-by-step test procedure for verifying proper construction of the console prior to installation of flight equipment.

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The Orbiter S-band FM system console was designed by R. J. Davis of the Spacecraft Systems Test Section of Lockheed Electronics Company, Inc./Systems and Services Division. George D. Doland, Principal Engineer of the Spacecraft Systems Test Section, prepared this console test procedure.

CONTENTS

ABBREVIATIONS AND ACRONYMS

ATS	Automated Test System
Bi-ϕ-L	biphase level
dB	decibel
dBm	decibel referred to 1 milliwatt
DFI	development flight instrumentation
ESTL	Electronic Systems Test Laboratory
°F	degrees Fahrenheit
FM	frequency modulated
GSE	ground support equipment
Hz	hertz
Kbps	kilobit per second
kHz	kilohertz
LRU	line replaceable unit
Mbps	megabit per second
MHz	megahertz
NRZ-L	nonreturn-to-zero level
OTS	Orbiter Test System
PCM	pulse code modulation
PM	phase modulation
RF	radio frequency
RMS	root mean square
TPS	test preparation sheet
TV	television
VCO	voltage-controlled oscillator

1. INTRODUCTION

The Orbiter S-band frequency-modulated (FM) system console is one of several consoles comprising the Orbiter Test System (OTS). The OTS will be used by the Electronic Systems Test Laboratory (ESTL) to support performance and compatibility testing. The acceptance test of the FM system console will be performed in the Spacecraft Systems Test Laboratory.

1.1 CONSOLE DESCRIPTION

The console was designed in accordance with the design document for Space Shuttle Task 501, Orbiter S-band FM System, LEC-10929, JSC-11604, dated August 1977.

Figure 1-1 is a sketch of the completed console. The principal panels and assemblies provide for mounting running-time indicators for the flight equipment, an indicator for monitoring the FM transmitter output power level and temperature, discrete signal status monitors, isolation amplifiers, logic card file, power distribution box, signal patch connectors, and control switches. The control panel will be located externally from the S-band FM system console.

The S-band FM system is used for transmitting recorded data, television data, main engine data, payload data, and encrypted data. Some data are digital while other data are analog. The console test provides procedures for verification of console wiring.

1.2 SPACECRAFT ITEMS

There are three spacecraft items in the S-band FM system console: the FM transmitter, the FM signal processor, and the radio frequency (RF) diplexer. Only two units are active, whereas the RF diplexer is passive and provides the capability to use

