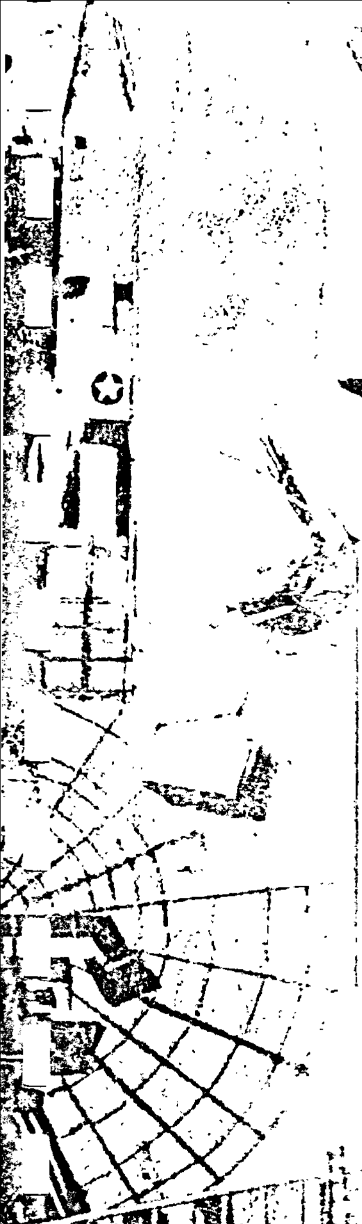
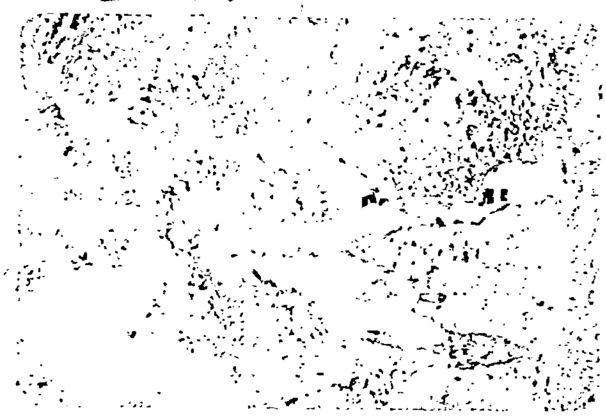
INSTRUCTION MANUAL

