NASA TM X-64013

TR-963

June 30, 1969

JOHN F. KENNEDY SPACE CENTER

POWER DENSITY MEASUREMENTS

TEST REPORT

TELEMETRIC SYSTEMS DIVISION

PRECEDING PAGE BLANK NOT FILMED.

JOHN F. KENNEDY SPACE CENTER, NASA

TR-963

POWER DENSITY MEASUREMENTS

TEST REPORT

ABSTRACT

This report describes power density measurements conducted at the Vehicle Assembly Building, Launch Complex 39, Pad A, and Launch Complex 34. It also contains a discussion of the techniques and instrumentation used in performing the measurements and an evaluation of the results of these measurements.

TELEMETRIC SYSTEMS DIVISION

June 30, 1969

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION I
INTRODUCTION

A. PURPOSE

This report describes power density measurements conducted at the Vehicle Assembly Building (VAB), Launch Complex 39, Pad A (LC-39A), and Launch Complex 34 (LC-34) and documents the pulse desensitization measurements which were performed as a result of the power density measurements.

B. SCOPE

This report contains a discussion of the techniques and instrumentation used in performing the measurements and an evaluation of the results of these measurements.

C. APPLICABLE DOCUMENTS

The following documents may be used as supplementary information:

1. Power Densities at Apollo/Saturn Assembly and Launch Complexes as a Result of High Power RF Emitters (TR-563), September 15, 1967.

2. Memorandum EMC-449-69, John H. Thorn, Power Density Measurements Vehicle Assembly Building, LC-39A, LC-34, January 14, 1969.

3. Memorandum EMC-447-69, John H. Thorn, Pulse Desensitization Measurements, January 8, 1969.

4. Applicable vendors' and manufacturers' manuals.

D. ABBREVIATIONS

AGC	- Automatic Gain Control	LUT	- Launch Umbilical Tower
CW	- Continuous Wave	MHz	- Megahertz (10^6 cycles per second)
dB	- Decibel	usec	- Microsecond
EMC	- Electromagnetic Compatibility	MSS	- Mobile Service Structure
FEC	- Federal Electric Corporation	ODOP	- Offset Doppler Tracking System
FPQ-6	- C-Band Radar-Fixed	PM	- Pulse Modulation
FPS-16	- C-Band Radar-Fixed	pps	- Pulse Per Second
GHz	- Gigahertz (10^9 cycles per second)	RF	- Radiofrequency
IF	- Intermediate Frequency	TPQ-18	- Pulsed Radar
KSC	- John F. Kennedy Space Center	USB	- Unified S-Band
kw	- Kilowatt	VAB	- Vehicle Assembly Building
LC-34	- Launch Complex 34	w/cm^2	- Watt Per Square Centimeter
LC-39A	- Launch Complex 39, Pad A	w/m^2	- Watt Per Square Meter

SECTION II
POWER DENSITY MEASUREMENTS

A. GENERAL

Power density measurements were performed at the VAB, LC-39A, and LC-34 by personnel of the Federal Electric Corporation (FEC) Electromagnetic Compatibility (EMC) Branch, as directed by the NASA Telemetric Systems Division, Electromagnetic Section (IN-TEL-33).

The purpose of these measurements was to:

1. Determine the power density of each primary radiofrequency (RF) emitter at each measurement location by actual measurement.

2. Compare the measured values with the calculated predicted values.

3. Compare the measured values at each measurement location with the current acceptable radiation and gasoline safety levels, which are discussed in TR-563, Power Densities at Apollo/Saturn Assembly and Launch Complexes as a Result of High Power Emitters.

B. TEST FACILITY AND EQUIPMENT

Power density measurements were performed at each of the following locations:

1. Vehicle Assembly Building. The first test was conducted at the southeast corner of the VAB, where all emitters were measured. The receiving antenna was located at the top of the stairwell, thus enabling the antenna and the antenna operator to be above the extending lightning rods and warning lights.

2. Launch Complex 39, Pad A. The second test site was at the 356-foot level of the service structure at LC-39A. At this location, all microwave measurements were performed with the receiving antenna mounted on the highest steel beam. The only protruding object above the antenna was the warning light post, which was not within the antenna's beamwidth.

3. Launch Complex 34. The third test site was at the 224-foot level of the service structure at LC-34. This area consisted of a metal floor with structural steel beams. The antenna was extended beyond these structural beams to obtain a clear view of the emitter.

Table 1 lists the systems which were primary sources of RF emissions measured and the important characteristics of each system. It also presents the distance of each RF emitter from the three measurement locations.

Table 1. Characteristics of RF Emitting Systems and Emitter Distances from Measurement Locations

System	Freq (MHz)	Peak Power (kw)	Pulse Width (usec)	Rep Rate (pps)	Antenna Gain (dB)	Distance (Miles)		
						VAB	LC-39A	LC-34
Command Control	450	8.0	CW	CW	16.0	10.60	11.70	2.10
ODOP	890	0.2	CW	CW	21.5	00.84	3.34	11.00
USB	2106	10.0	CW	CW	43.0	6.00	8.85	8.30
Mod II	2900	461.0	0.80	410	37.0	8.12	8.20	2.20
FPS-16	5690	1000.0	1.00	160	43.0	8.50	9.00	2.85
TPQ-18	5690	2000.0	1.00	160	49.0	11.20	14.00	9.30
FPQ-6	5690	2000.0	1.00	160	49.0	25.00	26.40	20.50
Mod IV	8800	300.0	0.18	1000	40.0	9.75	11.70	3.90

The measuring equipment used in these tests and the frequencies measured are shown in table 2. Accessories included RG-55 and RG-9 cables, a tripod, an antenna kit, adapters, a power cord, and tools.