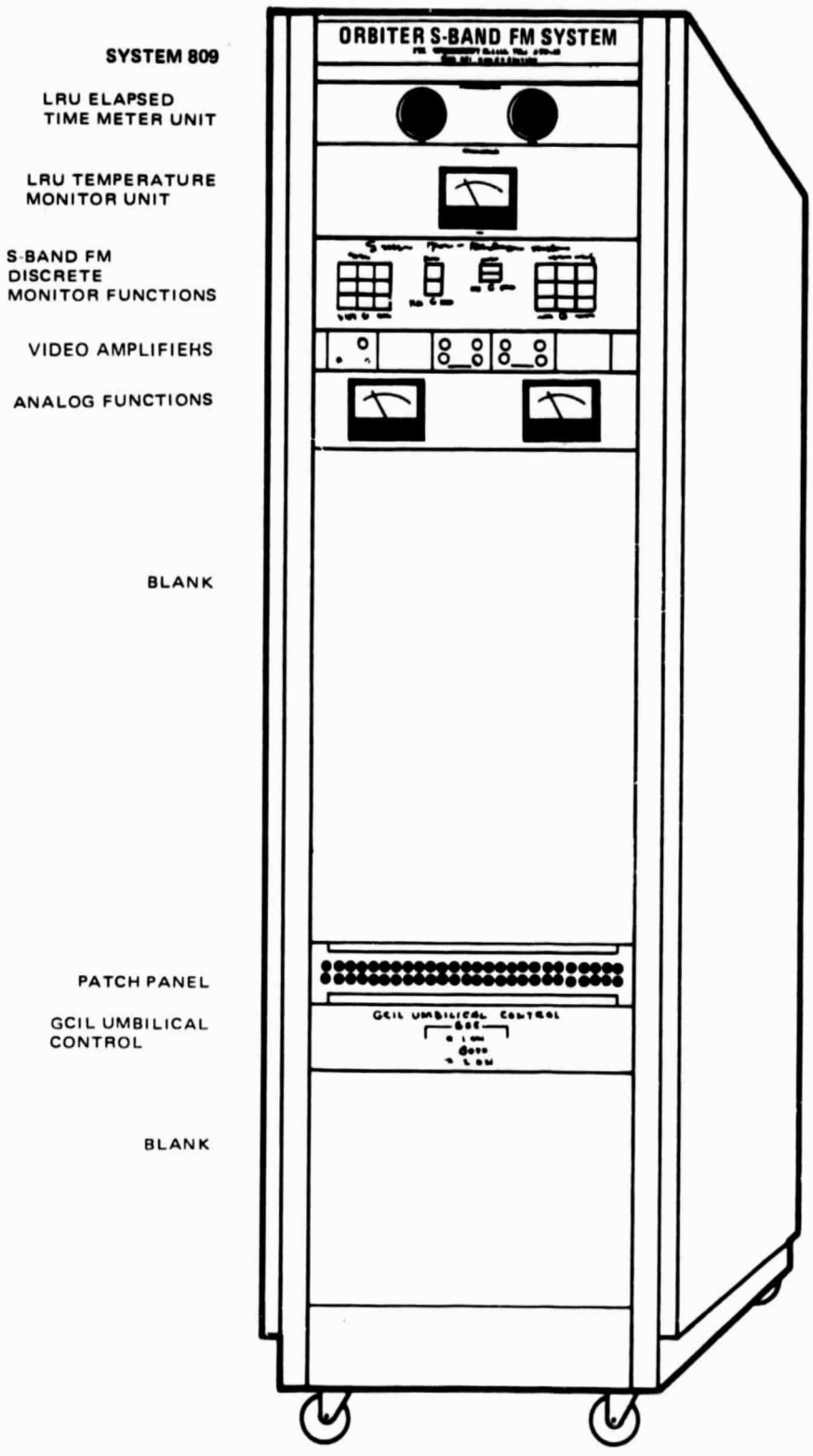

Figure 1-1.– S-band FM System Console.

the same antennas for the S-band FM system and development flight instrumentation (DFI) transmitter.

The FM transmitter has provision for only one signal input which is used to modulate the transmitted carrier. All processing and signal selection is provided by the FM signal processor. Some signals are conditioned by the signal source prior to being fed to the FM signal processor.

1.3 EQUIPMENT DESCRIPTION

The major items of the console were identified in section 1.1. Figure 1-2 is a sketch showing the approximate internal configuration of the console. The items, which include controls, indicators or connectors that must be accessible during testing, are described in detail in the following paragraphs.

1.3.1 INDICATORS AND METERS

The top two panels are shown in figures 1-1 and 1-2. The upper panel contains two elapsed time indicators, one for the S-band FM transmitter and the other for the FM signal processor. The lower panel contains a meter for measuring the temperature using a monitoring circuit.

1.3.2 DISCRETE SIGNALS

The third panel from the top of the console contains indicators for the functions selected and indicators for discrete functions from the flight equipment.

1.3.3 ISOLATION AMPLIFIERS

Below the discrete monitor function indicators is a panel containing buffer and isolation amplifiers. These amplifiers are also used to change signals from unbalanced to balanced or balanced to unbalanced signals. The signals provided or used by