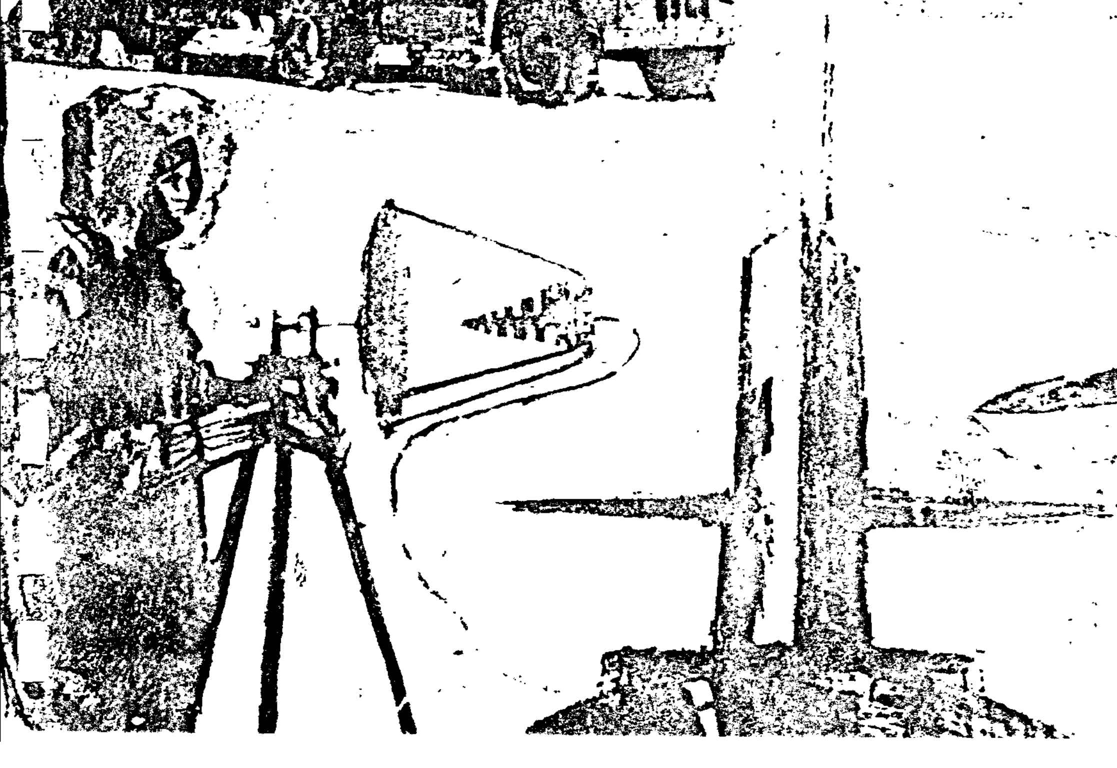


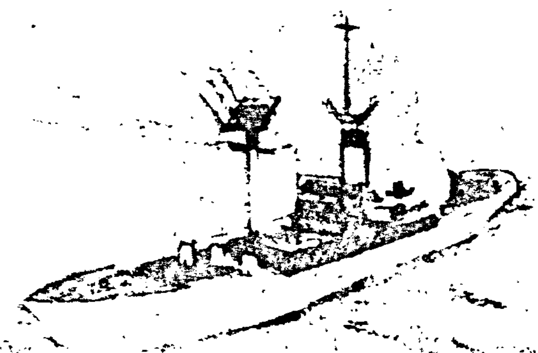
INSTRUCTION MANUAL

FOR

ELECTROMAGNETIC INTERFERENCE/
FIELD INTENSITY METER
MODEL NM-17/27
Manual No. 1-500783-255 (Rev. A)







SINGER
INSTRUMENTATION

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ILLUSTRATIONS

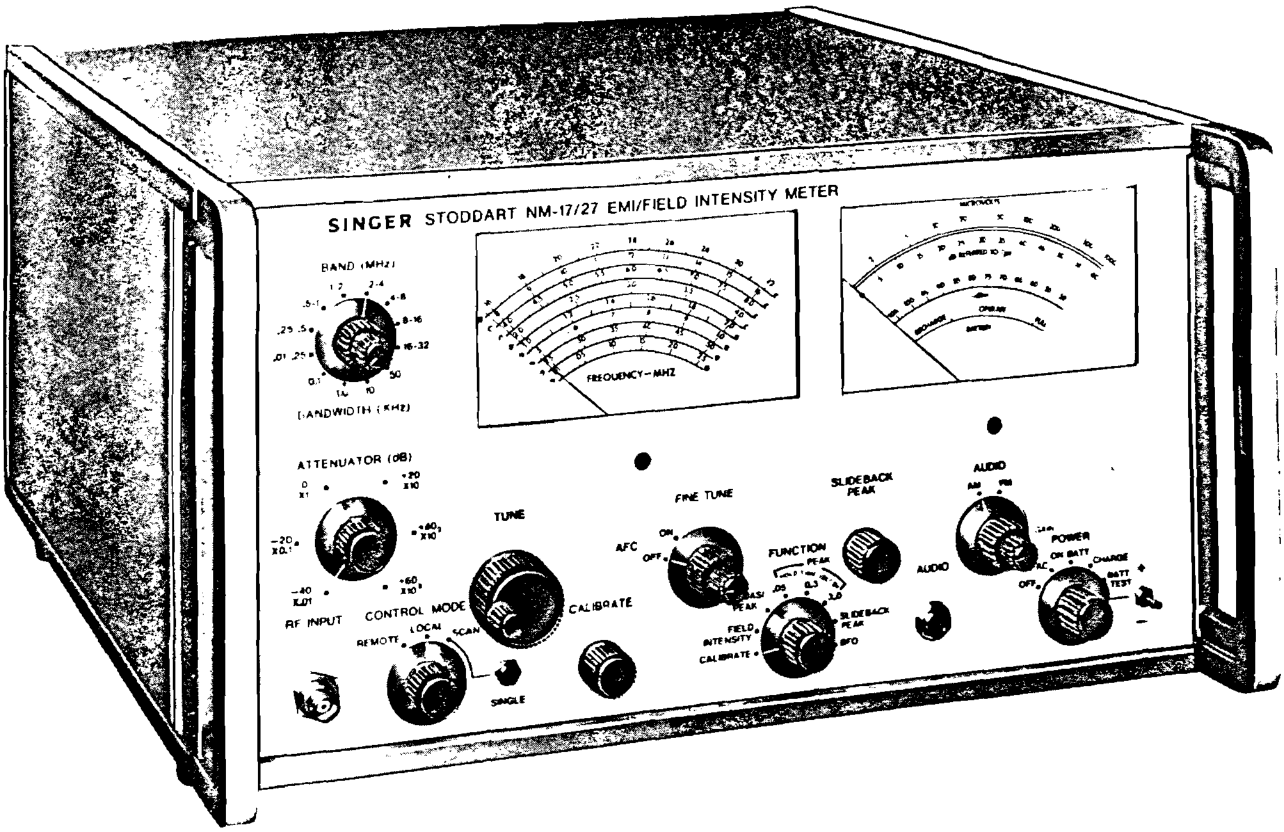


Figure 1—1. Electromagnetic Interference/Field Intensity Meter
Model NM-17/27

Section I

INTRODUCTION

1.1 SCOPE OF MANUAL

This manual provides operation and maintenance information for the Model NM-17/27 Electro-magnetic Interference/Field Intensity (EMI/FI) Meter (Figure 1-1). The manual is divided into eight sections containing a general description of the equipment and accessories, specifications, installation information, operating instructions, operating theory, maintenance information, schematic diagrams and a parts list.