C. TEST DESCRIPTION

At each of the three test sites, the power density measurements were conducted in accordance with the test plan. The test equipment configuration for measuring the 400-MHz to 1000-MHz frequency range is shown in figure 1. Figure 2 shows the 1-GHz to 10-GHz test equipment configuration. For the 400-MHz to 10-GHz measurements, the test equipment was configured as shown in figure 3.

The following parameters were verified with the radar operators, as applicable, where the information was available.

1. Frequency
2. Peak power
3. Antenna gain
4. Antenna polarization
5. Antenna dimensions
6. Azimuth
7. Elevation
8. Pulse width
9. Pulse repetition rate
10. Range
11. Transmitter line loss

Table 2. Power Density Measuring Equipment

	Frequency (MHz)					
Antennas	450	890	2106	2900	5690	8800
DM-105-T3 Dipole (400-1000 MHz)	x	x				
Horn (Stoddart) 91888-1			x			
Horn (Stoddart) 91889-1				x		
Horn (Stoddart) 91890-1					x	
Reflector (Stoddart) 91892-1					x	
Horn (Stoddart) 91891-1						x
Reflector (Stoddart) 91892-1						x
Receivers						
NF-105 (Empire)	x	x				
Polarad CFI			x	x	x	x
Tuning Heads						
NF-105-T3 (Empire)	x	x				
T-RS (Polarad) 1.9-4.34 GHz			x	x		
T-RM (Polarad) 4.2-7.74 GHz					x	
T-RX (Polarad) 7.3-10 GHz						x
Power Meter						
(HP-431B)	x	x	x	x	x	x
Signal Generators						
HP-612A (450 MHz-1.2 GHz)	x	x				
HP-8616A (1.8-4.5 GHz)			x	x		
Polarad 1107 (3.8-8.2 GHz)					x	
Polarad 1108 (7-11 GHz)						x
Spectrum Analyzer and Display	x	x	x	x	x	x