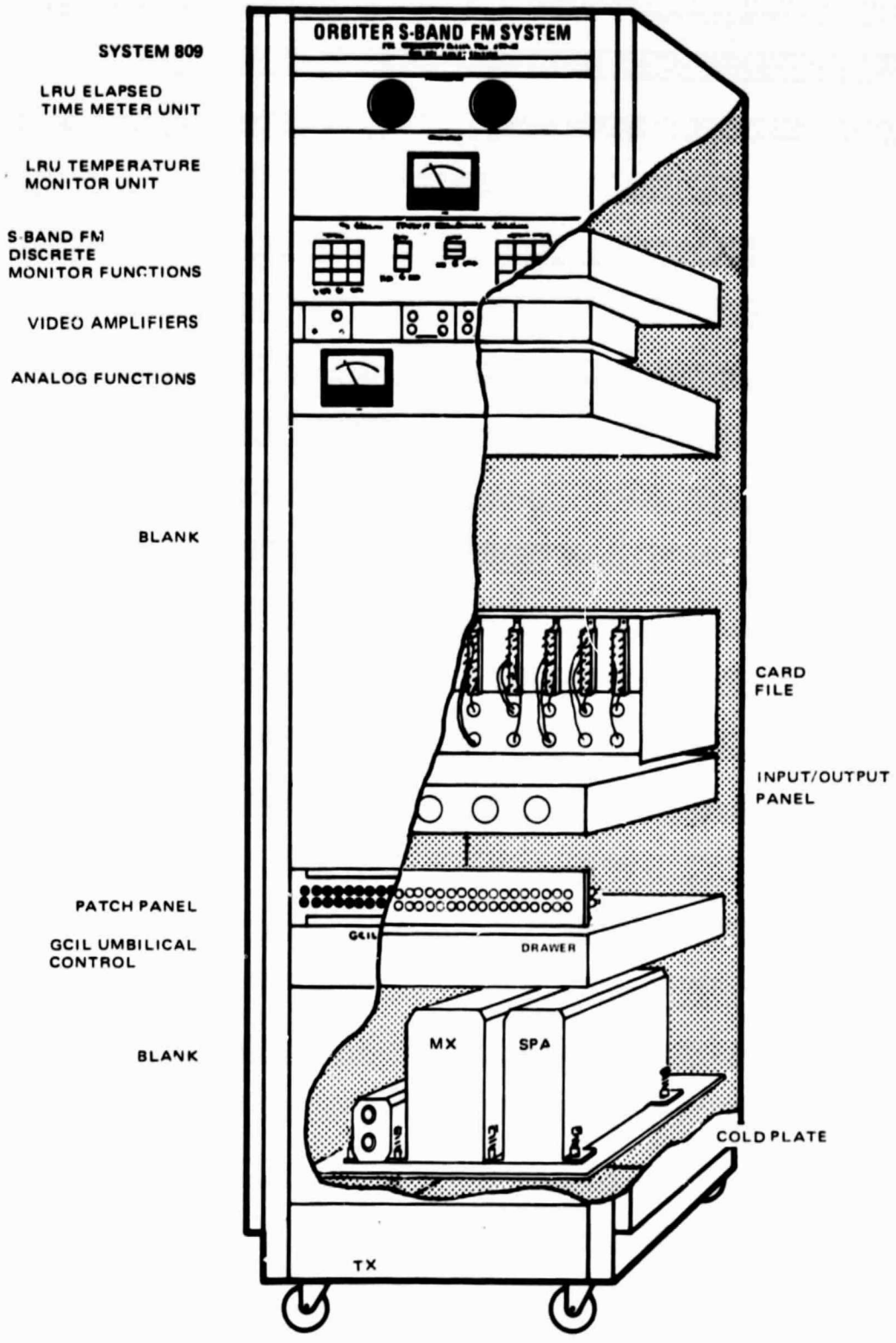

Figure 1-2.– S-band FM system console detail.

the test equipment are usually balanced; the flight equipment requires balanced signals.

1.3.4 PATCHING FACILITIES

Patching facilities are located lower in the console. The patching facilities provide a means to channel the configuration easily and also to monitor signals to or from the S-band FM system console.

1.3.5 CARD FILE

The card file, located in the rear of the console, contains buffers and lamp drivers. See figure 1-2 for a detailed sketch of the console including the card file.

1.3.6 GROUND CONTROL

Below the patch panel is the ground control logic interface control panel which contains a single switch. This panel is shown in figures 1-1 and 1-2.

1.3.7 CONTROL PANEL

Figure 1-3 is a drawing of the control panel. The control panel is not located in the Orbiter S-band FM System console, but instead it is mounted with other controls in a centralized location.

1.4 TEST EQUIPMENT

The purpose for the console test is to ensure that wiring is correct prior to installation of the flight equipment that could be damaged due to a wiring error. System performance with the flight equipment installed will be determined during the acceptance test. For the console test, the test equipment required includes:

