RADIO FREQUENCY RADIATION TEST SET

Model 8700 Series
OPERATION AND MAINTENANCE MANUAL

narda
A Subsidiary of LORAL

TECHNICAL MANUAL
OPERATION AND MAINTENANCE INSTRUCTIONS
FOR
RADIO FREQUENCY RADIATION TEST SET
8700 SERIES

U.S. Patent Nos.
3641439, 4518912, 4023093,
4629978, 4634968
Des. 280, 388,
4611166, 4605905
additional Foreign Patents

THE NARDA MICROWAVE CORPORATION

10/91 LCI 500

8700 Series

WARNING

ELECTROMAGNETIC RADIATION

USER MAY BE EXPOSED TO POTENTIALLY HAZARDOUS ELECTROMAGNETIC RADIATION DURING OPERATION. REVIEW AND ADHERE TO ALL SAFETY PROCEDURES.

WARRANTY INFORMATION. The Narda Microwave Corporation warrants each product of its manufacture to be free from any defect in material and workmanship for a period of one year after delivery to, and return by, the original purchaser. All warranty returns, however, must first be authorized by factory office representatives.

The limit of liability under this warranty shall be to repair or replace any product, or part thereof, which proves to be defective after inspection by Narda. This warranty shall not apply to any Narda product that has been disassembled, modified, physically or electrically damaged or any product that has been subjected to conditions exceeding the applicable specifications or ratings.

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SECTION I

INTRODUCTION

1-1. GENERAL. This manual contains information regarding the operation and maintenance of the Radio Frequency Radiation Test Set, comprising of Model 8716 or Model 8711 meter, and one or more 8700 Series Probes, hereinafter referred to as Test Set (see Figure 1-1). Section I, Introduction, contains general information relating to the use of the

Figure 1-1. Model 8700 Radio Frequency Radiation Test Set

manual, describes the purpose and use of the test set, and lists the tabulated data pertinent to the test set. Section II contains instructions for preparing the test set for use. A general Theory of operation of the test set is contained in Section III. Section IV contains instructions for evaluating radiation sources, safety precautions to be observed when taking measurements, and detailed information relating to the controls and indicators of the test set. Also included are procedures for startup, normal operation, operation under abnormal conditions and shut-down. Procedures for maintaining the test set are contained in Section V. Section VI contains information for calibration and alignment of the test set. Information for preparing the test set for shipment is provided in Section VII. Section VIII contains information for storing the test set. Section IX contains a list of replacement parts for the meters and probes.

1-2. DESCRIPTION. The test set is a portable, battery-operated instrument for detecting and measuring potentially hazardous electromagnetic radiation from .3 MHz to 40 GHz. It consists of a meter assembly and a probe assembly interconnected by the cable of the probe assembly. (See Figure 1-2.) The meter may be hand-held or for the Model 8716 carried by means of a shoulder strap. Self-clinching fasteners are provided on the meter assembly to secure the probe while transporting the unit out of the carrying case, during climbing or for one-hand operation. A carrying case is provided to protect the test set when not in use and for transporting the test set. A list of equipment supplied is contained in Table 1-1. The technical and physical characteristics of the test set are listed in Table 1-2.

The probe assembly detects electromagnetic radiation and transmits a signal to the meter assembly. The meter assembly processes the signals from the probe assembly to provide a display of the radiation level on the built-in meter. The meter display is calibrated to show the percentage of ANSI C95.1-1982 Radiation protection Guide from 0.3 to 300 percent with Model 8722 probes, or mW/cm^2 with other 8700 series probes. The meter assembly includes built-in test capability for testing the condition of the battery charge as well as checking and adjusting the zero-setting and functioning of the probe assembly.

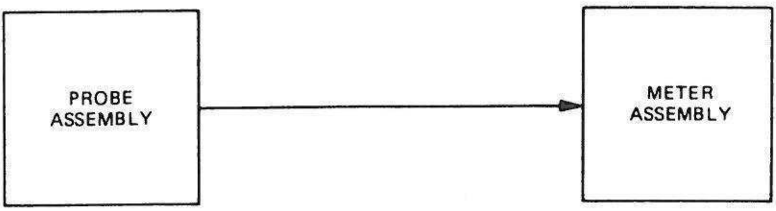


Figure 1-2. Radio Frequency Radiation Test Set Simplified Block Diagram

Table 1-1

List of Equipment Supplied

Nomenclature	Common Name	Part No.	Function
Carrying Case	Carrying Case	10666808	Houses test set when not in use and provides shielding from stray RF radiation.
Shoulder Strap	Shoulder Strap	99902000	Provides a convenient, safe method of carrying test set meter assembly.
Probe, Radio Frequency Radiation Test Set	Probe Assembly	(87XX)	Detects electromagnetic radiation for display by meter.

Table 1-1 (Cont)

Nomenclature	Common Name	Part No.	Function
Meter, Radio Frequency Radiation Test Set	Meter Assembly	8711 or 8716	Provides a display of electromagnetic radiation sensed by the probe.
Technical Manual	Technical Manual		Provides technical documentation for operating and maintaining the test set.
Battery*	Battery	88009000 (8711) NEDA 1604	To provide operating power (one required).

*Model 8716 contains 2 internal NiCad batteries (P/N 88018000)

Table 1-2

Leading Particulars

Item	Technical characteristics
METER, Model 8711	
Dynamic Range	30 dB
Scale	3-10 dB full scale ranges: 3, 30, and 300% (with model 8722) Multiple mW/cm^2 scales for use with other 8700 series probes
Meter	D'Arsonval Type, 1 1/2 inch scale
Instrument Accuracy	±3%
Response Time (approximate)	1 second; 3 seconds most sensitive scale
Zero Control	
Type	Continuous automatic zeroing in effect during all measurements.
Offset	.1%/C° typical

Table 1-2 (Cont)

Item	Technical characteristics
METER, Model 8711	
Battery	
Battery Type	One 9 volt, NEDA 1604 Disposable
Battery Life	150 hours minimum (200 hours typical at 2 hr/day rate
Size	
Meter Dimensions	1.75 x 4.62 x 2.62 inches
Weight	
Meter	1.0 lb
METER, Model 8716	
Dynamic Range	30 dB
Scale	3-10 dB full scale ranges: 3, 30, and 300% (with Model 8722), Multiple mW/cm2 scales for use with other 8700 series probes
Meter	D'Arsonval Type, 4 1/2 inch scale

Table 1-2 (Cont)

Item	Technical characteristics
METER, Model 8716	
Instrument Accuracy	±3%
Response Time (approximate)	1 second; 3 seconds most sensitive scale
Zero Control	
Type	Continuous automatic zeroing in effect during built-in test and all measurements.
Offset	.1%/C° typical
Maximum Hold Mode	Displays maximum average exposure level that is detected after being placed in the maximum hold mode
Battery	
Battery Type	Two 9 volt, NiCad Rechargeable
Battery Life	30 hours use (2:1 use to charge ratio)

Table 1-2 (Cont)

Item	Technical characteristics
METER, Model 8716	
Battery Test	Independent test of each battery with minimum battery condition mark provided on the meter scale
Self Test	
Number of Signals	2
Frequencies	12 GHz (radiated); 10 kHz (conducted)
Testability	Independent functional performance confirmation of each field sensitive element, and overall test of supporting electronics
Additional Features	Front Panel Adjustable Alarm
Recorder Output	+3V at full scale into minimum load resistance of 1000 ohms

Table 1-2 (Cont)

Item	Technical characteristics
METER, Model 8716	
Size	
Meter Dimensions	9.62 x 5.62 x 4.50 inches
Carrying Case Dimensions	18 x 14.75 x 8.50 inches
Weight	
Meter	4.4 lbs
Carrying Case	9.4 lbs
OVERALL SYSTEM SPECIFICATIONS	
Temperature	
Operating	-10°C to +50°C
Non-Operating	-55°C to +75°C

Table 1-2 (continued)

BROADBAND ISOTROPIC PROBES

Probe Model	8762	8761	8760	8721	8723	8752	8754	8731	8733
Type	ELECTRIC FIELD					MAGNETIC FIELD			
Freq. Ranges	300 kHz to 1 GHz			300 MHz to 40 GHz		0.3 to 10 MHz		10 MHz to 300 MHz	
Power Ranges Full Scale (Equivalent Power Density)	2 20 mW/cm^2 200	.2 2 mW/cm^2 20	.2 $\mu W/cm^2$ 2 $\mu W/cm^2$ 20 $\mu W/cm^2$	0.2 2 mW/cm^2 20	1 10 mW/cm^2 100	2 20 mW/cm^2 200	20 200 mW/cm^2 2000	0.2 2 mW/cm^2 20	1 10 mW/cm^2 100
Field Strength Full Scale (Mean Squared Field Strength)	8000 V^2/m^2 80,000 800,000	800 V^2/m^2 8,000 80,000	.800 V^2/m^2 8.0 80.0	800 V^2/m^2 8,000 80,000	3800 V^2/m^2 38,000 380,000	.05 A^2/m^2 .5 5.0	.5 A^2/m^2 5 50	.005 A^2/m^2 .05 .5	.026 A^2/m^2 .26 2.6
Accuracy of Probe Calibration at Test Frequencies	±0.5 dB								
Isotropic Response	±.5 dB			±1 dB		±.5 dB			
Freq. Sensitivity .3 to 10 MHz	–	–	–	–	–	±0.5 dB		–	–
3 to 300 MHz	±1 dB			–	–	–		–	–
10-300 MHz	–	–	–	–	–	–		2 dB Max Total Deviation	
13-200 MHz	–	–	–	–	–	–		±0.5 dB	
.3-1000 MHz	±2 dB			–	–	–		–	
1-40 GHz	–	–	–	±1.25 dB		–		–	–
.85-16 GHz	–	–	–	+0.75/-1 dB		–		–	–
.3 to 40 GHz	–	–	–	+1.25/-3 dB		–		–	–
CW Overload*	600 mW/cm^2	60 mW/cm^2	10 mW/cm^2	300 mW/cm^2	1000 mW/cm^2	600 mW/cm^2	6 W/cm^2	60 mW/cm^2	300 mW/cm^2
Peak Power*	600 W/cm^2	60 W/cm^2	10 W/cm^2	60 W/cm^2	300 W/cm^2	600 W/cm^2	1 kW/cm^2	20 W/cm^2	300 W/cm^2
Calibration Frequencies	0.3, 0.5, 1.0, 3.0, 13.56, 27.12, 40.68, 100, 200, 300, 750, 1000 MHz			0.3, 1.7, 2.45, 4.0, 5.0, 6.0, 7.0, 8.2, 9.3, 10, 11, 18, 26, 40 GHz		0.3, 0.5, 1, 3, 10 MHz		10, 13.56, 27.12, 40.68, 50, 75, 100, 150, 200, 250, 300 MHz	
Size Probe	17 3/4" (45 cm) Long Including 4" Cup			13" (33 cm) Long Including 2 1/8" Sphere		17 1/4" (43.8 cm) Long Including 4" Cup		16 1/2" (41.9 cm) Long Including 3 1/2" Dia. Sphere	
Cable	Four Feet Long (123 cm)								
High Freq. BIT	–			X		–		–	
Low Freq. BIT	X			–		X		X	