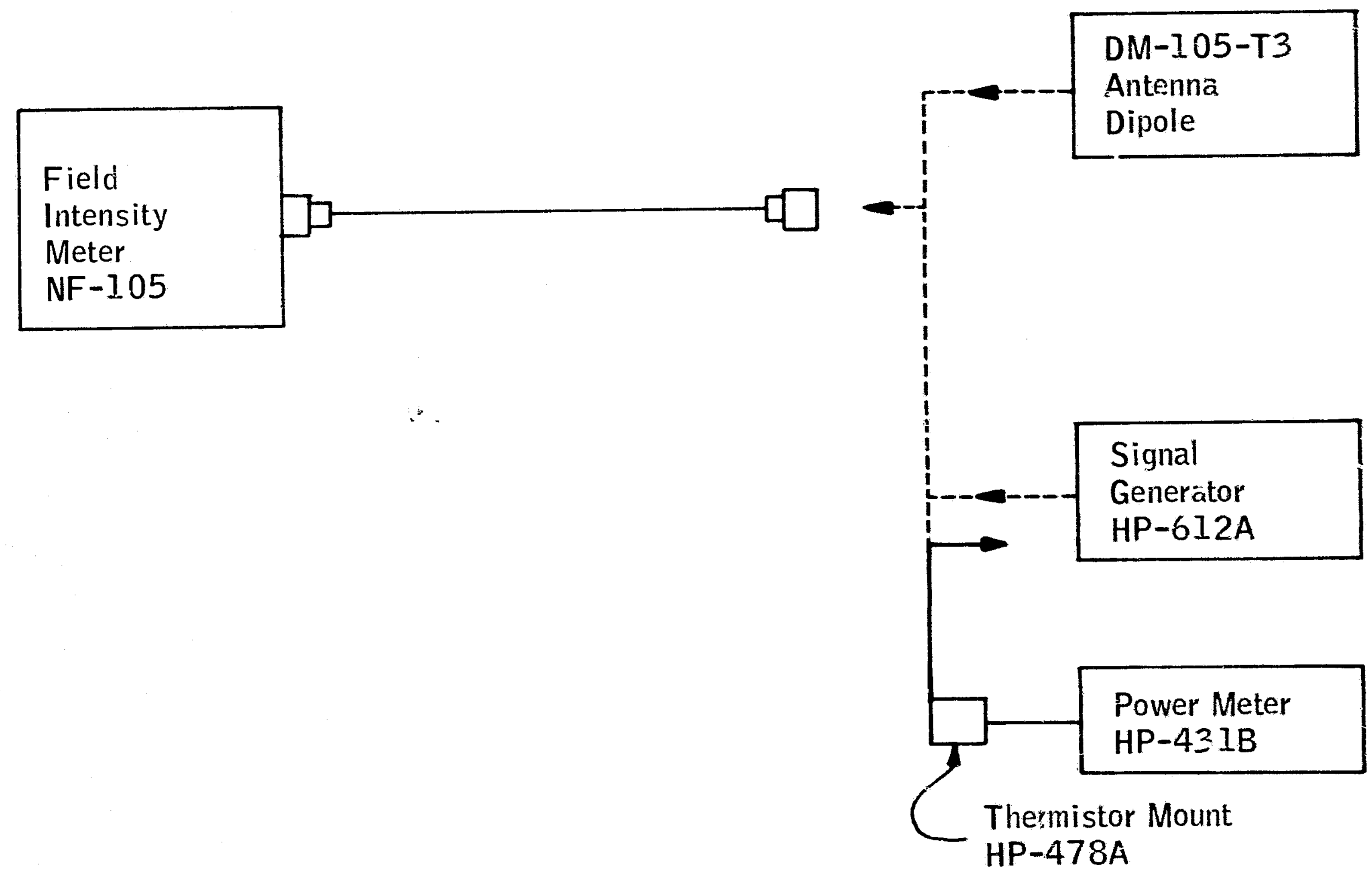
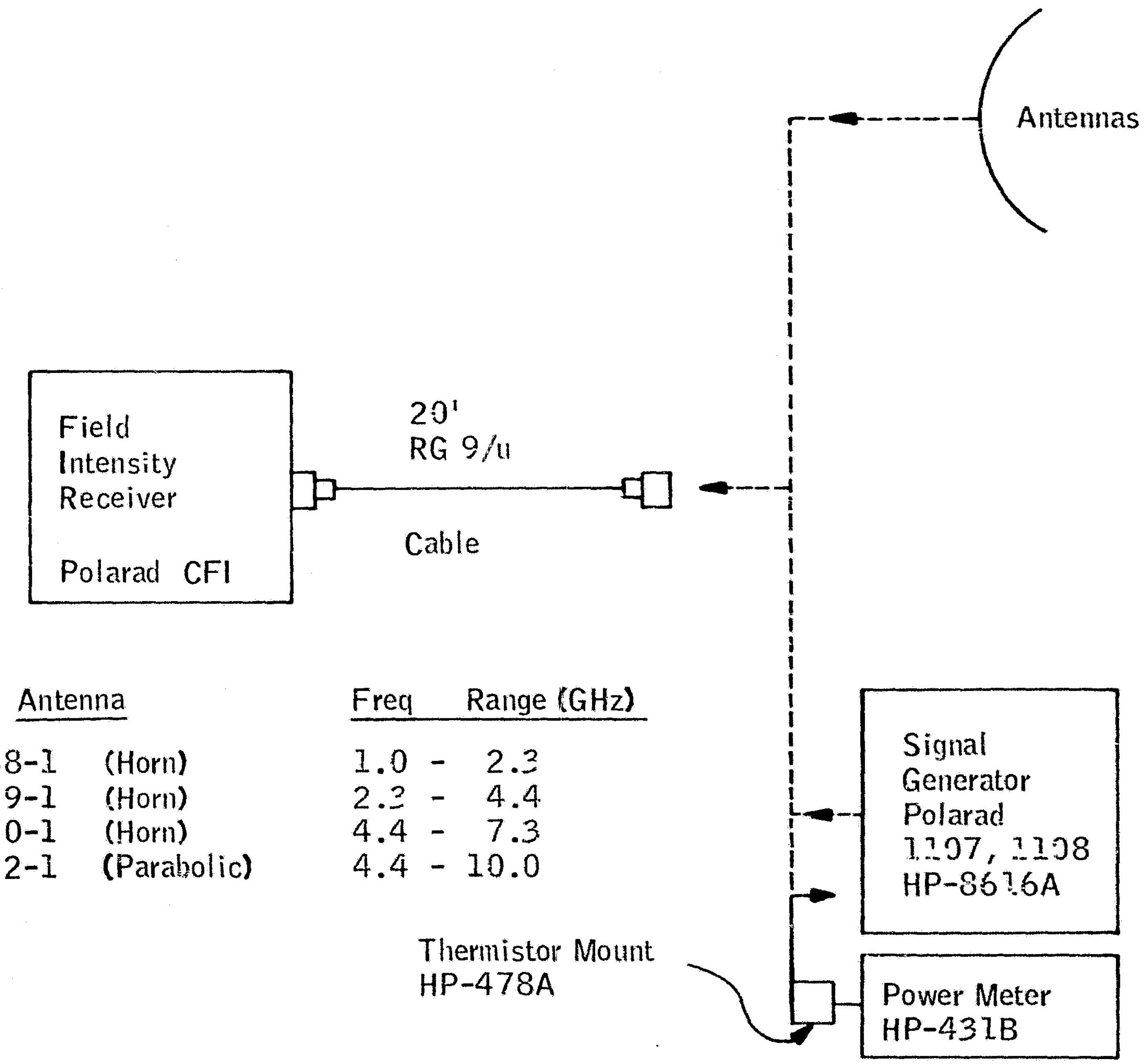
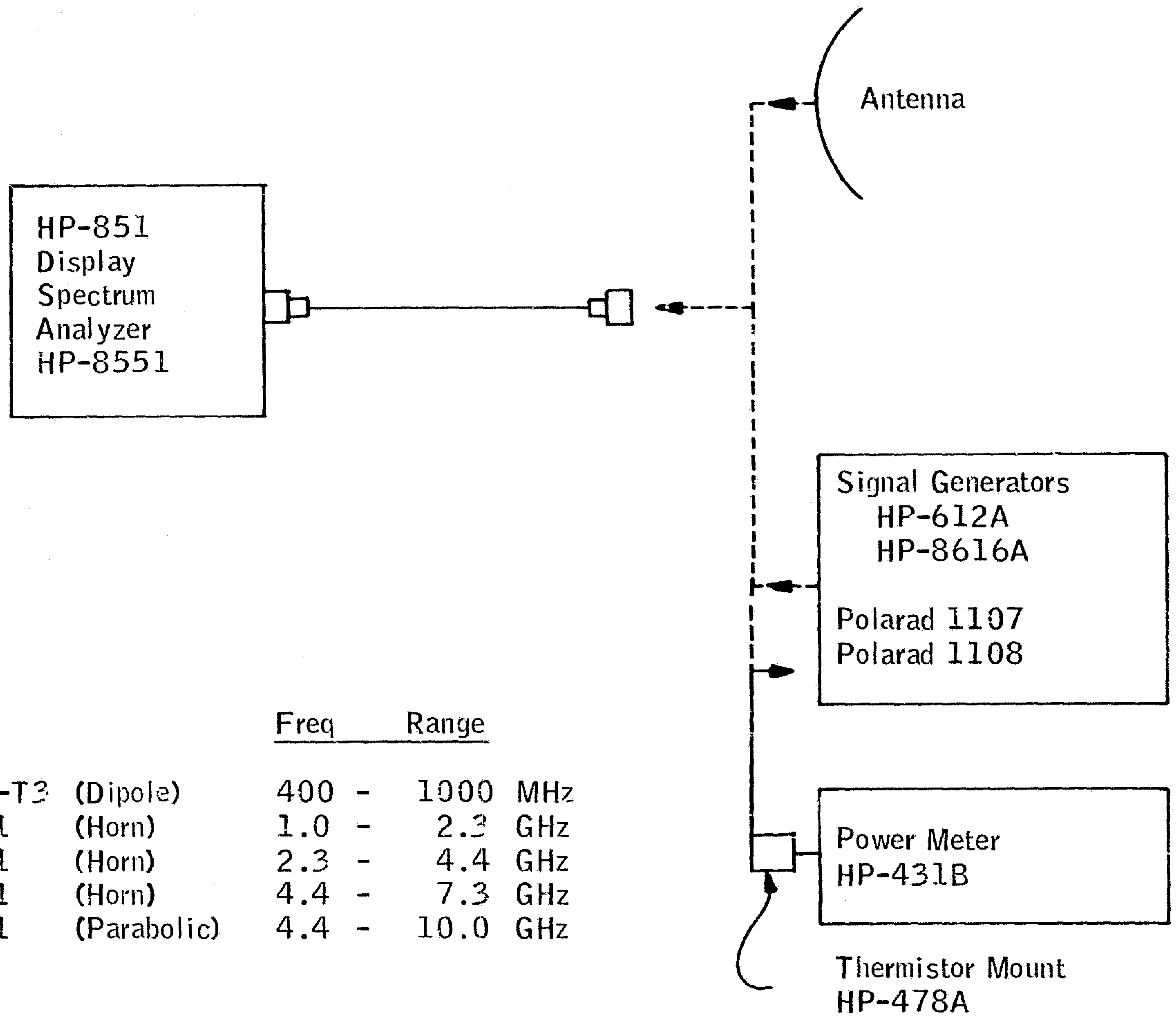