1. Continuity tester

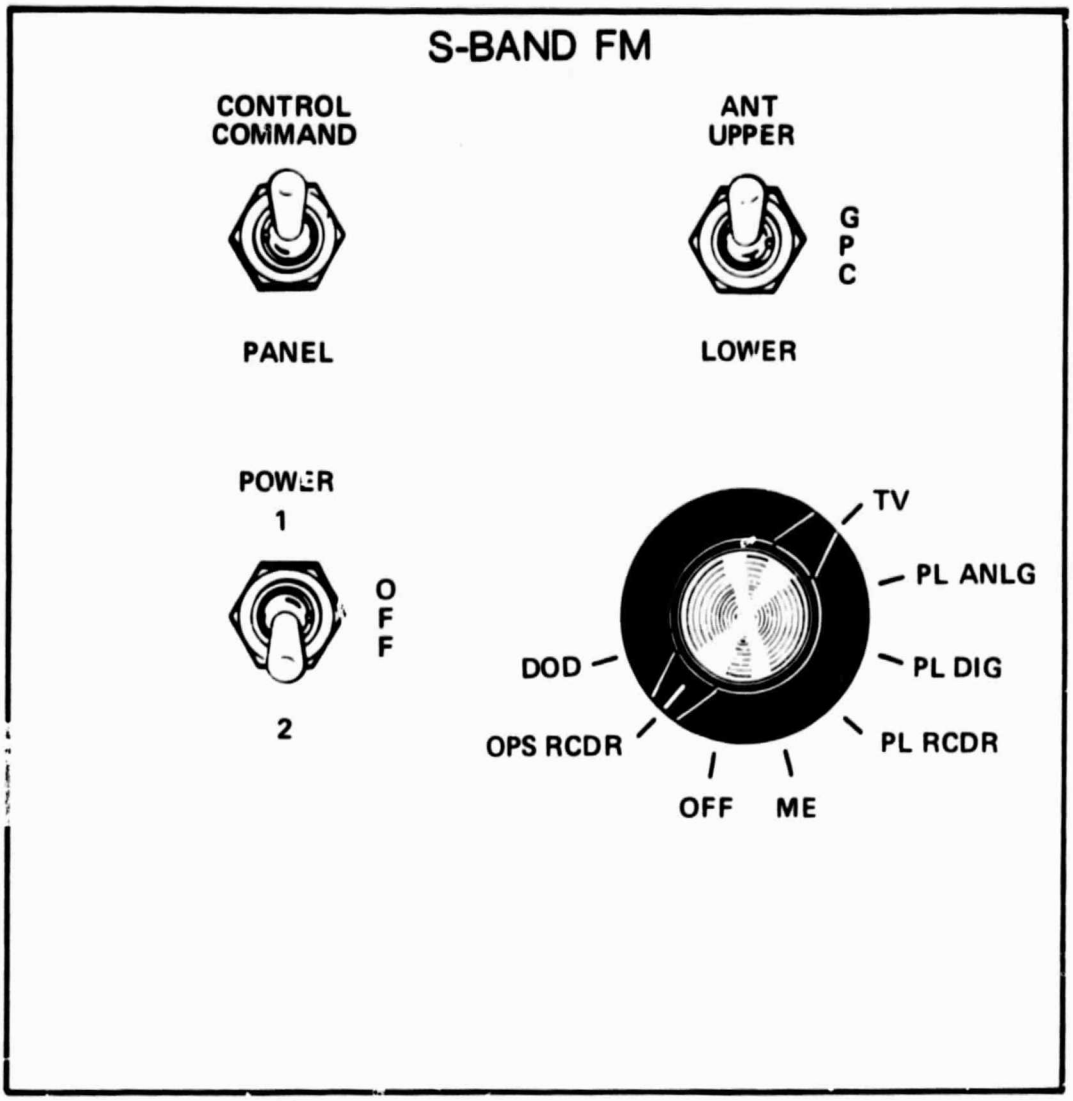

Figure 1-3.– S-band FM System control panel.

2. Multimeter
3. Digital voltmeter
4. Wide range oscillator
5. Square wave generator
6. Oscilloscope
7. Differential amplifier plug-in

2. TEST PROCEDURES

The step-by-step procedures are contained in the appendix. Below are brief explanations of the test sequences to be performed.

2.1 PRETEST REQUIREMENTS

The purpose for this sequence is to ensure that all preliminary steps have been performed prior to starting the console test. Items that are incomplete, may in some cases, be noted and the procedure started if authorized by the Technical Monitor.

2.2 TEST EQUIPMENT CALIBRATION

The purpose for this step is to record the test equipment used and calibration date.

2.3 POWER WIRING VERIFICATION

The purpose for this test is to check the power circuit wiring for continuity and shorts prior to the application of power.

2.4 VOLTAGE MEASUREMENTS

The purpose for this test is to measure the voltages at the flight equipment connectors to verify the voltage and polarity. The Orbiter Power System console is used as the source of power.

2.5 CONTROL CIRCUITS

The purpose for the control circuit test sequence is to ensure that the controls provide the correct signals to the flight equipment.

2.6 MONITOR CIRCUITS

The purpose for this test is to verify that the digital logic circuits correctly operate and provide power to the indicator

lamps. This test is performed by applying signals at the flight equipment connectors.

2.7 SIGNAL DISTRIBUTION

The purpose for this test is to verify the signal distribution wiring and buffer circuits in the digital logic assembly. These are functional tests and detailed performance testing is deferred until the acceptance tests.

2.8 COOLING AND TEMPERATURE

In preparation for the acceptance test, the console cold plates will be connected to a source of cooling water; the flow of cooling water will be verified and the temperature indicator operation verified.