– = Not Applicable
X = Applicable
* Operating & Non-Operating

Table 1-2 (continued)

ULTRA-BROADBAND ISOTROPIC PROBES

Probe Model	8741	8722
Type	E-Field (Flat)	E-Field (Shaped to ANSI Std.)
Freq. Ranges	.3 MHz to 40 GHz	
Power Ranges Full Scale (Equivalent Power Density)	.2 2 mW/cm^2 20	3 30% of Std. 300
Field Strength Full Scale (Mean Squared Field Strength)	8,000 80,000 V^2/m^2 800,000	Frequency Dependent
Calibration Accuracy	+/-.5 dB	
Isotropic Response	+/-1.5 dB	+/-.75 dB
Ellipse Ratio	+/-.75 dB	
Freq. Sensitivity .3 MHz to 40 GHz	+3/-1.5 dB	+/-2 dB from ANSI Std.
3 MHz to 40 GHz	+/-1.5 dB	–
CW Overload	200 mW/cm^2	10 dB above Full Scale
Peak Overload	15 W/cm^2	
Calibration Frequencies MHz	.3, 3, 10, 30, 100, 300, 750, 1000	
Calibration Frequencies GHz	1.7, 2.45, 4, 8.2, 10, 18, 26, 40	
Temp. Sensitivity	1%/C° < 1500 MHz .15%/C° > 1500 MHz	
Zero Offset	1%/C° (typical)	
Linearity	1% above 1500 MHz, 2% below 1500 MHz	
High Freq. BIT	X	X
Low Freq. BIT	X	X

– = Not Applicable
X = Applicable

PREPARATION FOR USE AND INSTALLATION

2-1. INTRODUCTION. This section contains procedures for unpacking the test set, inspecting the test set for shipping damage and for preparing the test set for use. Also included are pre-operational tests and adjustments.

2-2. PREPARATION FOR USE. To prepare the test set for use, perform the procedures contained in the following subparagraphs:

a. Unpacking Procedures. Do not unpack the test set within an area where RF radiation is suspected. The carrying case includes an RF shield to protect the probe from exposure to RF levels in access of damage levels during transportation and storage.

b. Inspection. To inspect the test set prior to use, perform the procedures contained in the following subparagraphs:

(1) Remove the meter assembly and probe assembly from the carrying case.

(2) Visually inspect the carrying case, meter assembly and probe assembly for evidence of shipping damage.

(3) Report any damage in accordance with applicable regulations.

c. Pre-operational Tests. Prior to performing a pre-operational check, review the procedures contained in Section 4, Operating Instructions. To perform a pre-operational test, refer to Figure 2-1 (8716) or Figure 2-2 and paragraph 2-3 (8711) and perform the procedures contained in the following subparagraphs:

(1) Make certain function selector switch A1S1 (8) of the meter assembly is set to OFF.

(2) Connect connector P1 (7) of the probe assembly to PROBE connector J1 (6) on the meter assembly.

(3) Set NORMAL/MAX HOLD switch S1 (2) to NORMAL.

(4) Set function selector switch A1S1 (8) to BAT TEST 1, depress probe test switch S2 (3) and observe that meter M1 (1) indicates BATTERY OK. If indication of meter M1 does not indicate BATTERY OK, refer to and perform the battery charging procedures contained in paragraph 5-2.

(5) Set function selector switch A1S1 (8) to BAT TEST 2 and observe that the pointer of meter M1 (1) indicates BATTERY OK. If indication of meter M1 does not indicate BATTERY OK, refer to and perform

the battery charging procedures contained in paragraph 5-2.

NOTE

The following step should be performed in an area of zero RF field and/or place probe in carrying case and close but do not latch cover.

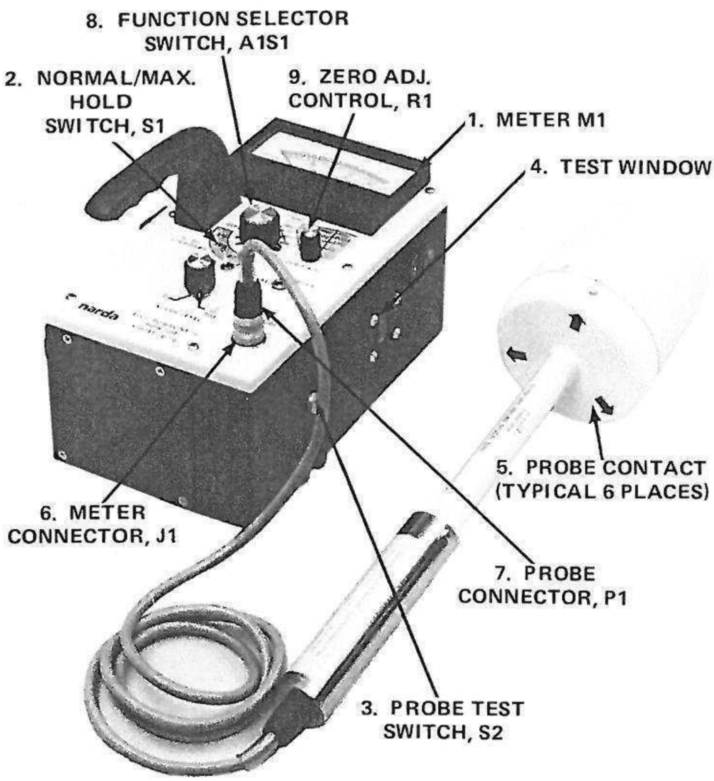


Figure 2-1. Probe Orientation During Pre-Operational Testing (Model 8716)

(6) On meter assembly, set function selector switch A1S1 (8) to 3% range and observe that the pointer of meter M1 (1) is aligned with the ZERO mark of the meter scale. If necessary, adjust ZERO ADJ control (9) until pointer of meter M1 (1) is aligned with the ZERO mark.

(7) Set function selector switch A1S1 (8) to 30%.

(8) On a workbench or table or other flat surface, set meter assembly on its back. Alternatively, the meter assembly may be held in the left hand and the probe in the right hand. Hold probe tube near sensor end.

(9) Carefully align one of the probe contacts (5) with probe test switch S2 (3).

(10) Carefully apply pressure to probe test switch S2 (3) and move cap of probe until it contacts test window (4).

(11) Observe pointer of Meter M1 (1) for movement upscale. Failure of meter to move upscale indicates a malfunction of the test set. On some model probes the pointer movement during test may require 20 to 30 seconds to reach upscale position.

(12) Release pressure on probe test switch S2 (3) and observe that the pointer of meter M1 (1) is aligned with the ZERO mark of the meter scale.

(13) Repeat steps (9) through (12) for each of the five additional contacts (5) on the probe assembly. (Models 8722 or 8741 only.)

(14) Set function selector switch A1S1 (8) to OFF, or make survey in accordance with the procedures contained in paragraph 4-5.

2-3. Pre-Operational Tests (8711). Prior to performing a pre-operational check, review the procedures contained in Section 4, Operating Instructions. To perform a pre-operational test, refer to Figure 2-2.

(1) Make certain function selector switch S2 (2) of the meter assembly is set of OFF.

(2) Connect connector P1 (5) of the probe assembly to PROBE connector J1 (4) on the meter assembly.

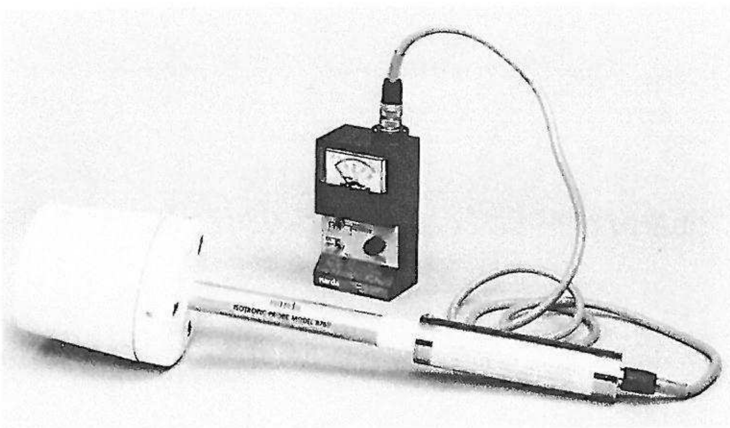


Figure 2-2. Model 8711 Pre-Operational Testing

(3) Set function selector switch S2 (2) to BAT TEST and observe that the pointer of meter M1 (1) indicates BATTERY OK. If indication of meter M1 does not indicate BATTERY OK, refer to and perform the battery replacement procedures contained in paragraph 5-2.

NOTE

The following step should be performed in an area of zero RF field and/or place probe in carrying case and close but do not latch cover.

(4) On meter assembly, set function selector switch A1S1 (2) to x 1 range and observe that the pointer of meter M1 (1) is aligned with zero mark of the meter scale. If necessary, adjust ZERO ADJ control (3) until pointer of meter M1 (1) is aligned with zero. Then set function selector switch A1S1 (2) to x .1 range and observe that the pointer of meter M1 (1) is still aligned with zero mark of meter scale. If not, adjust ZERO ADJ control until pointer is again aligned with zero. Set function selector to x .01 and repeat procedure for zeroing.

(5) Set function selector switch A1S1 (2) to OFF, or make survey in accordance with the procedures contained in paragraph 4-5.

SECTION III

GENERAL THEORY OF OPERATION

3-1. GENERAL. This section provides an overall functional description of the test set. Following the overall functional description of the test set, detailed functional descriptions of the probe and meter assemblies are provided.