1.2 PURPOSE AND USE OF EQUIPMENT

The Model NM-17/27 is a programmable, precision electromagnetic interference/field intensity (EMI/FI) meter for the measurement of conducted or radiated RF interference, within the frequency range of 10 kHz to 32 MHz in accordance with standard military and commerical EMI test specifications. The instrument performs automatic and semiautomatic testing when supplied with appropriate command signals and provides outputs of signal amplitude and frequency that are suitable for input to a digital data processing system. Some typical applications of the Model NM-17/27 are:

a. Determining the presence, level, frequency, and characteristics of conducted or radiated RF signals within the frequency range of 10 kHz to 32 MHz.

b. Automatic and semiautomatic EMI testing in accordance with military specifications, such as; MIL-STD-461A amd MIL-STD-826A, FCC rules and regulations, and other related specifications.

c. Spectrum signature recording when connected to an X-Y plotter.

d. Measurement of radiation from a component, system, or vehicle.

e. General laboratory applications as a tunable, programmable, two-terminal microvoltmeter.

f. RF current measurement in a conductor.

g. Antenna propagation studies, radiation pattern and field strength measurements.

h. Measurement of the susceptibility of electronic equipment to an electromagnetic environment.

i. Analyzing bandpass, band rejection, and discriminating characteristics of electronic components, circuitry, and systems.

j. Determination of shielding effectiveness.

1.3 GENERAL DESCRIPTION

The instrument is rugged and portable, and operates from internal, rechargeable batteries. It is an ideal unit for use in conjunction with a simple, lightweight computer and recorder, to form a high-speed, high-volume, mobile test station.

The instrument may be used to analyze narrowband or broadband signals within its frequency range. Field intensity or direct peak detector functions may be used for measurements in addition to quasi-peak, slideback peak and BFO detection modes. AM, FM and PM signals may be detected and are available at the video output receptacle for oscilloscope display. When used in conjunction with an oscilloscope, the Model NM-17/27 becomes an improved spectrum analyzer with integral pre-selection.

Exceptional gain flatness is inherent in the design of the Model NM-17/27. This feature permits X-Y plotting of signal amplitude and frequency information without extreme deviations from the calibration curve.

Electronic tuning permits remote and local tuning without mechanical drive. The internal electronic scan may be activated by a front-panel pushbutton. Four IF bandwidths are provided, permitting quick identification of broadband or narrowband signals:

a. The 50 kHz bandwidth provides greatest sensitivity for broadband signals.

b. The 10 kHz bandwidth can be used for broadband or narrowband signals.

c. The 1 kHz and 100 Hz bandwidths provide greatest sensitivity for narrowband signals and permit improved frequency resolution for closely spaced channels. (A fine-tuning control is provided for ease in tuning CW signals when these bandwidths are used.)

The frequency dial indicates operating frequency in all modes of operation: manual tuning, automatic scan, remote scan and AFC. Adjustments to the fine-tuning control are also indicated on the frequency dial. The primary detection circuitry of the Model NM-17/27 uses a logarithmic amplifier which provides 60 dB of dynamic display range on the panel meter. In conjunction with the five 20 dB RF attenuator steps (total of 100 dB attenuation) the overall measurement range is 160 dB (from 0.01 microvolt to one volt.

1.4 PROGRAMMABLE FUNCTIONS

In order to facilitate automated testing methods, the following critical control functions of the Model NM-17/27 are programmable by the application of voltage from a remote source:

a. Frequency band selection.

b. Bandwidth selection.

c. Frequency tuning.

d. Receiver gain (calibration).

e. Detector function selection.

1.5 SUPPLIED ACCESSORIES

The items listed in Table 1-1 are furnished with the Model NM-17/27 EMI/FI meter.