APPENDIX

TEST SEQUENCE

AND

DATA SHEETS

2.1 PRETEST REQUIREMENTS

Quality Control

1. Verify that the following items are complete:
   a. Drawing index complete. _____
   b. Top assembly drawing complete. _____
   c. Set of prints complete. _____
   d. OPS Console complete. _____
   e. Cooling System Console complete. _____
   f. Visual inspection complete. _____
   g. Assemblies inspected and accepted. _____
   h. Cabling verified. _____
2. Data recorded _____

2.2 TEST EQUIPMENT USED

Quality Control

1. Continuity Tester

_____

_____

_____ _____

2. Multimeter

_____

_____

_____ _____

3. Digital Voltmeter

_____

_____

_____ _____

4. Wide Range Oscillator

_____

_____

_____ _____

5. Square Wave Generator

_____

_____

_____ _____

Quality
Control

6. Oscilloscope

_____

_____

_____ _____

7. Differential Amplifier Plug-in

_____

_____

_____ _____

8. _____

_____

_____

_____ _____

9. _____

_____

_____

_____ _____

10. _____

_____

_____

_____ _____

2.3 POWER WIRING VERIFICATION

Quality Control

1. Verify that there is no continuity between all pins on connector 809-A13-J1 to chassis ground except for contact k. _____

2. Measure the resistance between chassis ground and contact k of connector 809-A13-J1. (Less than 1 ohm.) _____ _____

3. Verify that there is greater than 10 K ohms resistance between the following contacts on connector 809-A13-J1.

pin	and	pin
A		K
B		L
C		M
a		d
b		e
c		f
g		Y
1		Y
p		V
p		W
p		X

_____

Quality Control

4. Verify continuity between connector contacts and the terminal board terminals listed below:

Connector contact	Terminal connection
A13-J1-K	A11-TB2-19
A13-J1-K	A11-TB3-6
A13-J1-L	A11-TB2-15
A13-J1-L	A11-TB3- 2
A13-J1-M	A11-TB2-17
A13-J1-M	A11-TB3-10

_____

5. Verify continuity between connector contacts listed below:

A13-J1-K	and	W26-P6-V
A13-J1-L	and	W26-P4-B
A13-J1-M	and	W26-P7-V

_____

6. Place the POWER switch on the FM Control panel to the OFF position. Verify that there is no continuity between the connector contacts and the terminal board terminals listed below:

Connector contact		Terminal connection
A13-J1-B	and	A11-TB2-14
A13-J1-A	and	A11-TB2-18
A13-J1-C	and	A11-TB2-16

_____

Quality Control

7. Place the POWER switch on the FM Control panel to the 1 position. Verify continuity between the following connector contacts and terminals listed below:

Connector contact		Terminal connection
A13-J1-B	and	A11-TB2-14
A13-J1-A	and	A11-TB2-18

_____

Verify that there is no continuity between

A13-J1-C	and	A11-TB2-16

_____

8. Place the POWER switch on the FM Control panel to the 2 position. Verify continuity between the following contacts and terminals listed below:

Connector contact		Terminal connection
A13-J1-B	and	A11-TB2-14
A13-J1-C	and	A11-TB2-16

_____

Verify that there is no continuity between

A13-J1-A	and	A11-TB2-18

_____

9. Verify continuity between the following connector contacts and terminals:

Connector contact		Terminal connection
A13-J1-B	and	A11-TB3-1
A13-J1-A	and	A11-TB3-5
A13-J1-C	and	A11-TB3-9
W26-P4-A	and	A11-TB3-3
W26-P6-L	and	A11-TB3-7
W26-P7-L	and	A11-TB3-11

_____

Quality Control

10. Verify that there is at least 10 K ohms resistance between the following connector contacts:

W26-P4-A	and	W26-P4-B	
W26-P6-L	and	W26-P4-V	
W26-P7-L	and	W26-P7-V	_____

11. Verify continuity between the following connector contacts:

A13-J1-p	and	W35-P1-A	
A13-J1-p	and	W35-P1-B	
A13-J1-X	and	W35-P1-D	
A13-J1-X	and	W35-P1-E	
A13-J1-a	and	W35-P1-G	
A13-J1-b	and	W35-P1-H	
A13-J1-d	and	W35-P1-K	
A13-J1-e	and	W35-P1-L	
A13-J1-g	and	W35-P1-N	
A13-J1-l	and	W35-P1-P	
A13-J1-Y	and	W35-P1-R	_____