3-2. OVERALL FUNCTIONAL DESCRIPTION. The test set is a portable, battery-operated instrument consisting of an interconnected probe assembly and a meter assembly. The test set is designed to detect potentially hazardous electromagnetic radiation and to display the radiation level on the meter front panel. The probe assembly detects the electromagnetic radiation, and transmits a signal to the meter assembly for display. The meter assembly processes the signals from the probe for display on a built-in meter. The meter displays the radiation level as percent of the Radio Frequency Protection Guides (RFPG) for Model 8722 and mW/cm^2 for other 8700 Series probes. The following subparagraphs contain a functional description of the probe and meter assemblies.

a. Probe Assembly Functional Description. See Figure 3-1. The probe assembly senses the electromagnetic radiation and develops a signal for transmission to the meter assembly. The probe assembly has an isotropic sensing pattern so that the radiation may be sensed from any

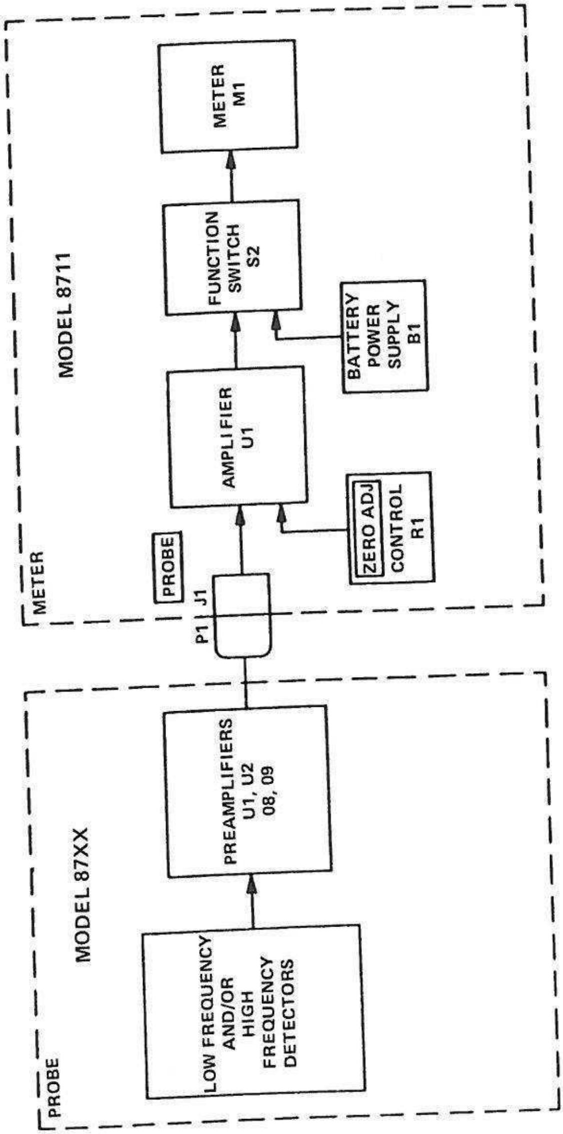


Figure 3-1. Radio Frequency Radiation Test Set
Functional Block Diagram (1 of 2)

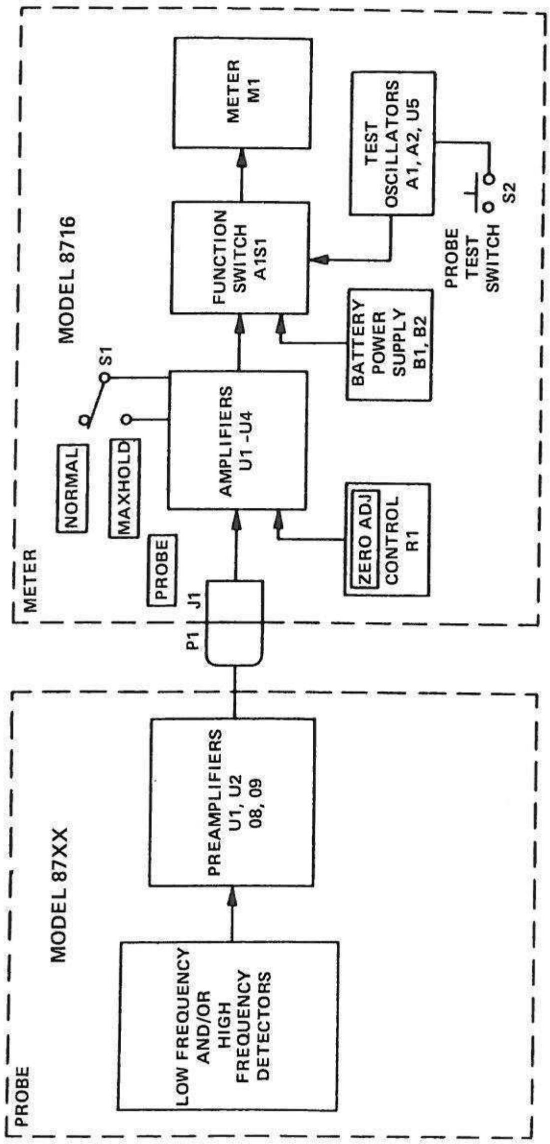


Figure 3-1. Radio Frequency Radiation Test Set
Functional Block Diagram (2 of 2)

direction, except through the handle. Detectors in the probe assembly sense the electromagnetic radiation present and apply signals to preamplifiers U1 and U2 located within the probe assembly. Preamplifiers U1 and U2 amplify the signals from the detectors and route them to the meter assembly via connector P1.

b. Meter Model 8711 Assembly Functional Description. The meter assembly receives the signals from the probe, processes the signals and provides a visual display of the maximum allowable exposure percentage. Signals received from the probe assembly at PROBE connector J1, are routed to amplifier U1. Amplifier U1 amplifies the signals from the probe assembly and generates a signal to drive the meter M1. The output of amplifiers is routed to Meter M1 via function switch A1S1.

c. Meter Model 8716 Assembly Functional Description. The meter assembly receives the signals from the probe, processes the signals and provides a visual display of the maximum allowable exposure percentage. Signals received from the probe assembly at PROBE connector J1, are routed to amplifiers U1-U4, U8 and U9. Amplifiers U1-U4, U8 and U9 amplify the signals from the probe assembly and generate a signal to drive the meter M1. The output of amplifiers is routed to Meter M1 via function switch A1S1. The operation of amplifiers is controlled by NORMAL/MAX HOLD switch S1. When the switch is set to the NORMAL position, meter M1 will display the instantaneous radiation level sensed by the probe assembly. When NORMAL/MAX HOLD switch S2 is set to MAX HOLD, meter M1 will display the highest radiation level sensed by the probe assembly. The display of the highest radiation level is reset when the NORMAL/MAX HOLD switch S1 is set to NORMAL or when the test set is turned off.

The meter assembly also contains built-in self testing facilities for checking the condition of the batteries, the operation of the probe assembly and for zero adjustment of the probe assembly. The operation of the test set for these functions is described in the following subparagraphs:

(1) Battery testing. The test set provides a means of testing the condition of batteries B1 and B2. When function switch A1S1 is set to BAT TEST 1 or BAT TEST 2, the respective battery is connected to meter M1. If the condition of the battery is satisfactory, the pointer of meter M1 will reach beyond the "test min" mark. If a battery is weak or dead, then meter M1 will not reach the "test min" mark, thereby informing the operator that the battery should be charged. The probe test switch can be depressed during the BAT TEST 1 test to insure battery capacity to operate built in test oscillator.

(2) Probe zero adjustment. The test set provides a means for checking and zero adjusting the meter and probe assemblies. When function switch is in an operate mode and the probe is in zero field, the pointer of meter M1 is normally aligned with the ZERO mark. If not, ZERO ADJ control R1 is used to adjust the operation of amplifiers U1-U4 so that the pointer of meter M1 is aligned with the ZERO mark on the meter scale.

(3) Probe test. The test set provides a means of testing whether the probe is operational.

HIGH FREQUENCY - 12 GHz (nominal) oscillator and aperture for illuminating the probe. Power output is capable of producing a meter indication of approximately 10% of ANSI C95-1982 RFPG with Model 8722 probe or .75 mW/cm2 with other E-field 8700 Series probes.

LOW FREQUENCY - External test point provides a 10 kHz (nominal) signal at the unit and test points on the probe to excite each of 3 low frequency elements and produce a meter indication of approximately 10% of ANSI C95.1-1982 RFPG with Model 8722 probe or .75 mW/cm2 with other E-field probes.

When function switch A1S1 is set to the 30% range and the tip of the probe is aligned with the test window of the meter assembly, one of the perimeter contacts of the probe is used to operate test switch S2. When test switch S2 is operated, oscillators A1, U5 within the meter assembly generate test signals that are sensed by the probe assembly, causing the pointer of meter M1 to move to approximately midscale. If no pointer motion is observed, either the probe or the meter assembly may be defective.

3-3. PROBE GENERAL DESCRIPTION. The .3 MHz to 40 GHz electromagnetic radiation probe Model 8722 provides a frequency sensitivity characteristic that is the inverse of the C95.1 1982 ANSI Standard Radio Frequency Protection Guide, thus providing for metering in percent of RFPG. The shaping and broadband range is accomplished using three modes of detection.

3-4. LOW FREQUENCY ELEMENT. In the lower frequency region below 1500 MHz, where the sensitivity varies by 20 dB, a dipole with diode detector and both distributed and discrete components is used.

Three sensors are supported at one end of the probe along mutually orthogonal axes, each sensor consisting of a dipole-diode combination. Each diode is shunted with circuitry to modify the frequency response to the induced signals so that the DC voltage output of the probe is proportional to the exposure level.

The resistive transmission line carries the modified signals to the metering circuits. These metering circuits include a pre-amplifier to condition the signals prior to transmission over the flexible cable for display on the metering instrument. The pre-amplifier contains the controls for calibration.

The conditioning amplifier lowers the impedance of the signals, preventing cable modulation by the flexible cable and also provides full time automatic zero control. The pre-amplifier is a true differential amplifier contributing good common rejection thereby reducing the susceptability to static charges. To further enhance this characteristic, a high resistance film covers the probe surface. The resistance is sufficiently high as to appear transparent to the radio frequency signal while providing a discharge path for static charges.

A lumped equivalent circuit of a dipole-diode sensor is shown in Figure 3-2. The segments illustrated separately as Ca1, Ca2, La1, La2, represents the dipole equivalent capacitance and inductance. When considering the combined effect of such reactances, they will be referred to as Ca and La. Similarly, the voltage induced in the dipole by the illuminating energy is represented by separate sources e. The equivalant resistance of the dipole is Ra. Note that the dipole is constr-ucted of conductive and resistive segments.

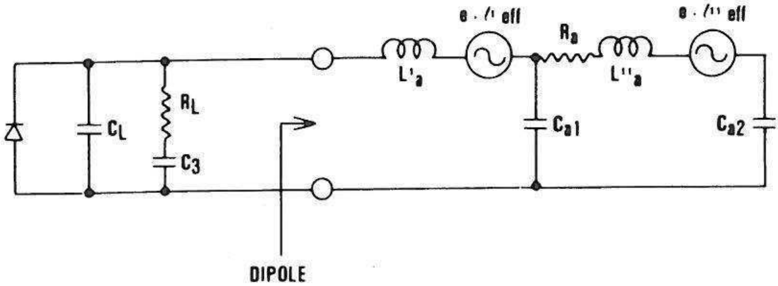


Figure 3-2. Lumped Equivalent Circuit of Dipole-Diode Sensors

In the frequency range of 30 to 300 MHz, the equivalent circuit simplifies to that of Figure 3-3.

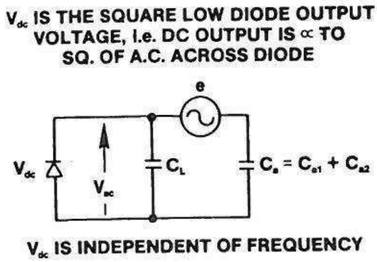


Figure 3-3. Equivalent Circuit for 30 to 300 MHz

The dipole resistance Ra and dipole inductance reactance of La are negligible compared to the dipole capacitive reactance Ca. Within this range C2 is selected to have a very low reactance and the resistance of R2 is selected to be extremely high relative to the reactance of shunting capacitor C1. The dipole capacitance Ca and the shunting capacitance C1 act as a capacitive voltage divider having a uniform output with frequency over this range. The value of C1 is selected to obtain the desired sensitivity from the diode.