Table 1-1. Supplied Accessories

Quantity	Device	Singer Part No.
1	AC Power Cable, 7½ ft.	1-910166-001
1	Module Extender Cable, 16 inches, 9 pin connectors	2-004543-001
1	41 Pin Connector (mates with PROGRAMMER input receptacle)	1-910101-005
1	Instruction Manual	1-500783-255
2	Rack Mounting Brackets	3-103317-001
4	Flat-head Screws, 10-32 x ½ (for Rack Mounting Brackets)	1-964064-265
1	Calibration Charts	1-403550-001

1.6 OPTIONAL ACCESSORIES

Accessories available for use with the Model NM-17/27 are listed below.

a. *Meter Transit Case**, Model 95207-2. Used to transport or store the Model NM-17/27 and supplied accessories.

b. *Programmable Rod Antenna Coupler**, Model 94592-1, (10 kHz to 32 MHz). Used with Rod Antenna (f) for measuring electric field strength.

c. *Programmable Loop Antenna/Coupler**, Model 94593-1. Used for measuring magnetic field strength.

d. *Antenna Control Cable*, Model 94594-1. Connects the Rod Antenna Coupler (b) or the Loop Antenna (c) to the Model NM-17/27 for automatic remote band switching of the antennas at a distance of up to 20 ft.

e. *Collapsible Tripod**, Model 91933-2. Used for mounting either antenna, or for mounting the Ground Plane (n) with either antenna.

f. *Rod Antenna**, 41 inches, Model 92197-3. Used with Rod Antenna Coupler (b) for measuring electric field strength.

g. *Remote Meter Cable*, Model 92191-1. Used with Remote Meter (u) to allow signal level indication of Model NM-17/27 within a distance of 20 ft.

h. *Headphones**, Model 10796. Used for audio reception of signal outputs. (Z = 600 ohms)

i. *RF Current Probe**, Model 91197-1. Used for measuring RF currents. Has a maximum transfer impedance of 0.33 ohms that is substantially constant from 5 kHz to 2MHz.

j. *RF Current Probe**, Model 91550-1. Used for measuring RF currents. Has a maximum transfer impedance of 5.5 ohms that provides the best sensitivity from 50 kHz to 100 MHz.

k. *RF Current Probe**, Model 91550-2. Used for measuring RF currents. Same as Current Probe, Model 91550-1 (j) except internally loaded and compensated to provide a substantially constant transfer impedance of one ohm from 150 kHz to 150 MHz.

l. *Loop Probe**, Model 90799-3. Used for localizing source of electromagnetic leakage, especially in areas of limited accessability.

m. *Tripod Bag*, Model 92049-1. Used in storing or transporting the Collapsible Tripod (e).

n. *Ground Plane**, Model 92199-3. Used with Rod Antenna Coupler (b) and Rod Antenna (f) as directed by measurement specifications to provide a true signal ground.

o. *Video Output Cable, X-Output Cable,* or *Y-Output Cable*, Model 90071-1. Used for connecting the signal output (video), or data outputs (X-axis or Y-axis), to the appropriate readout device.

p. *RF Transmission Line**, Model 92191-1. Used for connecting the Model NM-17/27 to a signal source within a distance of 20 feet.

q. *Headphone Extension Cable*, Model 90074-1. Used for connecting Headphones (h) to the Model NM-17/27 within a distance of 20 feet.

r. *Cable Bag*, Model 91981-2. Used for the storage or the transportation of the cables necessary for operation of the Model NM-17/27 system.

s. *Accessory Case*, Model 92220-6. Used for the storage or transportation of optional accessories.

t. *BNC to Type N Adapter**, Model 11663. Adapts the Current Probe type N connector to a BNC connector.

u. *Remote Meter*, Model 95175. Used with Remote Meter Cable (g) to allow signal level indication of Model NM-17/27 within a distance of 20 feet.

* Indicates items displayed in Figure 1–2.