Figure 1. Equipment Configuration for Measuring 400-MHz to 1000-MHz Frequency Range



Antenna		Freq Range (GHz)
91888-1	(Horn)	1.0 - 2.3
91889-1	(Horn)	2.2 - 4.4
91890-1	(Horn)	4.4 - 7.3
91892-1	(Parabolic)	4.4 - 10.0

Figure 2. Equipment Configuration for Measuring 1-GHz to 10-GHz Frequency Range



Antenna		Freq		Range	
DM-105-T3	(Dipole)	400	-	1000	MHz
91888-1	(Horn)	1.0	-	2.3	GHz
91889-1	(Horn)	2.3	-	4.4	GHz
91890-1	(Horn)	4.4	-	7.3	GHz
91892-1	(Parabolic)	4.4	-	10.0	GHz

Figure 3. Equipment Configuration for Measuring 400-MHz to 10-GHz Frequency Range

The polarization was checked by moving the antenna in the vertical and horizontal planes and in azimuth and elevation, checking for maximum field strength.

The power density measurements on the Polarad CFI Receiver were made in the Peak mode with a 1-MHz bandwidth setting. The Polarad CFI Receiver was the primary measuring instrument used at the VAB and LC-39A; the HP Spectrum Analyzer was used as the primary measuring device at LC-34. The results of these measurements are presented in table 3.

The pulse desensitization measurements made on the HP Spectrum Analyzer and the Polarad CFI Receiver showed the degradation in measurements presented in table 4.

Table 5 shows the measurement differences, allowing for pulse desensitization degradation.

The measured peak and average power densities, in watts per square meter, are shown in table 6. This table includes the uncorrected measurements and those measurements corrected by allowing for pulse desensitization.

The conclusions drawn from the results of the power density tests are presented in Section III. The results of these tests indicated the desirability of performing the pulse desensitization tests discussed in the Appendix.

Table 3. Results of the Power Density Measurements

VAB	Peak Calculated (w/m^2)	Peak Measured (w/m^2)	Δ dB
Command Control	8.8×10^{-5}	0.119×10^{-5}	- 18.7
ODOP	3.05×10^{-4}	21.6×10^{-4}	+ 8.5
USB	0.086	1.08	+11.0
Mod II	0.536	1.32	+ 4.0
FPS-16	4.3	1.28	- 5.0
TPQ-18	19.5	63.0×10^{-7}	- 65.0
FPQ-6	3.9	7.1×10^{-6}	- 54.8
Mod IV	4.92×10^{-3}	31.4×10^{-3}	- 12.0
LC-39A			
Command Control	7.2×10^{-5}	4.23×10^{-5}	- 2.0
ODOP	24.5×10^{-6}	191.0×10^{-6}	+ 9.[illegible]
USB	3.95×10^{-2}	86.0×10^{-2}	+13.5
Mod II	0.53	1.17	+ 3.5
FPS-16	3.83	0.122	- 15.0
TPQ-18	14.0	6.32×10^{-3}	- 33.[illegible]
FPQ-6	Down for Repair		
Mod IV	0.345	1.22×10^{-2}	- 14.5
LC-34			
Command Control	0.7×10^{-3}	1.89×10^{-3}	+ 4.3
ODOP	0.635×10^{-6}	1.36×10^{-6}	+ 3.3
USB	4.66×10^{-2}	8.6×10^{-2}	+ 2.7
Mod II	7.5	1.85×10^{-5}	- 56.0
FPS-16	39.39.0	3.2×10^{-2}	- 31.[illegible]
TPQ-18	29.4	1.41×10^{-2}	- 33.2
FPQ-6	5.9	4.45×10^{-2}	- 21.2
Mod IV	1.25	5.42×10^{-5}	- 43.6

Table 4. Continuous Wave to Pulse Modulation Measurements

Freq (GHz)	Pulse Width (usec)	Rep Rate (pps)	Degradation (dB)	
			HP Spectrum Analyzer	Polarad CFI Receiver
2.90	0.80	410	-36	-5
5.69	1.00	160	-18	-5
8.80	0.18	1000	-35	-15

NOTE

In tables 5 and 6, the items appearing in boxes were affected by pulse desensitization.