Descending in frequency and commencing at 30 MHz, the shape of the response is principally controlled by the resistance RL in conjunction with the reactance of shunting capacitor CL and dipole capacitance Ca.

The equivalent circuit then reduces to the one shown in Figure 3-4.

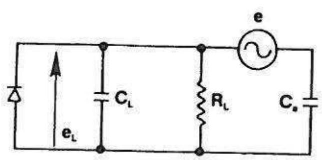


Figure 3-4. Equivalent Circuit for 3 to 30 MHz

The radio frequency voltage across the diode varies at a 6 dB per octave rate as the frequency decreases to 3 MHz. The diode having a square-law characteristic, provides a DC output voltage proportional to the square of the radio frequency voltage across the diode. The diode output sensitivity therefore decreases as the square of frequency ($1/f^2$).

Descending still further in frequency, at approximately 3 MHz the reactance C2 increases to the magnitude where it exceeds the resistance RL and the equivalent circuit reduces to approximate the schematic of Figure 3-5.

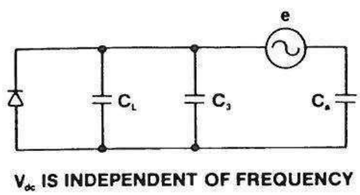


Figure 3-5. Equivalent Circuit for Frequencies below 3 MHz

Hence, the circuit again performs as a capacitive divider having a constant sensitivity for frequencies below 3 MHz.

Within the frequency range above 300 MHz and 1.5 GHz, the dipole characteristics are selectively modified to achieve controlled roll-off. The dipole is constructed of conductive and resistive portions, as illustrated in Figure 3-6.

The conductive portion connects to a resistive film portion of the terminals of the diode. The extent and location of the resistive film portion of the dipole is selected to achieve the desired character-

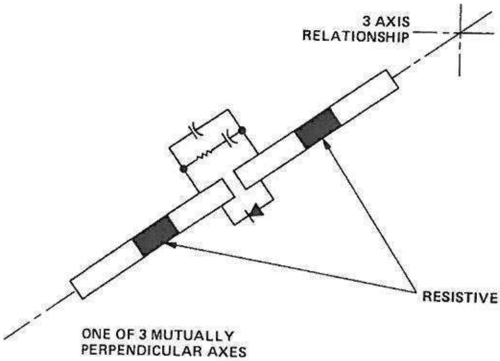


Figure 3-6. Pictorial View of Dipole Showing Resistive and Conductive Segments

istics. When the frequency increases above 300 MHz, the resistance of this film predominates over the reactance of that portion of the antenna. If the entire dipole had been constructed of resistance material, the sensitivity would decrease at a 6 dB per octave rate, or $1/f^2$. To approximate the desired 1/f (3 dB per octave) rate, only a portion of the dipole is made resistive. The resistivity in the present case is chosen to start roll-off at 300 MHz. That portion of the conductive dipole contributes a signal to the diode that is constant over the frequency range thereby achieving the desired reduction in sensitivity to approximate 1/f. The diode operates in its square-law region and the induced voltages are made approximately equal for both conductive and resistive portions.

In the low to high frequency transition (300 MHz to 1.5 GHz range), the equivalent circuit of Figure 3-4 reduces to that of Figure 3-7, where the resistance RL is much greater than the shunting reactance of C1 and the dipole reactance La is negligible.

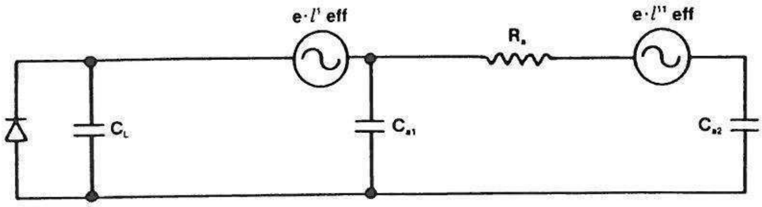


Figure 3-7. Equivalent Circuit for 300 MHz to 1.5 GHz

Under these circumstances the diode output voltage Vd becomes:

$$Vd = k\left[eLeff + \frac{eLeff}{f}\right]^2$$

The response of the diode sensor thus decreases as the frequency increases.

The resistivity of the dipole and the concomitant decreasing sensitivity, prevents affecting the response in the high frequency region as the dipole approaches resonance. The values of capacitance and inductance for the sections of the dipole can be calculated from the average characteristic impedance for each portion of the dipole. The equation for characteristic impedance Z_o is:

$$Z_o = \frac{1}{H_2 - H_1} \int_{H_1}^{H_2} 120 \ln \frac{(2r)}{a} \, dr$$

where H1 and H2 define the limits of each portion of the dipole, and a is the effective radius of the dipole. The equation can then be integrated over the portion of the antenna in question.

Using the expression for La and Ca

$$L_a = Z_o(8fo)^{-1}$$

$$C_a = (\ 2 foZ_o)^{-1}$$

The frequency response of a typical unit is illustrated in Figure 3-8. (A $\pm$ 2 dB margin that conforms to the ANSI Standard is also drawn on the graph).

Calibration factors are provided at multiple points over all frequency intervals making more precise measurements possible when the source frequency is known.

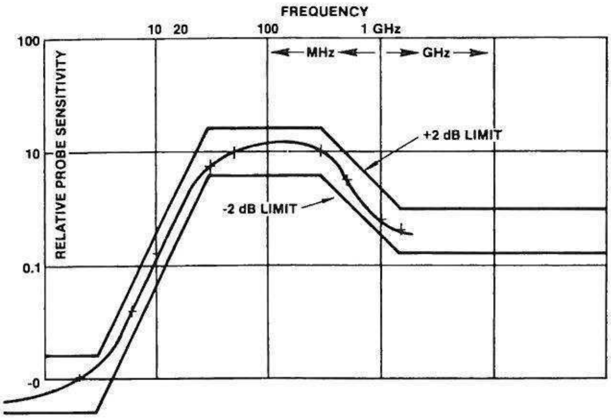


Figure 3-8. Frequency Response of Probe with ±2 dB Margins Conforming to C95.1-1982 Standard

As previously stated, the three dipoles are mutually orthogonal and the diodes are operated in their square law region. This region is defined as that in which the dc diode current is proportional to the square of the electric field tangential to the dipole L = K times E squared.

For a free space plane wave power flow S1 may be expressed in terms of E and the intrinsic impedance of free space.

$$S_1 = \frac{E^2}{\eta_o}$$

Power density S is equal to the sum of the squares of the coordinate field strengths divided by the space impedance = 377

$$S = \frac{Ex^2 + Ey^2 + E2}{\eta_o}$$

$$S = K[i_x + i_y + I_z]$$

Deviation from the preceding results in a polarization ellipse ratio as well as an isotropic response deviation. The maximum observed of this probe is ±.75 dB. Very little perturbation of the field occurs. Over the major portion of its range, the dipole is a small fraction of a wavelength and thereby couples very lightly into the field. The resistive portion of the dipole, in addition to providing the desired roll-off characteristic, also limits the coupling into the field. No resonance of the probe is observed. Response of the low frequency elements above 1.5 GHz is a smooth monotonic curve with sensitivity decreasing as the frequency increases. This response is shown in Figure 3-9.

The components used in the construction are beam lead diodes and chip capacitors and resistors. In addition, the diode is piggy-backed on its shunting capacitor C2. C2 and the diode form a loop which can couple into the magnetic field at high frequencies where the reactance is sufficiently low to permit induced currents to flow. These design selections minimize this possible coupling into the magnetic field.

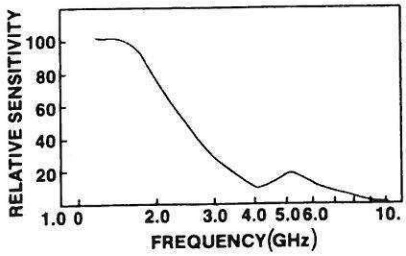


Figure 3-9. Low Frequency Element Response

Another subtle problem with which the design deals is the possible diode response to light energy. The unencapsulated beam diode can (and does) in classic manner have a response to light. This phenomena will cause down scale readings. The sun illuminating the junction of a beam lead diode will inject minority carriers. This reduces the barrier level and produces a voltage across the junction equal to the reduction. This photo voltaic effect is completely eliminated by a black film coating surrounding the sensor assembly.

3-5. HIGH FREQUENCY ELEMENT. The element which is used in the higher frequency region functions in two modes. Between 1500 MHz and approximately 18 GHz, it is a resistive dipole. Above 12 GHz it utilizes the phase relay of a traveling wave to produce additional output. As a resistive dipole, in the 1.5 to 18 GHz region, each probe contains three mutually perpendicular elements.

Resistive thermocouples are distributed along the length of the dipole at spacings that will not permit resonance over the operating range of frequencies (see Figure 3-10). The dipole may be viewed as a group or series connected small resistive dipoles or as a very low Q resonant circuit.

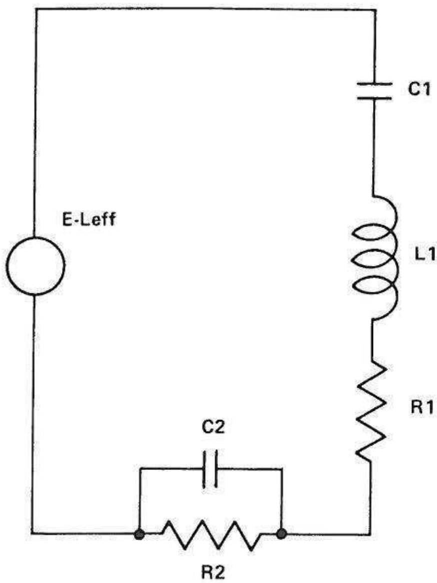


Figure 3-10. Lumped Equivalent Circuit of the Probe with Single Elements Relative to the Total Probe. R2 Represents One of the Distributed Thermocouples

A lumped equivalent schematic representation of a probe element is shown in Figure 3-10. R2 and C2 represent a terminal load of one of the probe elements (center-fed dipoles) and L1, C1 are the lumped equivalent inductance and capacitance of the probe element determined from the average characteristic impedance Z_o.

The dipole when oriented tangential to the electric field will have an induced current proportional to the electric field in the region where the distributed resistance of the dipole is greater than the reactance of the dipole. This current will heat the dissimiliar resistive deposited films producing a thermoelectric output voltage proportional to the square of the electric field. As the reactance of the dipole increases above the dipole resistance, the induced current is proportionately reduced, in lowered sensitivity. This occurs above 12 GHz and below 1.5 GHz.