Quality
Control

12. Verify that there is no continuity between the following connector contacts:

W35-P1-A	and	W35-P1-D & E
W35-P1-B	and	W35-P1-E & D
W35-P1-G	and	W35-P1-K & L
W35-P1-H	and	W35-P1-L & K
W35-P1-N	and	W35-P1-R
W35-P1-P	and	W35-P1-R

_____

2.4 VOLTAGE MEASUREMENTS

Quality Control

1. Connect the Orbiter FM System console to the Orbiter Power System or Auxiliary Power console. Note which console is used. _____ _____

2. Energize the power source. _____

3. At the FM Control panel, place the POWER switch in the OFF position and measure the voltage at contact A with respect to contact B at connector P4 of cable W26. (0 ± .2 volts) _____ _____

4. At the FM Control panel, place the POWER switch in the 1 position and measure the voltage as in step 3. (28 ± 2 volts) _____ _____

5. At the FM Control panel, place the POWER switch in the 2 position and measure the voltage as in step 3. (28 ± 2 volts) _____ _____

6. At the FM Control panel, place the POWER switch in the OFF position and measure the voltage at contact L with respect to contact V at connector P6 of cable W26. (0 ± .2 volts) _____ _____

7. At the FM Control panel, place the POWER switch in the 1 position and measure the voltage as in step 6. (28 ± 2 volts) _____ _____

Quality Control

8. At the FM Control panel, place the POWER switch in the 2 position and measure the voltage as in step 6. (0 ± .2 volts _____ _____

9. At the FM Control panel, place the POWER switch in the OFF position and measure the voltage at contact L with respect to contact V at connector P7 of cable W26. (0 ± .2 volts)

_____ _____

10. At the FM Control panel, place the POWER switch in the 1 position and measure the voltage as in step 9. (0 ± .2 volts) _____ _____

11. At the FM Control panel, place the POWER switch in the 2 position and measure the voltage as in step 9. (28 ± 2 volts) _____ _____

12. Measure the voltage at contact A with respect to contact D at connector P1 of cable W35. (24 ± 2 volts) _____ _____

13. Measure the voltage at contact B with respect to contact E at connector P1 of cable W35. (24 ± 2 volts) _____ _____

14. Measure the voltage at contact G with respect to contact K at connector P1 of cable W35. (5.0 ± 0.2 volts) _____ _____

Quality Control

15. Measure the voltage at contact H with respect to contact L at connector P1 of cable W35. (5.0 ± 0.2 volts) _____ _____

16. Measure the voltage at contact N with respect to contact R at connector P1 of cable W35. (+15 ± 1 volts) _____ _____

17. Measure the voltage at contact P with respect to contact R at connector P1 of cable W35. (-15 ± 1 volts) _____ _____

2.5 CONTROL CIRCUITS

Quality Control

1. Verify that there is 28 ± 2 volts at contact A with respect to contact V of connector P6 of cable W26 when TV is selected at the S-band FM Control panel. Also verify that there is 0 ± .2 V for all other positions. _____
2. Repeat step 1 for connector P7 of cable W26. _____
3. Verify that there is 28 ± 2 volts at contact D with respect to contact V of connector P6 of cable W26 when PL ANLG is selected at the S-band FM Control panel. Verify there is 0 ± .2 V for all other positions. _____
4. Repeat step 3 for connector P7 of cable W26. _____
5. Verify that there is 28 ± 2 volts at contact E with respect to contact V of connector P6 of cable W26 when PL DIG is selected at the S-band FM Control panel and there is 0 ± .2 V for all other positions. _____
6. Repeat step 5 for connector P7 of cable W26. _____
7. Verify that there is 28 ± 2 volts at contact C with respect to contact V of connector P6 of cable W26 when PL RCDR is selected at the S-band FM Control panel and there is 0 ± .2 V for all other positions _____
8. Repeat step 7 for connector P7 of cable W26. _____

Quality Control

9. Verify that there is 28 ± 2 volts at contact G with respect to contact V of connector P6 of cable W26 when ME is selected at the S-band FM Control panel. Verify that there is 0 ± .2 volts for all other positions. _____

10. Repeat step 9 for connector P7 of cable W26. _____

11. Verify that there is 28 ± 2 volts of contact B with respect to contact V of connector P6 of cable W26 when OPS RCDR is selected at the S-band FM Control panel and there is 0 ± .2 volts for all other positions. _____

12. Repeat step 11 for connector P7 of cable W26. _____

13. Verify that there is 28 ± 2 volts at contact F with respect to contact V of connector P6 of cable W26 when DOD is selected at the S-band FM Control panel and there is 0 ± .2 volts for all other positions. _____