Table 5. Power Density Measurement Differences

System	Δ_1dB*			Δ_2dB**		
	VAB	LC-39A	LC-34	VAB	LC-39A	LC-34
Command Control	- 18.7	- 2.0	+ 4.3	- 18.7	- 2.0	+ 4.3
ODOP	+ 8.5	+ 9.0	+ 3.3	+ 8.5	+ 9.0	+ 3.3
USB	+ 11.0	+ 13.5	+ 2.7	+ 11.0	+ 13.5	+ 2.7
Mod II	+ 4.0	+ 3.5	- 56.0	$\boxed{+\ 9.0}$	$\boxed{+\ 8.5}$	$\boxed{-\ 20.0}$
FPS-16	- 5.0	- 15.0	- 31.0	$\boxed{0}$	$\boxed{-\ 10.0}$	$\boxed{-\ 13.0}$
TPQ-18	- 65.0	- 33.5	- 33.2	$\boxed{-\ 60.0}$	$\boxed{-\ 28.5}$	$\boxed{-\ 15.2}$
FPQ-6	- 54.8	***	- 21.2	$\boxed{-\ 49.8}$	$\boxed{***}$	$\boxed{-\ 3.2}$
Mod IV	- 12.0	- 14.5	- 43.6	$\boxed{+\ 3.0}$	$\boxed{+\ 0.5}$	$\boxed{-\ 8.6}$

* Δ_1dB — Difference in dB of measured value from predicted, uncorrected for pulse desensitization.

** Δ_2dB — Difference in dB of measured value from predicted, corrected for pulse desensitization.

*** — Radar down for repair.

Table 6. Uncorrected and Corrected Power Density Measurements

VAB	Measured Peak (w/m²)	Uncorrected Average	Measured Peak (w/m²)	Corrected Average
Command Control	0.119×10^{-5}	0.119×10^{-5}	0.119×10^{-5}	0.119×10^{-5}
ODOP	21.6×10^{-4}	21.6×10^{-4}	21.6×10^{-4}	21.6×10^{-4}
USB	1.08	1.08	1.08	1.08
Mod II	1.32	0.434×10^{-3}	$\boxed{4.2}$	$\boxed{1.37 \times 10^{-3}}$
FPS-16	1.28	0.205×10^{-3}	$\boxed{4.05}$	$\boxed{0.65 \times 10^{-3}}$
TPQ-18	63.0×10^{-7}	1.0×10^{-9}	$\boxed{195.0 \times 10^{-7}}$	$\boxed{3.16 \times 10^{-9}}$
FPQ-6	7.1×10^{-6}	1.13×10^{-9}	$\boxed{22.5 \times 10^{-6}}$	$\boxed{3.58 \times 10^{-9}}$
Mod IV	31.4×10^{-3}	6.28×10^{-6}	$\boxed{1.0}$	$\boxed{198.0 \times 10^{-6}}$
LC-39A				
Command Control	4.23×10^{-5}	4.23×10^{-5}	4.23×10^{-5}	4.23×10^{-5}
ODOP	191.0×10^{-6}	191.0×10^{-6}	191.0×10^{-6}	191.0×10^{-6}
USB	86.0×10^{-2}	86.0×10^{-2}	86.0×10^{-2}	86.0×10^{-2}
Mod II	1.17	0.383×10^{-3}	$\boxed{3.7}$	$\boxed{1.21 \times 10^{-3}}$
FPS-16	0.122	1.96×10^{-5}	$\boxed{0.385}$	$\boxed{6.2 \times 10^{-5}}$
TPQ-18	6.32×10^{-3}	1.01×10^{-6}	$\boxed{20.0 \times 10^{-3}}$	$\boxed{3.2 \times 10^{-6}}$
FPQ-6	Radar down for repair			
Mod IV	1.22×10^{-2}	0.244×10^{-5}	$\boxed{35.0 \times 10^{-2}}$	$\boxed{7.0 \times 10^{-5}}$
LC-34				
Command Control	1.89×10^{-3}	1.89×10^{-3}	1.89×10^{-3}	1.89×10^{-3}
ODOP	1.36×10^{-6}	1.36×10^{-6}	1.36×10^{-6}	1.36×10^{-6}
USB	8.6×10^{-2}	8.6×10^{-2}	8.6×10^{-2}	8.6×10^{-2}
Mod II	1.85×10^{-5}	0.605×10^{-8}	$\boxed{7.6 \times 10^{-2}}$	$\boxed{2.41 \times 10^{-5}}$
FPS-16	3.2×10^{-2}	5.1×10^{-6}	$\boxed{2.0}$	$\boxed{3.23 \times 10^{-4}}$
TPQ-18	1.41×10^{-2}	2.26×10^{-6}	$\boxed{0.9}$	$\boxed{1.42 \times 10^{-4}}$
FPQ-6	4.45×10^{-2}	0.710×10^{-5}	$\boxed{2.7}$	$\boxed{4.5 \times 10^{-4}}$
Mod IV	5.42×10^{-5}	1.08×10^{-8}	$\boxed{17.2 \times 10^{-2}}$	$\boxed{3.4 \times 10^{-5}}$

SECTION III
CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The following conclusions were drawn from the results of the power density tests:

Where differences occur between the predicted values and the measured values, these differences are greater for pulse measurements than for continuous wave (CW) measurements. Most of the measured values are positive for the CW measurements and negative for the pulse measurements. The positive differences are probably due to the presence of multipath scattering on such metal structures as the Mobile Service Structure (MSS), and Launch Umbilical Tower (LUT), or the LC-34 service structure which may concentrate impulse energy at any point. The negative differences are due primarily to path differences in terrain and vegetation losses, out-of-phase multipath losses, possible Fresnel zone occurrences, or transmitter degradation.