Above 12 GHz as the element sensitivity decreases another mode of operation becomes manifest. In this mode, the dipole is aligned along the Poynting Vector with the cold junctions oriented tangential to the electric field. Each of the three mutually orthogonal elements contains four resistive dipoles with the cold junctions oriented at right angles. This provides for the independence of probe orientation relative to the polarization of the field.

The instantaneous charge distribution on adjacent cold junction elements produce a potential difference across the thin film resistive thermocouples and a resultant dissipation of energy in these films. As the frequency increases, the phase difference between the potentials developed in adjacent also increases the open circuit voltage.

$$V_{oc} = \int_{o}^{H} \frac{E \sin\beta(H-h)}{\sin\beta H} \left[e^{JWT} - e^{Jiwt-Br}\right] dh$$

$$\frac{V_{oc}}{E} = \frac{\lambda(1-\cos\beta r)}{\pi-\sin\beta H} (1-\cos\beta H)$$

An equivalent circuit (see Figure 3-11) can be developed from a transmission line analysis of a pair of adjacent elements. The resistive thermocouple terminates two open circuited transmission lines:

The characteristic impedance of the line,

$$R_o = 276 \log D/r$$

and the open circuit impedance of the transmission line,

$$Z_{oc} = -jR\cot. \frac{2\pi S}{\lambda}$$

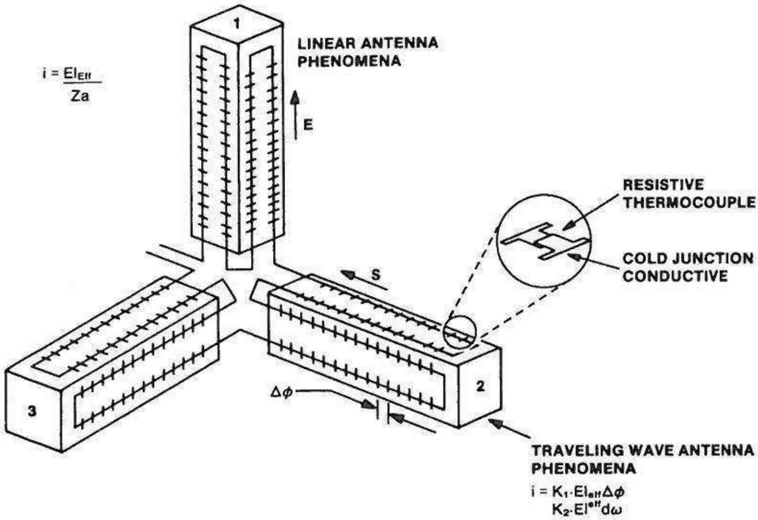


Figure 3-11. High Frequency Elements

The reactance across the thermocouple is the parallel connection of both transmission lines. Therefore,

$$Xc = Zoc$$

$$Xc = Zoc/2$$

$$Ca = \frac{\lambda}{\left[2\pi c 138 \log \frac{d-r}{r}\right] \operatorname{Cot} \frac{2\pi s}{\lambda}}$$

The transmission line inductance contributes

$$La = 4 \times 10^{-7} (\log \frac{d-r}{r}) (2s)$$

The radiation resistance of both dipoles, assuming a sinusoidal current distribution is:

$$Ra = \frac{160\pi^2 s^2}{\lambda^2}$$

In the table below VT2 is proportional to the power dissipated in the thin film thermocouple and the resultant dc thermoelectric voltage generated.

CALCULATED RESPONSE OF TRAVELING WAVE MODE

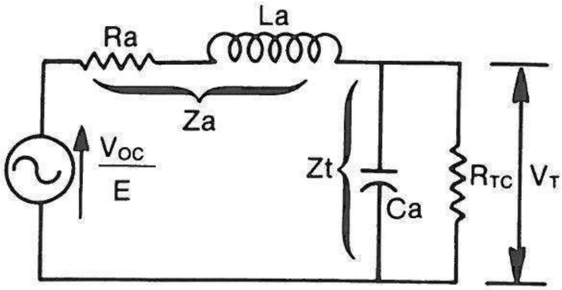
FREQUENCY GHz	$\frac{V_{OC}}{E}$	$(V_T)^2$
12	25.5×10^{-6}	3×10^{-9}
18	58.2×10^{-6}	12×10^{-9}
40	284×10^{-6}	10.4×10^{-9}

The combined response from the low frequency dipole-diode element and two modes of operation of the resistive dipole is shown for the frequency range in Figure 3-12, together with the recommended maximum ANSI C95.1-1982 exposure levels.

3-6. PROBE AMPLIFIER. Dual probe amplifiers located in the handle are connected to the probe elements by inflexible monolithic resistive leads. This prevents cable modulation from affecting the signal derived from the elements.

These amplifiers are commutating auto zero instrumentation amplifiers to provide automatic zeroing of the meter. Each instrumentation amplifier consists of three distinct sections, two analog, one digital. The two analog sections, a differential to single ended voltage converter and a commutating auto zero amplifier have on-chip analog switches to steer the input and output signals. While one op amp is processing the signal the second op amp is in auto zero mode, charging a capacitor to a voltage equal to its DC error voltage. The amplifiers are connected and reconnected at a 5 kHz rate, so that all times one or the other of the on-chip amplifiers is processing the signal while the error voltages are being updated to compensate for variables such as low frequency noise voltage and input, offset voltage changes due to temperature, drift or supply voltage effects.

The reference voltage for zero is provided by the output of the bridge consisting of R1-R2 and thermistors Th1 and Th2. This bridge provides a correction voltage for the pyroelectric voltage generated by the amplifier input feedthru capacitors. The rate of adjustment is accomplished by the setting of potentiometer R7. The absolute zero reference is established by R101 in the meter.



$$Ca = \frac{\lambda}{\left[2\pi c\ 138 \log \frac{d-r}{r}\right] \text{Cot } 2\frac{\pi s}{\lambda}}$$

$$La = 4 \times 10^{-7}\left(\log \frac{d-r}{r}\right)(2s)$$

$$Ra = \frac{160\pi^2 s^2}{\lambda^2}$$

From Transmission Line Theory

Figure 3-12. Traveling Wave Mode Equivalent Circuit

3-7. PROBE SELF TEST PROVISIONS.

a. Test Points. Each probe has either 3 high frequency or 3 low frequency test points, with the exception of Models 8722 and 8741 which have both high and low frequency test points. When the probe test switch (Figure 2-1, (3)) is depressed (Model 8716 only) both high and low frequency test sources are enabled, causing a clearly visable upscale

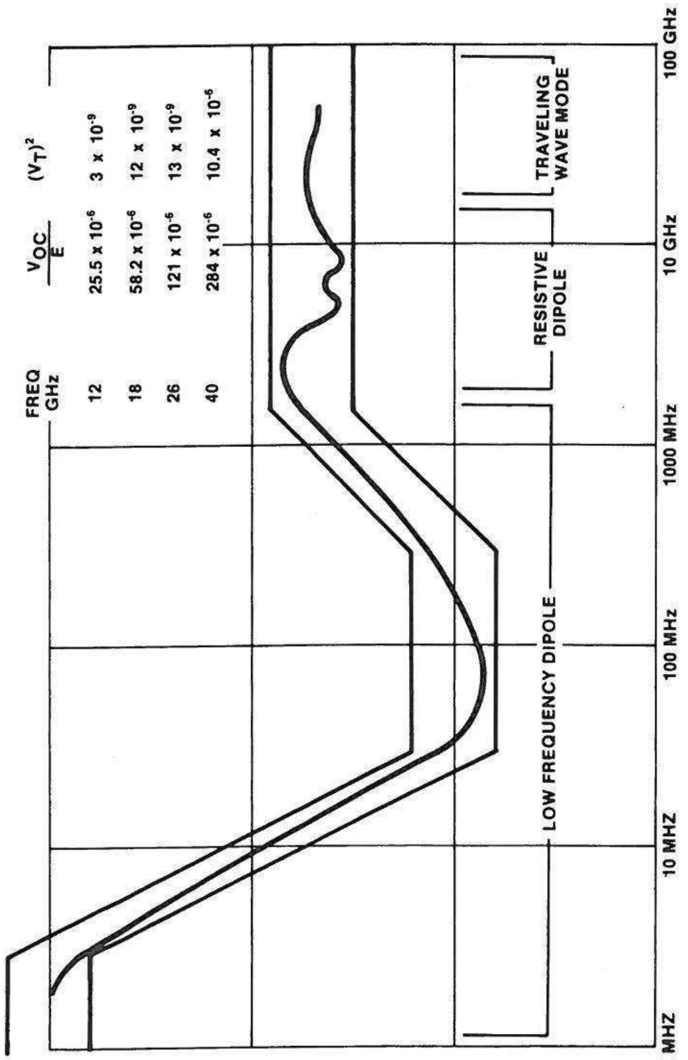


Figure 3-13. Combined Frequency Sensitivity and ±2 dB of ANSI C95.1-1982 RFPG

indication on the meter to confirm satisfactory operation of that element. Table 2-1 lists which probes are applicable to either low or high frequency testing.

3-8. METER CIRCUITS (MODEL 8711 ONLY).

Input Amplifiers. The probe outputs of the low frequency and high frequency elements are fed to their respective input conditioning amplifiers of a Quad operational amplifier. One amplifier provides the low frequency element circuit with temperature compensation thru the temperature dependance of thermistor TH1 and correction for non-linearity by nonlinear characteristic of CR1. Both amplifiers provide a gain of 2 driving a summing amplifier, and the segment of the Quad, which adds the low and high frequency signals together. Ranging is also accomplished in this latter amplifier controlling the gain over three 10 dB steps. The output of the summing amplifier drives the analog indicating meter.

3-9. METER CIRCUITS (MODLE 8716 ONLY).

a. Input Amplifiers. The probe outputs of the low frequency and high frequency elements are fed to their respective input conditioning amplifiers U4 and U1. U1 provides the low frequency element circuit with temperature compensation thru the temperature dependence of thermistor T1 and correction for non-linearity by non-linear characteristics of CR2. Both U1 and U4 provide a gain of two and a full scale voltage of 2 at TP1 and TP2. U2 is a summing amplifier which adds the low frequency and high frequency signals together. U3 is the ranging amplifier and controls the gain over three 10 dB steps. The output also provides a recorder output of volts full scale at a minimum load resistance of 1000 ohms.

b. Indicator Circuits. The indicator circuits consist of amplifiers U8, U9 and the meter. There are two modes of operation, Max Hold and Normal. In the Normal mode, Switch S1 shorts out CR6, and U8, U9 operate as linear cascaded amplifiers with unity gain. In this mode the meter becomes a portion of the summing resistor of the feedback network consisting of R27 and R28.

In the Max-Hold mode of operation, switch S1 is open allowing CR6 to become functional within the circuit. The amplifiers now operate as a peak holding circuit in which the charge stored on C9 is proportional to the maximum power density surveyed. U8 has a MOSFET input which together with the extremely high back resistance of CR6 prevents leakage of the charge in C9. When S1, the Normal/Max Hold mode switch is momentarily set to normal, capacitor C9 discharges and resets the circuit.