14. Repeat step 13 for connector P7 of cable W26. _____

15. Place the POWER switch on the S-band FM Control panel to OFF. _____

16. Place the ANT switch on the S-band FM Control panel to GPC. Verify that there is continuity between contacts 5 and 8 of connector A11-J1, and between 6 and 38 of the same connector. _____

Quality Control

17. Verify that there is no continuity between the contacts in the following list.

5	and	6
5	and	7
5	and	9
6	and	37
6	and	39

_____

18. Place the ANT switch on the S-band FM Control panel in the UPPER position. Verify continuity between contacts 5 and 7, and between 6 and 37 of A11-J1.

_____

19. Place the ANT switch on the S-band FM Control panel to the LOWER position. Verify continuity between contacts 5 and 9, and between 6 and 39 of A11-J1.

_____

2.6 MONITOR CIRCUITS

Quality Control

1. Place the POWER switch on the S-band FM Control panel to the OFF position. Verify that the XMTR DC POWER OFF indicator is illuminated, and the XMTR DC POWER ON indicator is not illuminated. _____
2. Verify that both of the SIG PROC PROCESSOR 1 ON indicators are not illuminated. _____
3. Verify that both elapsed time indicators are not operating. _____
4. Place the POWER switch on the S-band FM Control panel to the 1 position. Verify that the XMTR DC POWER ON indicator is illuminated and the XMTR DC POWER OFF indicator is not illuminated. _____
5. Verify that the SIG PROC PROCESSOR 1 ON indicator is illuminated, and the SIG PROC PROCESSOR 2 ON indicator is not illuminated. _____
6. Verify that both elapsed time indicators are operating. _____
7. Place the POWER switch on the S-band FM Control panel to the 2 position. Verify that the XMTR DC POWER ON indicator is illuminated and the XMTR DC POWER OFF indicator is not illuminated. _____

Quality Control

8. Verify that the SIG PROC PROCESSOR 2 ON indicator is illuminated and the SIG PROC PROCESSOR 1 ON indicator is not illuminated. _____

9. Verify that both elapsed time indicators are operating. _____

10. Place the POWER switch on the S-band FM Control panel in the OFF position. _____

11. Place the signal selector control on the S-band FM Control panel to TV. Verify that the TV monitor lamp is illuminated and that the other signal selector monitor lamps are not illuminated. _____

12. Place the signal selector to PL ANLG and verify that the PL ANLG lamp is illuminated and the others are not illuminated. _____

13. Place the signal selector to PL DIG and verify that the PL DIG lamp is illuminated and the others are not illuminated. _____

14. Place the signal selector to PL RCDR and verify that the PL RCDR lamp is illuminated and the others are not illuminated. _____

15. Place the signal selector to ME and verify that the ME lamp is illuminated and the others are not illuminated. _____

16. Place the signal selector to OFF and verify that the OFF lamp is illuminated and the others are not illuminated. _____

Quality Control

17. Place the signal selector to OPS RCDR and verify that the OPS RCDR lamp is illuminated and the others are not illuminated. _____

18. Place the signal selector to DOD and verify that DOD lamp is illuminated and the others are not illuminated. _____

19. Connect contacts 24 and 25 of A11-J2 to the 28 volt return. _____

20. Connect contacts 18 and 19 of A11-J2 to the +28 volt LRU power source. _____

21. Apply +28 volts (LRU power) to contact 20 of A11-J2 and verify that the AUTO monitor lamp on the S-band FM DISCRETE MONITOR FUNCTIONS panel becomes illuminated and is not illuminated when the voltage is removed. _____

22. Apply +28 volts (LRU power) to contact 21 of A11-J2 and verify that the AUTO monitor lamp becomes illuminated and is not illuminated when the voltage is removed. _____

23. Apply +28 volts (LRU power) to contact 28 of A11-J2 and verify that the MAN UPPER monitor lamp becomes illuminated and is not illuminated when the voltage is removed. _____

Quality Control

24. Apply +28 volts (LRU power) to contact 29 of A11-J2 and verify that the MAN UPPER monitor lamp becomes illuminated and is not illuminated when the voltage is removed. _____

25. Apply +28 volts (LRU power) to contact 26 of A11-J2 and verify that the MAN LOWER monitor lamp becomes illuminated and is not illuminated when the voltage is removed. _____

26. Apply +28 volts (LRU power) to contact 27 of A11-J2 and verify that the MAN LOWER monitor lamp becomes illuminated and is not illuminated when the voltage is removed. _____