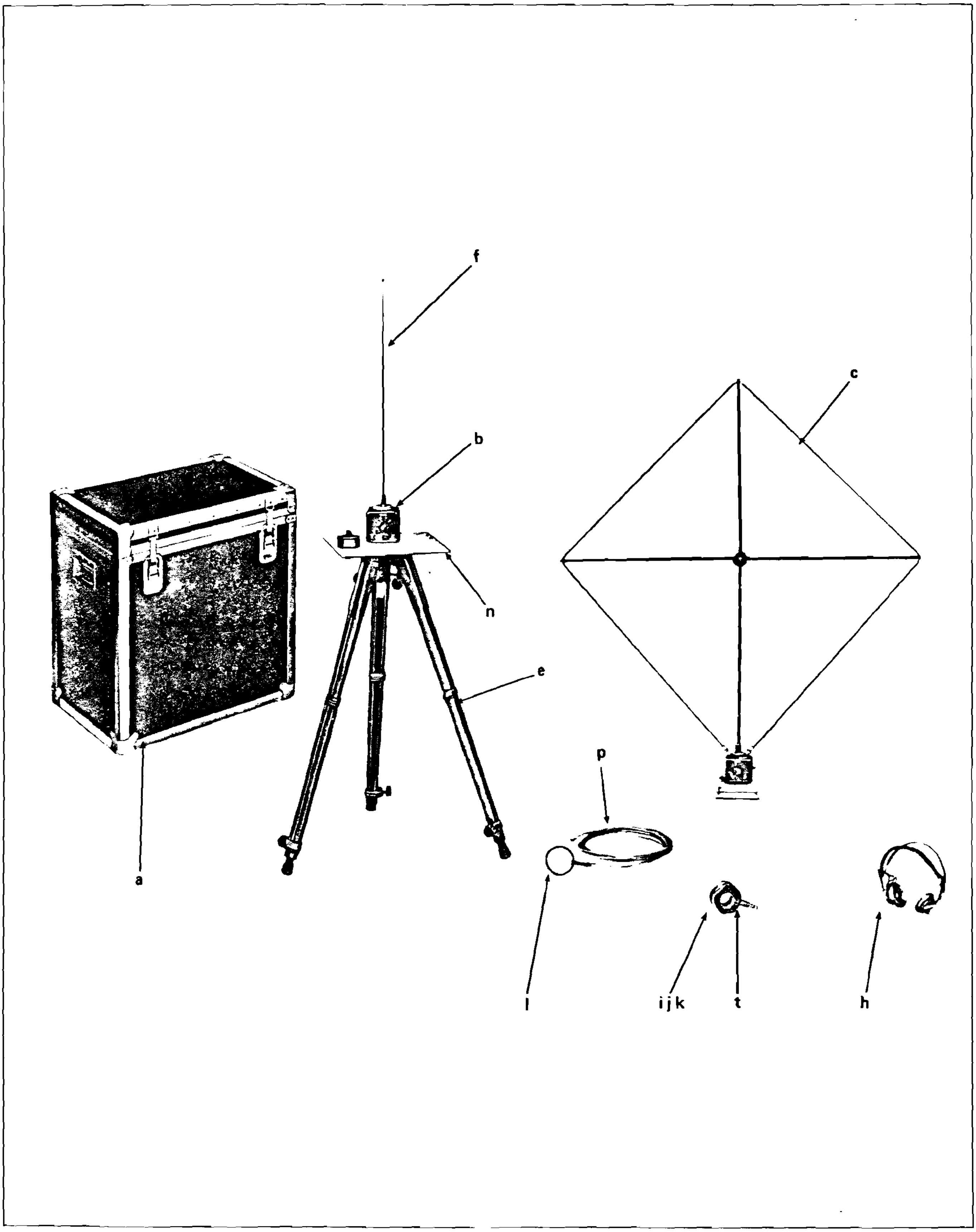


Figure 1—2. Optional Accessories

Section II
SPECIFICATIONS

2.1 INTRODUCTION

This section contains specification information for the Model NM-17/27.

2.2 SPECIFICATIONS

Table 2–1 contains specification data for the Model NM-17/27.

Table 2–1. Specifications

Characteristic	Specifications
Receiver type	Superheterodyne, single conversion on Bands 1 and 4: dual conversion on Bands 2, 3, 5, 6, 7 and 8.
Intermediate frequencies:	Bands 1 and 4: 0.455 MHz Bands 2, 3, 5 and 6: 1.6 MHz/0.455 MHz Bands 7 and 8: 5.0 MHz/0.455 MHz
Frequency	
Range:	0.01 MHz to 32 MHz in 8 bands. A sufficient overlap in frequency range is provided between each band to prevent hiatus in overall frequency coverage. Band 1: 0.01 to 0.25 MHz Band 2: 0.25 to 0.5 MHz Band 3: 0.5 to 1.0 MHz Band 4: 1 to 2 MHz Band 5: 2 to 4 MHz Band 6: 4 to 8 MHz Band 7: 8 to 16 MHz Band 8: 16 to 32 MHz
Accuracy:	True frequency is within ±2% of indicated frequency, or within ±5 kHz, whichever is greater.
Voltage measurement	
Range:	0.01 uV to 1.0 V (160 dB); 60 dB on meter scale and 100 dB of attenuator range.
Accuracy:	±2 dB for CW signals ±3 dB for impulse signals
Gain flatness:	Maximum ±2 dB (25°) (typically ± 1dB) (Maximum ±3 dB, −15°C to +50°C)
Sensitivity (as a two-terminal RF voltmeter):	To produce a 3 dB meter indication above noise:
Narrowband, CW signal:	Field intensity function, Bands 1 thru 8: uV / dBuV / dBm 100 Hz bandwidth (0.01 – 32 MHz): 0.016 / −36 / −143 1 kHz bandwidth (0.01 – 32 MHz): 0.05 / −26 / −133 10 kHz bandwidth (0.02 – 32 MHz): 0.16 / −16 / −123
Broadband, impulse signal:	Direct peak function, Bands 1 thru 8: uV/MHz / dBuV/MHz 10 kHz bandwidth (0.01 – 0.014 MHz): 140 / +43 10 kHz bandwidth (0.014 – 0.02 MHz): 70 / +37 10 kHz bandwidth (0.02 – 32 MHz): 45 / +33 50 kHz bandwidth (0.07 – 32 MHz): 20 / +26
Calibrator:	Internal solid-state impulse generator, fixed amplitude, approximately 500 Hz repetition rate.