Potentiometer R28 calibrates the meter at full scale.

3-10. ALARM SECTION (MODEL 8716 ONLY). Comparitor U10, and transistor Q1 provide the threshold circuitry and driver for audible alarm G. The threshold value is set from front panel potentiometer R102. Panel calibration for this potentiometer is from 0 to 100% at full scale indication and resistor R13 provides for the adjustment of the calibration.

When the signal level from the output of U2 exceeds the threshold level, transition from a negative to positive voltage occurs at the output of U10. This drives Q1 into conduction, excites G and sounds the audible alarm. The alarm ceases when the signal level drops below the threshold and a polarity reversal again occurs at the output of U10. The operation of this circuit is independent of the Max-Hold/ Normal switch.

3-11. POWER SUPPLY (MODEL 8711 ONLY). A single common 9 volt transistor battery NEDA Type 1604 powers the meter. A load current of 1.5 milliamperes, permit approximately 150 hours of use time at a 2 hour/day rate. Battery condition can be measured using the BATTERY TEST switch position to display battery voltage relative to a minimum acceptable level.

3-12. POWER SUPPLY (MODEL 8716 ONLY). The primary power source for the Model 8716 is two 9 volt NiCad batteries. Two, three-terminal voltage regulators, U6 and U7, provide ±5 volt stabilized supplies to reduce zero offset due to battery use and the resultant reduction in battery voltage. U6 provides the negative supply voltage and U7 provides the positive supply voltage. The two NEDA 1602 batteries will provide a minimal of 30 hours use with a 2:1 use to charge ratio.

3-13. SELF TEST SOURCES (MODEL 8716 ONLY). Low frequency test source is provided by U5 which produces a 10 kHz test signal to be injected thru low frequency test points on probe. High frequency test source is provided by A1 which produces a 12 GHz signal at its aperture. This oscillator uses a FET for maximum power efficiency. Both low frequency and high frequency sources are energized simultaneously when the test button is pressed. The test button itself is the low frequency test point.

SECTION IV

OPERATING INSTRUCTIONS

4-1. GENERAL. This section contains instructions for evaluating radiation sources using the test set and provides safety precautions when working in a potentially hazardous radiation area. Also included is detailed information relating to the controls and indicators of the test set as well as start up, normal, abnormal and shut-down procedures for the test set.

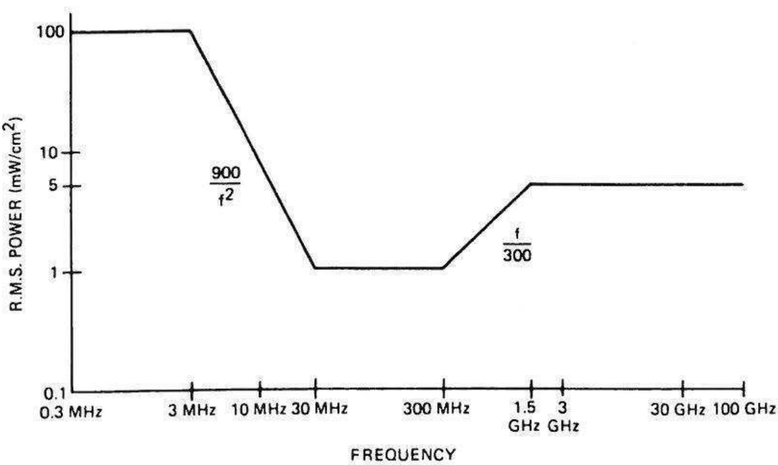
4-2. PERCENTAGE OF RADIO FREQUENCY PROTECTION GUIDES EVALUATION. The PERCENT OF RFPG scale of meter M1 is used to display the potential personnel hazard from a radiating source (see Figure 4-2 for Model 8716 and Figure 4-3 for Model 8711). Use the guideline contained in the following paragraphs for interpreting the meter readings.

4-3. SAFETY PRECAUTIONS. The following contain information pertaining to personnel safety while working in a hazardous radiation environment.

The ANSI Radio Frequency Protection Guide (C95.1-1982) (RFPG) covers the recommended levels for the 300 kHz to 100 GHz range. A summary of the standard is included on the next page for informational purposes.

Frequency Range (MHz)	Power Density* (mW/cm2)	E2* (V2/m2)	H2* A2/m2
0.3-3	100	400,000	2.5
3-30	900/f2	4,000 (900/f2)	0.025 (900/f2)
30-300	1.0	4,000	0.025
300-1500	f/300	4,000 (f/300)	0.025 (f/300)
1500-100,000	5	20,000	0.125

Notes: f is the frequency, in MHz
*Whole body exposure averaged over any 0.1-hour (6-minute) period.



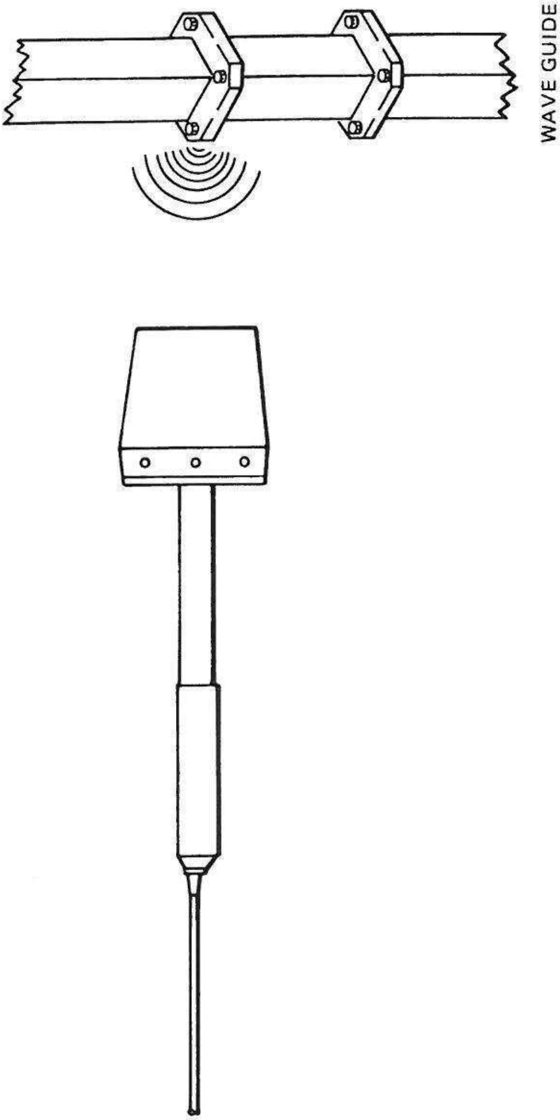


Figure 4-1. Probe Orientation During Use

Whole body exposure averaged over 0.1 hour. Both electric and magnetic fields must be measured separately below 300 MHz (near field exposure). For mixed or broadband fields consisting of a number of frequencies for which there are different values of the RFPG, the fraction of the RFPG incurred within each frequency interval shall be determined, and the sum of all such fractions shall not exceed unity.

Below 100% of C95.1-1982 RFPG, continuous exposure is permissible, since the time averaged value will always be less than 100% of the standard. However, INTERMITTENT exposure to levels in excess of the continuous exposure level whose average over an 0.1-hour (6-minute) period is less than or equal to the RFPG is also permissible.

Example: exposure to 2.0 mw/cm^2 at frequency of 100 MHz (200% of std) for 3 minutes, followed by 3 minutes of 0 exposure, 3 minutes of 2.0 mW/cm^2 exposure, 3 minutes of 0 exposure, etc. (a 50% DUTY FACTOR) yields a TIME AVERAGED VALUE of 1.0 mW/cm^2 or 100% of std.

WARNING

Do not enter a suspected radiation field until a safe level has been ascertained. If location or direction of propagation of source is not known, hold probe at 45 degrees to the ground, deck or horizontal surface with arm outstretched (See Figure 4-1). If the source location is known, point the probe towards it with the arm outstretched. Always approach an area of a suspected radiation or radiating equipment carefully. When a meter reading is observed, do not approach the unit under test or radiating source any closer than necessary to verify the source and levels of radiated signals. Move probe within the area to find the exact site of the radiating source. If measurements are greater than the limits of the C95.1-1982 RFPG, back away from the area until a safe level is observed, or the exposure time is limited so that the average over a six-minute period does not exceed 100%.

4-4. OPERATING CONTROLS AND INDICATORS. Figures 4-2 and 4-3 show the operating controls and indicators for the test sets. Table 4-1 lists and describes each control and indicator of the Model 8716 meter test set and Table 4-2 describes each control and indicator for the Model 8711 meter.

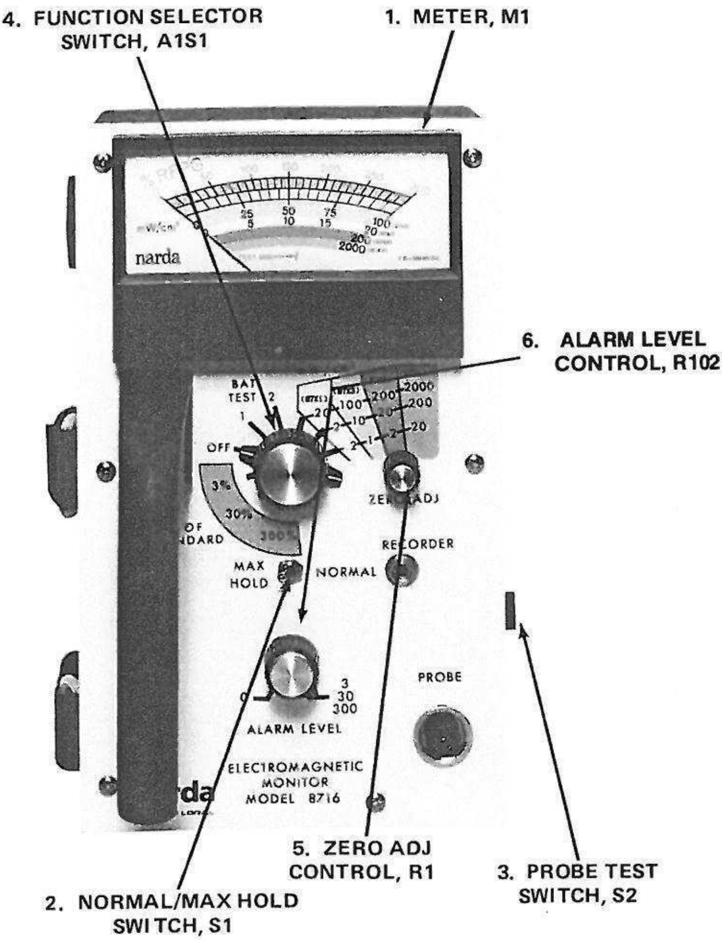


Figure 4-2. Model 8716 Controls and Indicators

Table 4-1

Test Set Controls and Indicators

Figure and Index No.	Control or Indicator	Function
4-2-1	Meter M1	Indicates percentage of the allowable exposure level. The top portion of the scale indicates percent of exposure level measured from 0.3% to 300%. The bottom portion of the scale is marked in mW/cm2 for use with other 8700 series probes. TEST MIN Marker. Indicates the condition of the batteries. A reading upscale of the TEST MIN mark indicates the batteries are satisfactory for use.