The maximum power density measured was 1.32 w/m^2 peak power. The measurement was taken at the VAB from the Mod II transmitter. When this value was corrected for pulse desensitization, it became 4.2 w/m^2 peak.

The measured values at each location were compared with the current acceptable radiation and gasoline safety levels.

1. Explosives Safety Calculated Levels. According to Air Force Manual 127-100D "Explosives Safety Manual," the maximum safe power density level at 2.4 GHz is 2.4 w/m^2 and at 5.4 GHz is 12.8 w/m^2; however, these levels are based on free space calculations from a transmitter. If a free space calculation is assumed, the peak calculated level of both the S-band (Mod II) and the C-band (TPQ-18 and FPS-16) is above the minimum safe level; however, if average power is assumed, the calculated and the measured (corrected) levels would be below the minimum safe levels.

Free space conditions will exist at some point after liftoff due to the lack of ground attenuation at higher altitudes. At this point, the power density will decrease as a function of $1/D^2$, where D is the distance between the vehicle and the ground antenna. Therefore, it would be expected that the power density would increase due to a reduction in ground attenuation at liftoff, reach a peak at some later time, and then decrease. This conclusion was verified by automatic gain control (AGC) measurements data for certain previous flights with the exception that the AGC levels exceeded the full scale setting of the AGC instrumentation near the peak values.

2. Ordnance Hazards. In Section IV of the Kennedy Space Center (KSC) "Microwave and Radar Hazards Handbook," a discussion of ordnance hazards emphasizes several basic problems associated with ordnance in high RF environments; however, no quantitative minimum safe levels are specified. Specific areas applicable to the ordnance condition defined in this report are:

a. The available data and publications concerning ordnance hazards are inconclusive and limited.

b. Values of minimum firing current may vary as much as plus or minus 10 percent for a given type of squib.

c. The use of a shunt or fuse link in parallel with the bridge wire between the external legs of the squib almost completely offsets the effects of static electricity; however, the placement of the shunt in the leg wires of the firing circuit may be critical with respect to high radio frequencies; therefore, the use of a shunt does not rule out the possibility that RF hazards exist.

MIL-P-24014, General Requirements for Preclusion of Hazards from Electromagnetic Radiation to Ordnance, Measured Levels, specifies the level of potential ordnance hazards from radar and radio transmitters. A comparison of the specification levels with those levels measured during the test shows that all the measured levels are below the safe ordnance level. However, some of the measured levels are close to the specified level, and since the empirical data taken are for one particular set of conditions, they do not represent a statistical mode.

3. Personnel Radiation Hazard. The presently accepted maximum safe level of electromagnetic energy to which the human body may be exposed at any frequency is 0.01 w/cm^2. This level is an average power level, not peak power, since available data indicate that the only detrimental effects are thermal in nature and depend only on average levels. The minimum safe level for radiation hazards to personnel was not exceeded in any of the measurements.

B. RECOMMENDATIONS

No recommendations were made as a result of these tests.

APPENDIX
PULSE DESENSITIZATION MEASUREMENTS

A. GENERAL

The pulse desensitization measurements were conducted as a result of the wide divergences between the predicted and measured values of the pulsed radars in the power density tests.

The following information was extracted from "Spectrum Analysis - Application Note Sixty-Three," May 1965, page 23 of C. Measuring Absolute RF Levels, by the Hewlett-Packard Company:

> One further consideration must be made about the analyzer at this point and that is pulse desensitization. When measuring pulsed signals and comparing their spectrum amplitudes with those for CW signals, the shape and bandwidth of the IF amplifier in the analyzer must be shown. Because the analyzer must be selective for resolving spectra, its IF bandwidth does not admit all of the frequency components contained in a pulse at one time. Therefore, the peak amplitude of the main lobe of a pulse's spectral display is typically 20 dB lower than the response to a CW signal of equal peak value to that of the pulse. This is termed pulse desensitization and is given in terms of dB loss by the equation $\alpha = 20 \log K\ t\ \Delta f$ where
>
> α = attenuation of pulse spectrum main lobe relative to a CW signal of equal strength.
>
> K = an IF bandshape constant for the particular 851A being used.
>
> t = measured pulse width in sec.
>
> Δf = IF bandwidth selected on the analyzer.

B. POLARAD CFI RECEIVER PULSE DESENSITIZATION/BANDWITH MEASUREMENT

1. Purpose. This test was conducted to measure the difference in the signa levels caused by the receiver not capturing the entire bandwidth occupied by the pulsed rada signal.

2. Test Facility and Equipment. These measurements were performed in the EMC Laboratory, using the following equipment:

a.	Receiver	-	Polarad CFI
		-	Tuning Heads CFI (M&S)
b.	Signal Generator	-	Rohde and Schwarz SHF
		-	HP-8616

c. Modulator - HP-8716

The test equipment configuration is shown in figures 4 and 5.

3. Test Description. The test was conducted in two phases. First, the C-band measurements were obtained; second, the S-band measurements were taken.

a. C-Band Measurement. The equipment was connected as shown in figure 4 and was operated in accordance with the manufacturers' instruction manuals, with the following initial settings:

(1)	Frequency RF	-	5690 Hz
(2)	Pulse Width	-	1.0 usec
(3)	Pulse rep rate	-	160 pps

The receiver was tuned to the initial frequency with the signal generator in the CW mode, and the attenuator was adjusted to a reference mark on the meter. Then, the receiver was carefully peaked to all signals.