Table 2–1., Specifications (Cont.)

Characteristic	Specifications
RF input	
Impedance:	Approximately 50 ohms (Type BNC coaxial connector).
VSWR:	Maximum 1.5:1 (typically 1.2:1).
Undesired response rejection (referenced to 3 dB S + N/N in 1 kHz bandwidth):	Intermediate frequency rejection: 70 dB minimum Image frequency rejection: 70 dB minimum Spurious rejection: 70 dB minimum
Local oscillator emission:	Less than 50 picowatts
Shielding effectiveness:	Minimum 80 dB (typically greater than 100 dB)
Automatic frequency control holding range:	Greater than ±7 kHz in 100 Hz and 1 kHz bandwidths. Greater than ±20 kHz in 10 kHz bandwidth. Greater than ±70 kHz in 50 kHz bandwidth.
Selectable 6 dB IF bandwidth	0.1 kHz ±10% 1 kHz ±10% 10 kHz ±10% 50 kHz ±10% (tolerance does not apply to band 1).
Internal frequency scan:	Electronically scans any band in one minute, providing outputs to X-Y recorder. Pen lift provided (isolated contact closure).
Detector functions:	
Field intensity:	Average value of output of the 60 dB logarithmic detector.
Quasi-peak:	Weighted average of output of the 60 dB logarithmic detector. Charge time is 1 millisecond; discharge time is 600 milliseconds.
Peak function:	Responds to true peak value. Calibrated in rms of an equivalent sine wave. Selectable hold times of 0.05, 0.3, and 3 seconds.
Slideback peak:	Manual slideback detector with aural null indication.
BFO:	Beat frequency oscillator. Nominal tone is 1 kHz.
Programmable functions requirements:	
Frequency band selection:	–12 V, 30 mA maximum.
Frequency tuning:	0 V to +10 V minimum sawtooth (input resistance of 2 kilohms).
Bandwidth selection:	+12 V, 12 mA maximum.
Detector function selection:	+12 V, 60 mA maximum. Selects functions: calibrate, FI, QP, direct peak and hold time and CAL control.
Receiver gain (calibrate control):	0 V to approximately –6 V (input resistance of 100 kilohms).
Data outputs (simultaneously available):	
X-axis output:	0 V to +1 V ±5% across 1,000 ohms, 0 V to +2 V open circuit, for any frequency band. BNC connector on rear panel.
Frequency readout:	10 mV per kHz, bands 1, 2 and 3; other bands: 100 mV per MHz. Accuracy ±2%. From PROGRAMMER receptacle on rear panel.
Y-axis output:	0 V to +1 V ±5% across 1,000 ohms, 0 V to +2 V open circuit, for 0 dB to full-scale meter deflection. BNC connector on rear panel.
dB readout:	10 mV per dB, –0.40 volts to +1.20 volts ±10 mV for full-voltage measurement range. From PROGRAMMER receptacle on rear panel.
LO outputs (8) (optional):	–20 dBm minimum.

Table 2–1., Specifications (Cont.)