Table 4-1 (Cont)

Figure and Index No.	Control or Indicator	Function
4-2-2	NORMAL/ MAX HOLD Switch S1	Selects operating mode of meter assembly during measurements as follows: NORMAL Position. Displays the instantaneous RF Radiation level on meter M1. MAX HOLD Position. Displays and holds the maximum RF Radiation reading on Meter M1. Meter M1 reading is reset when NORMAL/ MAX HOLD Switch is set to NORMAL or Function Selector switch A1S1 is set to OFF.
4-2-3	Probe Test Switch S2	Energizes internal signal source for testing probe.

Table 4-1 (Cont)

Figure and Index No.	Control or Indicator	Function
4-2-4	Function Selector Switch, A1S1	Selects the test set function and meter M1 scale to be used for measurements, as follows: OFF. Turns off test set. BAT TEST 1. Indicates the condition of battery No. 1 on the scale of meter M1. BAT TEST 2. Indicates the condition of battery No. 2 on the scale of meter M1. Lowerscale Display mW/cm2, full scale values are dependent upon probe. Upper Scale (8722) 300% Range. Displays % of RFPG on meter with full scale value of 300%.

Table 4-1 (Cont)

Figure and Index No.	Control or Indicator	Function
4-2-4 (Cont)		30%. As above except full scale value is 30%. 3%. As above except full scale value is 3%.
4-2-5	ZERO ADJ Control, R1	Used to adjust meter M1 for ZERO SET indication.
4-2-6	ALARM LEVEL Control R102	Used to adjust alarm level, based on meter M1 deflection.

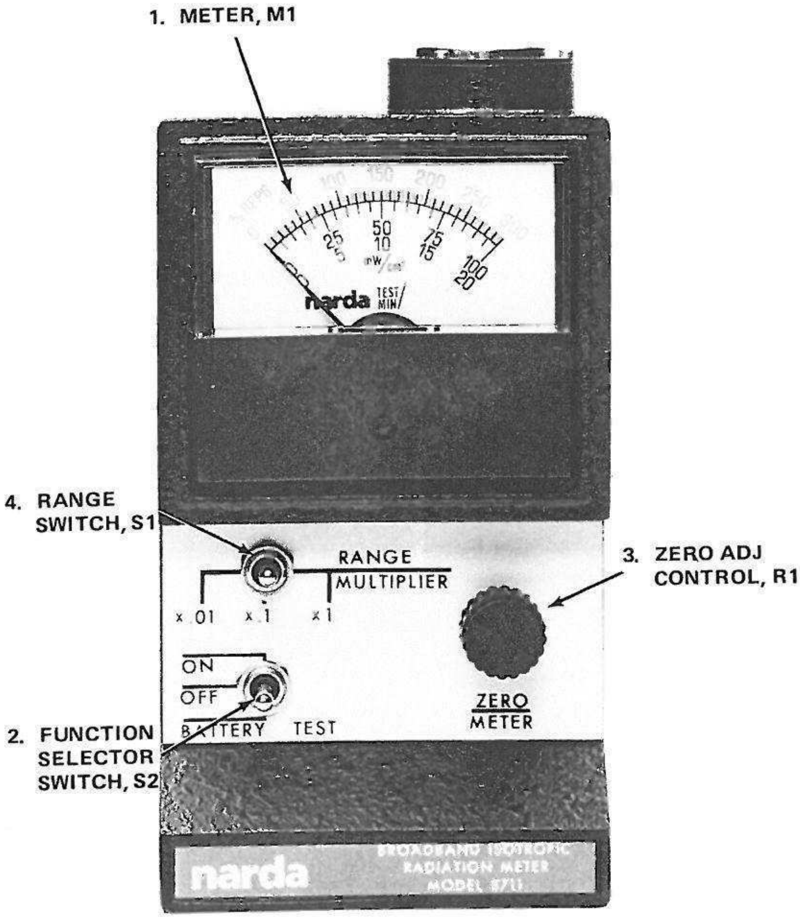


Figure 4-3. Model 8711 Controls and Indicators

Table 4-2

Test Set Controls and Indicators
For Model 8711 Meter

Figure and Index No.	Control or Indicator	Function
4-3-1	Meter M1	Indicates percentage of the allowable exposure level. The top portion of the scale indicates percent of exposure level measured from 0.3% to 300%. The bottom portion of the scale is marked in mW/cm^2 for use with other 8700 series probes. TEST MIN Marker. Indicates the condition of the battery. A reading upscale of the TEST MIN mark indicates the battery is satisfactory for use.

Table 4-2 (Cont)

Figure and Index No.	Control or Indicator	Function
4-3-2	Function Selector Switch, S2	Selects the test set function and meter M1 scale to be used for measurements, as follows: OFF. Turns off test set. BAT TEST. Indicates the condition of battery on the scale of meter M1. ON. Energizes test set.
4-3-3	ZERO ADJ Control, R1	Used to adjust meter M1 for ZERO SET indication.
4-3-4	Range switch S1	Selects range multiplier.

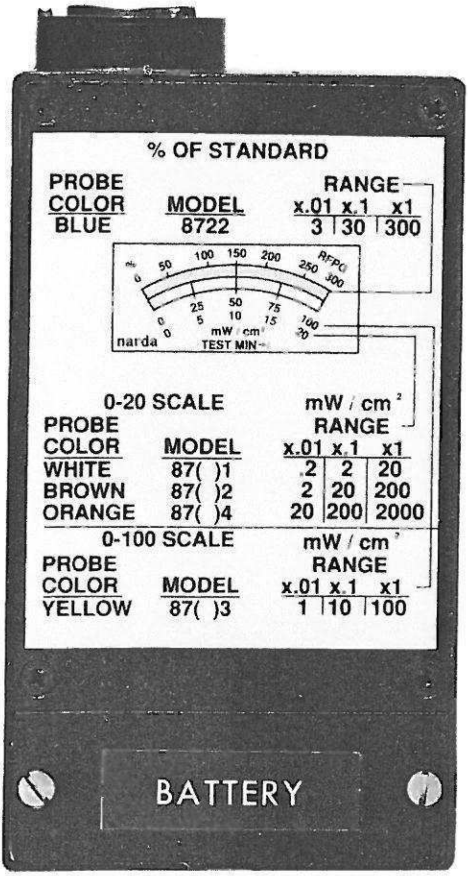


Figure 4-4. Model 8711 Rear View

4-5. OPERATING PROCEDURES (MODEL 8716). The following steps should be followed for the Model 8716. Refer to 4-6 for the Model 8711. To start up, operate, operate under abnormal conditions and shut-down the test set, perform the procedures contained in the following subparagraphs:

CAUTION

Do not place the test set, operating or non-operating in an area where fields are expected to exceed a 300% reading as damage to the test set may result.

a. Initial Start-Up Procedures. To start-up the test set, refer to Figure 2-1 and perform the procedures contained in the following subparagraphs.

(1) Make certain Function Selector Switch A1S1 (8) of the meter assembly is set to OFF.

(2) Connect connector P1 (7) of the probe assembly to PROBE connector J1 (6) on the meter assembly.

(3) Set NORMAL/MAX HOLD switch S1 (2) to NORMAL.

(4) Set Function Selector Switch A1S1 (8) to BAT TEST 1 and observe that Meter M1 (1) reads above the TEST MIN mark. If indication of Meter M1 does not display above TEST MIN mark, refer to and perform the battery charging or replacement procedure contained in paragraph 5-2 for the Model 8716.

(5) Set Function Selector Switch A1S1 (8) to BAT TEST 2 and repeat Step 4.

NOTE

The following step should be performed in an area of zero RF field and/or place probe in carrying case and close but do not latch cover. Alternately, the probe elements may be shielded by wrapping them with a piece of Aluminum foil.

(6) On meter assembly, set Function Selector Switch A1S1 (8) to most sensitive scale, observe that the pointer of Meter M1 (1) is aligned with the ZERO mark of the meter scale. If necessary, adjust ZERO ADJ control (9) until pointer of Meter M1 (1) is aligned with the ZERO mark.

(7) Set Function Selector Switch A1S1 (8) to 30%. The pointer of Meter M1 (1) should stay on zero mark.

(8) On a workbench or table or other flat surface, set meter assembly on its back. Alternatively, the meter assembly may be held in the left hand and the probe in the right hand.

(9) Carefully align one of the probe contacts (5) with Probe Test Switch S2 (3).

(10) Carefully apply pressure to Probe Test Switch S2 (3) and move cap of probe until it contacts test window (4).

(11) Observe pointer of Meter M1 (1) for movement upscale. Failure of meter to move upscale indicates a malfunction of the test set. On some model probes the pointer movement during test may require 20 to 30 seconds to reach upscale position.

(12) Release pressure on Probe Test Switch S2 (3) and observe that the pointer of Meter M1 (1) is aligned with the ZERO mark of the meter scale.

(13) Repeat steps (9) through (12) for each of the five additional contacts (5) on the probe assembly.

(14) Make survey in accordance with para. 4-5(b).

b. Normal Operating Procedure. To operate the test set, refer to Figure 4-1 for the Model 8716 and Figure 4-2 for the Model 8711 and perform the procedures contained in the following subparagraphs.

NOTE

The meter assembly may be hand held utilizing the front panel handle or carried using the shoulder strap. The probe assembly may be hand held or secured to the side of the meter assembly. (Model 8716 only.)

(1) If probe assembly is to be secured to the meter assembly, position handle of probe as shown in detail A of Figure 2-1. Secure probe assembly by passing fastener strap (1) around handle of probe assembly, through D ring (11) and folding fastener strap back on itself. (Model 8716 only.)

(2) Set Function Selector Switch to most sensitive range.

(3) Set NORMAL/MAX HOLD switch (2) to NORMAL if a continuous indication of the RF radiation present is required or to MAX HOLD if a sustained indication of the maximum RF Radiation encountered is required. (Model 8716 only.)

WARNING

Always approach an area of suspected radiation or potentially hazardous equipment carefully. When a meter reading is observed, do not approach the unit under test or radiating source any closer than necessary to verify the source of radiated signal and to measure the level of RF radiation present. Move probe within the area to find the exact site of the radiating source. If readings exceed the full scale reading on the most sensitive range, reset the test set to the middle range. If readings then are greater than the measuring range of the middle range of the probe in use, reset the test set to the maximum measuring range. When measuring microwave frequencies, move the test set probe slowly when searching for the highest RF level, to insure the maximum measuring level capability of the probe is not exceeded.

CAUTION

Do not place the test set, operating or non-operating in an area where fields are expected to exceed full rated power density as damage to the test set may result.