The CW output of the generator was rated. The generator was modulated, the attenuator was adjusted to the reference on the receiver, and the attenuator reading was noted. The results of this test are presented in table 7.

b. S-Band Measurement. The equipment was connected as shown in figure 5 and was operated in accordance with the manufacturers' instruction manuals, with the following initial settings:

(1)	Frequency RF	-	2900 MHz
(2)	Pulse width	-	0.8 usec
(3)	Pulse rep rate	-	410 pps

The receiver was tuned to the initial frequency with the signal generator in the CW mode, and the attenuator was adjusted to a reference mark on the meter. Then the receiver was carefully peaked to all signals.

The CW output of the generator was noted. The generator was modulated, the attenuator was adjusted to the reference on the receiver, and the attenuator reading was noted. The results of this test are presented in table 8.

C. HEWLETT-PACKARD SPECTRUM ANALYZER PULSE DESENSITIZATION MEASUREMENT

1. Purpose. This test was conducted to measure the difference in the signal levels in the Pulse and CW modes due to pulse desensitization.

2. Test Facility and Equipment. These measurements were performed in the EMC Laboratory using the following equipment:

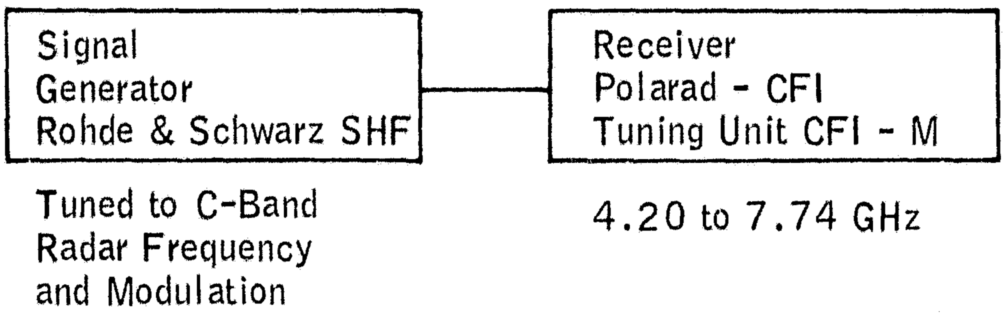


Figure 4. Equipment Configuration for C-Band Measurements

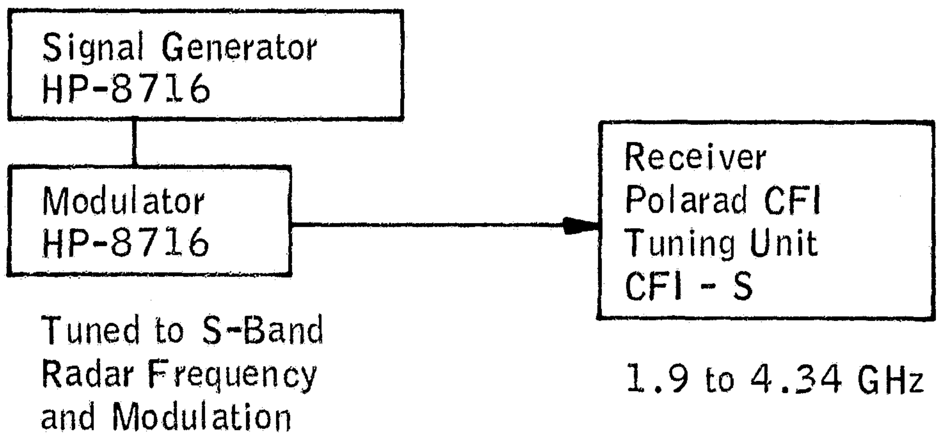


Figure 5. Equipment Configuration for S-Band Measurements

Table 7. Results of C-Band Measurements

Signal Generator		Receiver
Pulse Width (usec)	Output (dBm)	Bandwidth (MHz)
10	-49.0	1
1	-44.0	1
10	-41.5	5
1	-39.5	5
10	-35.5	Wideband
1	-34.2	Wideband
0.2	-35.0	1
0.2	-45.0	5
0.2	-45.5	Wideband
CW	-49.7	1

Table 8. Results of S-Band Measurements

Signal Generator		Receiver
Pulse Width (usec)	Output (dBm)	Bandwidth (MHz)
0.8	-59.5	1
8.0	-64.5	1
80.0	-65.0	1
CW	-65.0	1
0.8	-59.0	5
8.0	-60.0	5
80.0	-61.0	5
CW	-61.0	5
0.8	-48.2	Wideband
8.0	-48.8	Wideband
80.0	-49.5	Wideband
CW	-49.5	Wideband

a.	Signal Generator	-	Rohde and Schwarz SHF
b.	Crystal Detector	-	HP-423A
c.	Termination (100 ohms)	-	HP-10100B
d.	Oscilloscope	-	Tektronix RM-35A
e.	Spectrum Analyzer	-	HP-8551A
	Display	-	HP-851A

The test equipment configuration is shown in figures 6 and 7.