Characteristic	Specifications
Signal outputs (simultaneously available):	For a full-scale CW signal:
IF (455 kHz):	80 mV rms minimum across 50 ohms. BNC connector on rear panel.
Log video:	300 mV ±10% peak across 50 ohms, dc to 10 kHz. BNC connector on rear panel.
Linear video:	100 mV minimum peak-to-peak across 50 ohms, 20 Hz to 15 kHz, for 30% amplitude modulation. BNC connector on rear panel.
Audio (AM or FM):	30 mW minimum across 600 ohms. The 3 dB bandwidth is 20 Hz to 4 kHz, for 30% amplitude modulation. Phone jack on front panel.
FM video:	100 mV minimum peak-to-peak across 50 ohms. Output is typically 25 mV/5 kHz deviation. Video bandwidth is dc to 5 kHz minimum. BNC connector on rear panel.
Power requirements:	
Ac power:	105 V to 130 V or 210 V to 260 V, 50 Hz to 400 Hz, approximately 30 watts.
Battery:	Rechargeable nickle-cadmium cells provided in removeable battery pack. Approximately eight hours continuous operation. Internal charging circuits charge battery in approximately 15 hours. Battery test indication is provided on front panel meter.
Mechanical	
Dimensions (including handles):	Approximate height: 22.2 cm (8.7 inches) Approximate width: 42.4 cm (16.7 inches) Approximate depth: 47 cm (18.5 inches)
Weight (including battery pack) pack):	Approximately 27.3 kg (60 pounds)
Environmental:	
Temperature:	Operational: −15°C to +50°C (+5°F to +123°F) Non-operational −50°C to +75°C (−58°F to +167°F)
Vibration:	Meets MIL-T-21200, Class 3 non-operating.
Altitude:	Operational to at least 4,570 m. (15,000 ft.) (mean sea level).

Section III
INSTALLATION

3.1 INTRODUCTION

This section contains information on bench operation vs rack mounting, 115 V vs 230 V operation, and operation from a battery and battery care information.

3.2 BENCH OPERATION

The Model NM-17/27 is shipped ready for use as a bench-operated instrument. A folding support that is attached to the feet under the front of the instrument may be pulled down to elevate the front of the instrument for ease of operation.

3.3 RACK MOUNTING

A set of adapter brackets and attaching screws are provided to permit mounting of the Model NM-17/27 into a standard 19-inch rack. To prepare the instrument for rack mounting, proceed as follows:

a. Remove the six screws that attach the four feet and folding support to the bottom of the instrument. Retain the screws, feet, and support for future use.

b. Attach one rack mounting bracket (Part No. 3-103317-001) to each side of the instrument using two 10-32 x ½ screws (Part No. 1-964064-265) in each bracket.

3.4 OPERATION FROM AN AC POWER SOURCE

The Model NM-17/27 requires ac power of 105 to 130 volts, or 210 to 260 volts, 50 to 400 Hz, approximately 30 watts.

a. Set the 115/230 V slide switch on the rear panel to the position corresponding to the ac power line voltage. For 115 V operation, use two 0.5 A fuses, for 230 V operation, use two 0.25 A fuses.

> **WARNING**
>
> The Model NM-17/27 is designed for operation from a polarized, three-terminal power receptacle having one terminal connected to earth ground. When only a two-terminal power receptacle is available, to eliminate shock hazard, use a three-prong to two-prong adapter and connect the adapter pigtail lead to the power receptacle ground.

b. Connect the female end of the 7½-foot power cable to the ac power receptacle on the rear panel of the instrument. Connect the male end of the cable to the ac power source.

c. Set the POWER switch on the front panel to the ON AC position. The Frequency meter scale lamps should illuminate.

3.5 OPERATION FROM INTERNAL BATTERIES

The Model NM-17/27 may be operated from the internal rechargeable batteries for a period of 8 hours when the batteries are fully charged.

a. To operate from the internal batteries, set the POWER switch to the ON BATT position.

b. To check the condition of the internal batteries, set the POWER switch to BATT TEST. Set the BATT TEST toggle switch to + and thereafter to –. In both positions the Output meter should indicate above the RECHARGE zone of the BATTERY scale.

c. If either the + or – battery test causes the Output meter to indicate in the RECHARGE zone of the BATTERY scale, the equipment should be switched off, operated from an ac power source, or the batteries charged. (Refer to Paragraph 3.6 for recharging of batteries.)

NOTE

The Model NM-17/27 is fully capable of normal operation from an ac power source when internal batteries are completely discharged or if the battery pack is removed from the instrument. When operated from an ac power source (POWER switch at ON AC position), the battery trickle charger will require approximately 40 hours to recharge fully discharged batteries. With the power switch in the CHARGE position, the batteries will be fully charged in approximately 15 hours.

d. If there is no indication on Output meter for either positive or negative battery test in Step b, press the appropriate reset button on rear panel.

3.6 BATTERY CHARGING

To charge the fully or partially discharged internal batteries, set the POWER switch to CHARGE position. With fully discharged batteries, the batteries will be fully charged in approximately 15 hours. Overcharging the batteries for any length of time will not damage the battery cells. The fully charged batteries should operate the instrument continuously for eight hours without recharging. If the operating time is considerably shorter, then the battery pack is defective and should be replaced.

NOTE

When a number of cells are operated in series, charge imbalance occurs. To reduce the possibility of one or more cells going into reverse charge towards the end of the discharge cycle, charge balancing is recommended. The recommended method of charge balancing is to deliberately charge for a longer period of time than is necessary to reach maximum ampere – hour rating. Balancing is recommended once a month or every 15 charge/discharge cycles by charging for about 50% longer than the normally recommended time.