NOTE

If a full-scale reading is observed on Meter M1 (with range switch in 300% or maximum mW/cm^2 position), leave the area immediately and refer to paragraph 4-5.a. and repeat the initial start-up procedures to verify that the probe or meter assembly has not been damaged.

(4) Approach the area or equipment cautiously, starting as far away as possible and keep the probe extended at arms length toward the radiation source. Hold the probe to point towards radiating source.

(5) Observe meter (1, Figure 4-2) for indication of RF Radiation.

(6) Slowly move the probe in a horizontal and vertical arc while observing meter (1) to determine the direction of maximum signal.

(7) Hold probe stationary and allow indication on Meter M1 to stabilize.

(8) For each measurement, observe and record the indication on the PERCENT OF RFPG scale of meter (1) if using Model 8722 or mW/cm2 when using other 8700 series probes.

NOTE

In the case of a single radiating source, if the frequency is known, multiply the meter reading by the calibration factor listed on the handle of the probe assembly.

c. Adverse or Abnormal Operating Procedures. This paragraph contains procedures for operating the test set when moving the test set between temperature extremes. Procedures are also provided for operating the test set in fields at frequencies below 1 MHz.

(1) Operation at temperature extremes. To operate the test set when moving between temperature extremes, allow the test set to stabilize at the new temperature condition for at least 20 minutes before use. If immediate operation is required, perform the procedure contained in the following paragraphs:

(a) Set function selector switch (4) to most sensitive range.

(b) Adjust ZERO ADJ control (5) until the pointer of Meter M1 (1) is aligned with the ZERO mark on Meter M1 (1).

(c) Set Function Selector Switch (4) to desired range and make required measurements.

(d) Repeat steps (a) through (c) at approximately five-minute intervals until no further adjustment of ZERO ADJ control (5) is required.

(2) Additional Uncertainties for Electric fields Below 1 MHz. When making electric field measurements below 1 MHz, uncertainties in the order of 3 dB are possible unless certain

precautions are taken. This uncertainty results from capacitively coupling into a high potential source. To avoid this effect, the probe should not be brought closer than 3 feet to an excited radiator in this frequency range. In addition, the probe and meter should be at the same approximate potential.

This can be accomplished by strapping the probe to the meter with the velcro fastener provided on the meter. The probe cable should be coiled and maintained close to the meter. Hold the meter by its insulated handle.

4-6. MODEL 8711 OPERATING PROCEDURES. To start up, operate, operate under abnormal conditions and shut-down the test set, perform the procedures contained in the following subparagraphs:

CAUTION

Do not place the test set, operating or non-operating in an area where fields are expected to exceed the probe full scale rating as damage to the test set may result.

a. Initial Start-Up Procedures. To start-up the test set, refer to Figure 2-2 and perform the procedures contained in the following subparagraphs.

(1) Make certain Function Selector Switch A1S1 (2) of the meter assembly is set to OFF.

(2) Connect connector P1 (5) of the probe assembly to PROBE connector J1 (4) on the meter assembly.

(3) Set Function Selector Switch A1S1 (2) to BAT TEST and observe that Meter M1 (1) reads above the TEST MIN mark. If indication of Meter M1 does not display above TEST MIN mark, refer to and perform the battery replacement procedures contained in paragraph 5-3.

NOTE

The following step should be performed in an area of zero RF field and/or place probe in carrying case and close but do not latch cover. Alternately, the probe elements may be shielded by wrapping them with a piece of Aluminum-foil.

(4) On meter assembly, set Range Switch A1S2 (6) to most sensitive scale, observe that the pointer of Meter M1 (1) is aligned with the ZERO mark of the meter scale. If necessary, adjust ZERO ADJ control (3) until pointer of Meter M1 (1) is aligned with the ZERO mark.

(5) Set Range Switch A1S2 (6) to x1. The pointer of Meter M1 (1) should stay on zero mark.

(6) Make survey in accordance with paragraph 4-5b. and c.

SECTION V

MAINTENANCE INSTRUCTIONS

5-1. GENERAL. This section contains maintenance instructions for the test set. These instructions include procedures for cleaning, battery charging or replacement. If the test set requires maintenance that is beyond the scope of this section, refer to Section VI, or return the set to Narda.

5-2. MAINTENANCE PROCEDURES. The following procedures contain maintenance instructions for cleaning the test set, replacing or recharging the batteries. Subparagraph a. contains procedures for cleaning the test set. Subparagraphs b. and c. contain procedures for battery charging (b) or replacement (c). Refer to paragraph 5-3 for Model 8711 battery replacement.

a. Cleaning. Mild solutions of household cleaners such as ammonia or dishwashing detergent can be used to loosen ground-in-dirt and grease from the exterior of the meter and probe assemblies. To clean the meter and probe assemblies, perform the procedures contained in the following paragraphs.

CAUTION

To prevent damage to the test set, do not allow moisture to collect on or within the test set. Use only damp cleaning cloths during cleaning operations.

1. Clean outer surface of the meter assembly and probe assembly with a clean cloth dampened with a mild dishwashing detergent or water solution.

2. Wipe dry using a clean, dry cloth.

3. Clean meter display window and test window using a mild ammonia and water solution.

4. Wipe dry using a clean, dry cloth.

b. Battery charging. See Figure 5-1. To charge batteries, perform the procedure contained in the following subparagraphs:

CAUTION

To prevent damage to meter assembly (1), make certain Function Selection Switch A1S1 is set to OFF. Insure the flag above the line cord connector on the Model 8716 indicates the proper charging voltage. The Model 8716 may be charged using either 115 or 230 VAC. To change the charging voltage or replace the NiCad batteries, refer to subparagraph (c).

1. Plug system into line voltage and allow to charge overnight (16 hours).

2. Check battery charge level, if battery charge level remains close to TEST MIN marking on meter M1 perform steps (3) through (5).

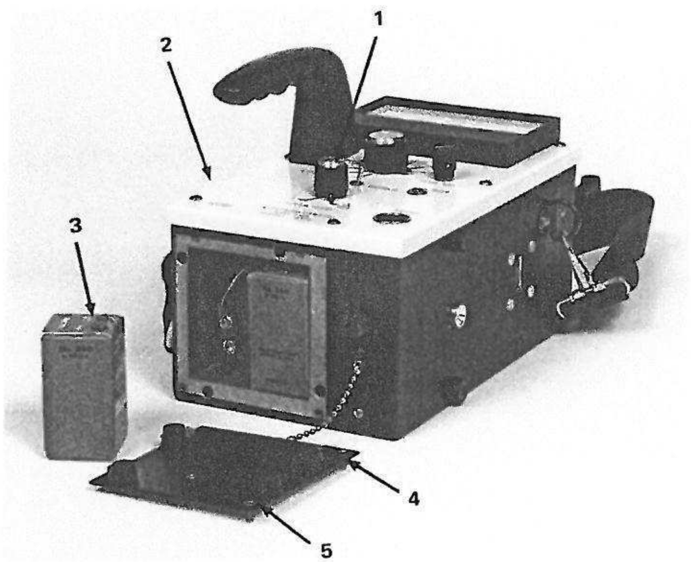


Figure 5-1. Radio Frequency Radiation Test Set, Battery Replacement (8716)

3. Place system in case (probe disconnected), turn function selector switch A1S1 to mid range. Allow system to discharge for 24 hours.

4. Charge system for 15 min. only. Then discharge system completely again.

5. Charge system overnight (16 hours). Insure battery charge level is above TEST MIN mark on meter M1. If batteries are not charged fully proceed with the instructions contained in subparagraph c.

c. Battery replacement. See Figure 5-1. To replace batteries, perform the procedure contained in the following subparagraphs:

1. Loosen screws (5) and remove cover (4).

2. Carefully remove battery (3) from battery compartment and disconnect battery connector (2).

3. Battery charge voltage should be verified or changed, to correspond with AC line voltage.

4. Connect replacement battery (3) to battery connector (2).

5. Carefully position battery (3) in battery compartment of meter assembly (1).

6. Position cover (4) over battery compartment and fasten with captive screws (5).

7. Check flag on rear cover. Insure flag voltage corresponds to switch selection (Step 3).

8. Set Function Selector Switch A1S1 to BAT TEST 1 and make certain that Meter M1 indicates above TEST MIN mark on Meter M1.

9. Set Function Selector Switch A1S1 to BAT TEST 2 and make certain that Meter M1 indicates above TEST MIN mark on Meter M1.

10. Set Function Selector Switch A1S1 to OFF. If batteries were replaced and are not fully charged, see page 5-1, Section 5-2 (b).

d. Battery Replacement Model 8711. See Figure 5-2. To replace batteries, perform the procedure contained in the following subparagraphs:

CAUTION

To prevent damage to meter assembly (1), make certain Function Selection Switch A1S1 is set to OFF.

1. Loosen two screws (5) and remove cover (4).

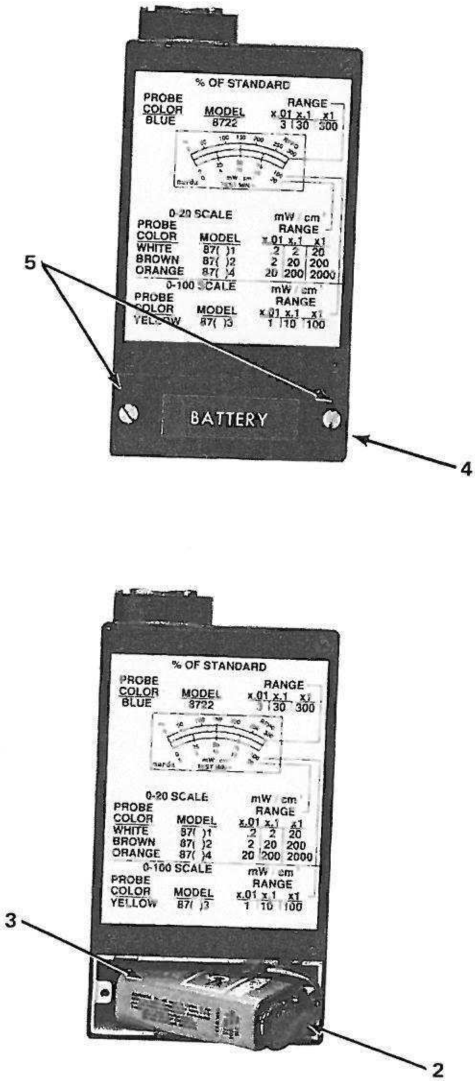


Figure 5-2. Radio Frequency Radiation Test Set, Battery Replacement (8711)

2. Carefully remove battery (3) from battery compartment and disconnect battery connector (2).

3. Connect replacement battery (3) to battery connector (2).

4. Carefully position battery (3) in battery compartment of meter assembly (1).

5. Position cover (4) over battery compartment and fasten with two captive screws (5).

6. Set Function Selector Switch S2 to BAT TEST and make certain that Meter M1 indicates above TEST MIN mark on Meter M1.

7. Set Function Selector Switch S2 to OFF.