3. Test Description. To conduct measurements at the 8.8-GHz frequency, the equipment was set up as shown in figure 6, and pulse width calibration was performed using the following initial settings:

a. Signal Generator

Frequency	8.8 GHz
Power out	0 dBm
Range	-5
PM	Unmod (CW)
Automatic line conditioner	0 on -5 scale
FM	Unmod

b. Oscilloscope

Time Base

Horizontal display	A
Triggering mode	AC
Trigger	EXT +
Stability	Preset
Triggering level	0
Time/cm	.1 usec
Variable	Calibrated

Preamp

Mode	A
Polarity	(+)
Vertical position	.05
Volts/cm	Calibrated
Focus, intensity, astigmatism	Good display

The following adjustments were made from the signal generator initial settings:

a.	PM switch	-	Internal
b.	Rep period	-	1 x 1

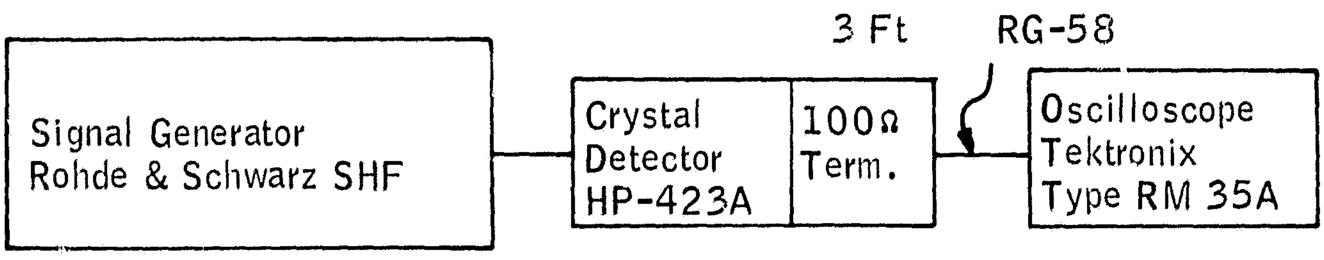


Figure 6. Equipment Configuration for Pulse Width Calibration

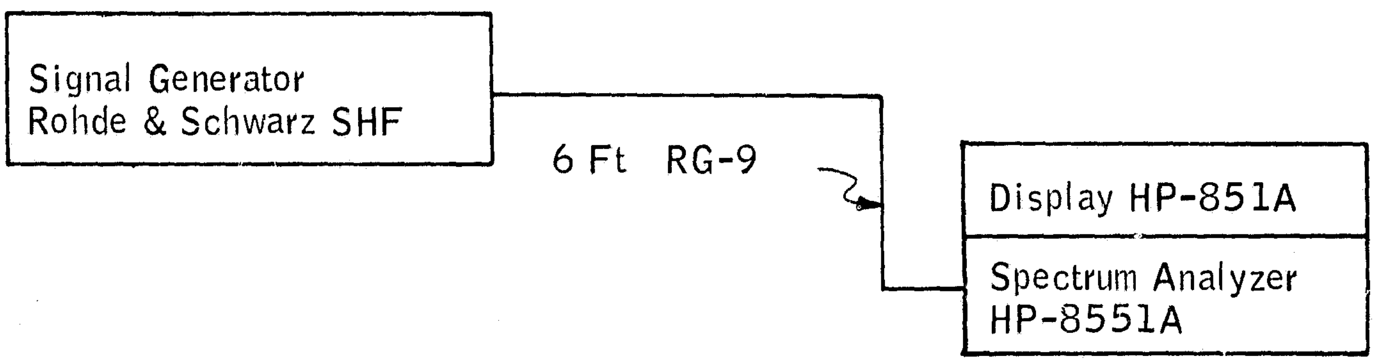


Figure 7. Equipment Configuration for Pulse Desensitization Measurements

c. Delay - Off
d. Width - 1.8 x 1

With the test equipment configured as shown in figure 7, using the signal generator width control, the oscilloscope display was adjusted for 1.8 usec.

Tests were conducted using the HP-8551 Spectrum Analyzer and a pulse modulated signal generator. The settings for the spectrum analyzer were obtained from the data sheets for the LC-34 power density measurements. Calibration of the pulse width and the repetition rates was accomplished by using the HP-423A Crystal Detector and the HP-101000B (100-ohm) Termination Feed-Through. The detected pulses were displayed on the oscilloscope, and the readings recorded. These procedures were repeated for the 2.9-GHz and 5.69-GHz frequencies, with the signal generator set to the frequency of interest. The results of these tests are presented in table 9.

D. CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions. The following conclusions were drawn from the test.

a. The C-band measurements show a -5-dB degradation in signal level due to a narrowing of the pulse width from 10 usec to 1 usec, with the bandwidth constant at 1 MHz in the Peak mode.

b. The S-band measurements show a -5-dB degradation in signal level due to a narrowing of the pulse width from 8.0 usec to 0.8 usec, with the bandwidth constant at 1 MHz in the Peak mode.

c. Since both X-band heads were under repair, the results of the C-band measurements for a pulse width of 0.2 usec were taken. This showed a -15-dB degradation in signal level from CW to 0.2 usec bandwidth.

2. Recommendations. No recommendations were furnished as a result of these tests.

Table 9. Results of Spectrum Analyzer Pulse Desensitization Measurements

Freq (GHz)	Pulse Width (usec)	Rep Rate (pps)	Degradation (dB)
2.900	0.8	410	-36
5.690	1.0	160	-18
8.800	0.18	1000	-35

Table 10. Summary of Pulse Desensitization Tests

Freq (GHz)	Pulse Width (usec)	Rep Rate (pps)	Desensitization (dB)	
			Polarad CFI	Hewlett-Packard Spectrum Analyzer
2.900	0.8	410	-5	-36
5.690	1.0	160	-5	-18
8.800	0.18	1000	-15	-35

APPROVAL

TR-963

POWER DENSITY MEASUREMENTS
TEST REPORT

ORIGINATOR:

J. H. Thorn
Field Measurements Section Supervisor
Federal Electric Corporation

APPROVED BY:

D. M. Van Tassell
EMC Branch Supervisor
Federal Electric Corporation

D. L. Lester
EMC Section IN-TEL-33
NASA Technical Representative