27. Apply +28 volts (LRU power) to contact 23 of A11-J2 and verify that the ANT SW S5A ON monitor lamp becomes illuminated and is not illuminated when the voltage is removed. _____

28. Apply +28 volts (LRU power) to contact 22 of A11-J2 and verify that the ANT SW S5B ON monitor lamp becomes illuminated and is not illuminated when the voltage is removed. _____

29. Apply +28 volts (LRU power) to contact 31 of A11-J2 and verify that the FM 1 ON monitor lamp becomes illuminated and is not illuminated when the voltage is removed. _____

Date _____

Quality Control

30. Apply +28 volts (LRU power) to contact 30 of A11-J2 and verify that the FM 2 ON monitor lamp becomes illuminated and is not illuminated when the voltage is removed. _____

2.7 SIGNAL DISTRIBUTION

Quality Control

1. Patch from VID DR-1 OUT to PROC TV IN. Insert a 500 kHz (app) signal at 5.0 ± .2 V peak-to-peak into VID DR-1 IN. Measure the output signal at W10-P2, contacts A and D with a differential oscilloscope. (10.0 ± 0.5 V P/P)

   _____ _____

2. Remove the patch from VID DR-1 OUT and patch from VID DR-2 OUT to PROC TV IN. Insert a 500 kHz (app) signal at 5.0 ± .2 V peak-to-peak into VID DR-2 IN. Measure the output signal at W10-P2, contacts A and D with a differential oscilloscope. (10.0 ± 0.5 V P/P) _____ _____

3. Remove the patch used in step 2. Patch from DYN AMP-1 OUT to PL ANLG IN. Insert a 500 kHz (app) signal at 5.0 ± 0.2 V peak-to-peak into DYN AMP-1 IN. Measure the output at W9-P2, contacts A and D with a differential oscilloscope. (10.0 ± 0.5 V P/P) _____ _____

4. Remove the patch used in step 3. Patch from DYN AMP-2 OUT to PL ANLG IN. Insert a 500 kHz (app) signal at 5.0 ± 0.2 V peak-to-peak into DYN AMP-2 IN. Measure the output at W9-P2, contacts A and D with a differential oscilloscope. (10.0 ± 0.5 V P/P) _____ _____

Quality Control

5. Remove the patch used in step 4. Insert a 100 kHz (app) square wave signal at 4.0 ± 0.5 V peak-to-peak into the patch panel ME-1 input. Measure the output at W36-P8, contacts K and L with a differential oscilloscope. (7.0 ± 2.0 V P/P) _____ _____

6. Insert the 100 kHz signal into the patch panel ME-2 input and measure the output at contacts R and P of W36-P8. (7.0 ± 2.0 V P/P) _____ _____

7. Insert the 100 kHz signal into patch panel ME-3 input and measure the output at contacts U and T of W36-P8. (7.0 ± 2.0 V P/P) _____ _____

8. Insert the 100 kHz signal into patch panel MS PB input and measure the output at contacts D and E of W36-J8. (7.0 ± 2.0 V P/P) _____ _____

9. Insert the 100 kHz signal into patch panel OI PB input and measure the output at contacts A and B of W36-J8. (7.0 ± 2.0 V P/P) _____ _____

10. Insert the 100 kHz signal into patch panel DOD input and measure the output at contacts G and H of W36-J8. (7.0 ± 2.0 V P/P) _____ _____

11. Insert the 100 kHz signal into patch panel PL DIG input and measure the output at contacts A and D of W36-P9. (7.0 ± 2.0 V P/P) _____ _____

Quality Control

12. Insert the 100 kHz signal into patch panel 1024 #1 IN and measure the output at contacts P and S of W26-P6. (7.0 ± 2.0 V P/P) _____ _____

13. Insert the 100 kHz signal into patch panel 1024 #2 IN and measure the output at contacts P and S of W26-P7. (7.0 ± 2.0 V P/P) _____ _____

2.8 COOLING AND TEMPERATURE

Quality Control

1. Connect the cold plate cooling water input and output couplings to the Orbiter Cooling System. _____
2. Record the pyrometer temperature. _____
3. Energize the Orbiter Cooling System and verify coolant flow. _____
4. Verify that the temperature decreases at least 5 degrees. Record the temperature _____. _____

CONCLUSION AND COMMENTS

Results of the console test performance indicate that the equipment is satisfactory for installation of the flight equipment.

(Check) Yes _____, No _____ _____

The following comments are made (if any):

_____

_____

_____

_____

_____

_____ _____