4

Section IV

OPERATING INSTRUCTIONS

4.1 INTRODUCTION

Instructions and information for preparing the Model NM-17/27 for use, functional descriptions of controls and receptacles, instructions for using signal input devices available as accessories, operating instructions, and calibration instructions are presented in this section of the manual.

4.2 OPERATING CONTROLS, INDICATORS, AND RECEPTACLES

All external operating controls, indicators, and receptacles of the Model NM-17/27 are located on the front panel and on the rear panel (See Figure 4-1). Functional descriptions of the panel features are contained in Table 4-1.

4.3 BASIC OPERATION

Specific operational procedures for detecting and measuring RF signals with the Model NM-17/27 will vary, depending upon the purpose of measurement, the signal pickup device used, and the type of signal being measured. Military and commercial EMI test specifications generally include detailed requirements and instructions for performing measurements of conducted or radiated interference. However, the following basic operating procedure will generally apply for all measurement conditions:

a. Select the appropriate signal pickup device.

b. Determine type of signal to be measured (narrowband or broadband).

c. Calibrate the instrument (Adjust the instrument for standard gain).

d. Measure signal.

e. Calculate the measured signal level in the required units of measurement.

4.4 SIGNAL PICKUP DEVICES

Various accessories are available for use with the Model NM-17/27 as signal pickup devices. Typical among these are the two antennas and the three RF current probes described in the paragraphs that follow. The antennas consist of a rod antenna and a loop antenna and are used for radiated signal measurements. The RF current probes are used for measuring RF currents appearing on cables or conductors, such as: power lines, and signal and control lines.

4.4.1 Loop Antenna, Model 94593-1

The Model 94593-1 Loop Antenna/Coupler is a collapsible assembly consisting of the antenna coupler, mast section, three arms, and a length of modified coaxial cable that forms the loop. The antenna coupler matches the impedance of the loop to the 50-ohm input impedance of the Model NM-17/27 in each of the eight bands.

The loop should be assembled as follows:

a. Insert the mast section of the antenna in the receptacle on the top of the coupler.

b. Install the three supporting arms into the holes in the mast section, aligning the slots at the ends of the arms in the plane of the loop.

c. Insert the modified coaxial cable (used to form the loop) in the slots in the arms and connect the cable ends to the BNC receptacles on the top of the coupler.

The Loop Antenna/Coupler can be mounted directly on the Model 91933-2 Tripod by turning the tripod center screw into the mating tapped hole in the base of the coupler. The loop may be rotated to any azimuth setting around the vertical axis of the tripod. The maximum signal intensity pickup for vertically polarized signals (in the far field) is obtained when the plane of the loop is vertical and in line with the signal source.

Connect the Loop Antenna/Coupler RF OUTPUT receptacle to the Model NM-17/27 RF INPUT receptacle using the Model 92191-1 RF Transmission Line. For automatic switching of the eight bands by the Model NM-17/27, connect the Model 94594-1 Antenna Control Cable between the Loop Antenna/Coupler and the PROGRAMMER receptacle on the rear panel of the Model NM-17/27, and rotate the Loop Antenna/Coupler BAND (MHz) switch to the AUTO position. Manual band switching may be accomplished by providing 12 V across the two banana plug terminals mounted on the side of the antenna coupler case and rotating the BAND (MHz) switch on the Loop Antenna/Coupler to the desired frequency range.

CAUTION

Do not use the Model 94594-1 Antenna Control Cable during manual band switch operation because the 12 V across the banana plugs may interfere with the Model NM-17/27 circuitry.

Each Loop Antenna/Coupler is individually calibrated and antenna correction factors (ACF) versus frequency curves are provided in the Calibration Charts (P/N 1-403550-001) supplied with Model NM-17/27 equipment. The ACF's are in dB values which are added to Model NM-17/27 meter indications when calculating RF field strength in terms of dB referred to 1 uV/meter.

4.4.2 Antenna Coupler, Model 94592-1, and Rod Antenna, Model 92197-3

The Model 92197-3 41-inch telescopic Rod Antenna must be attached to the insulated TNC receptacle on top of the Model 94592-1 Antenna Coupler and extended to its maximum length during use. The Rod Antenna and Antenna Coupler may be attached to the Model 92199-3 Ground Plane by two 8-32 screws through the Ground Plane, into the base of the Antenna Coupler.

The Ground Plane may be mounted on the Model 91933-2 Tripod or placed on the ground. For screen room use, mount on the Tripod and connect the Ground Plane to the screen room ground or as directed by the measurement specification. For RF field strength measurements the

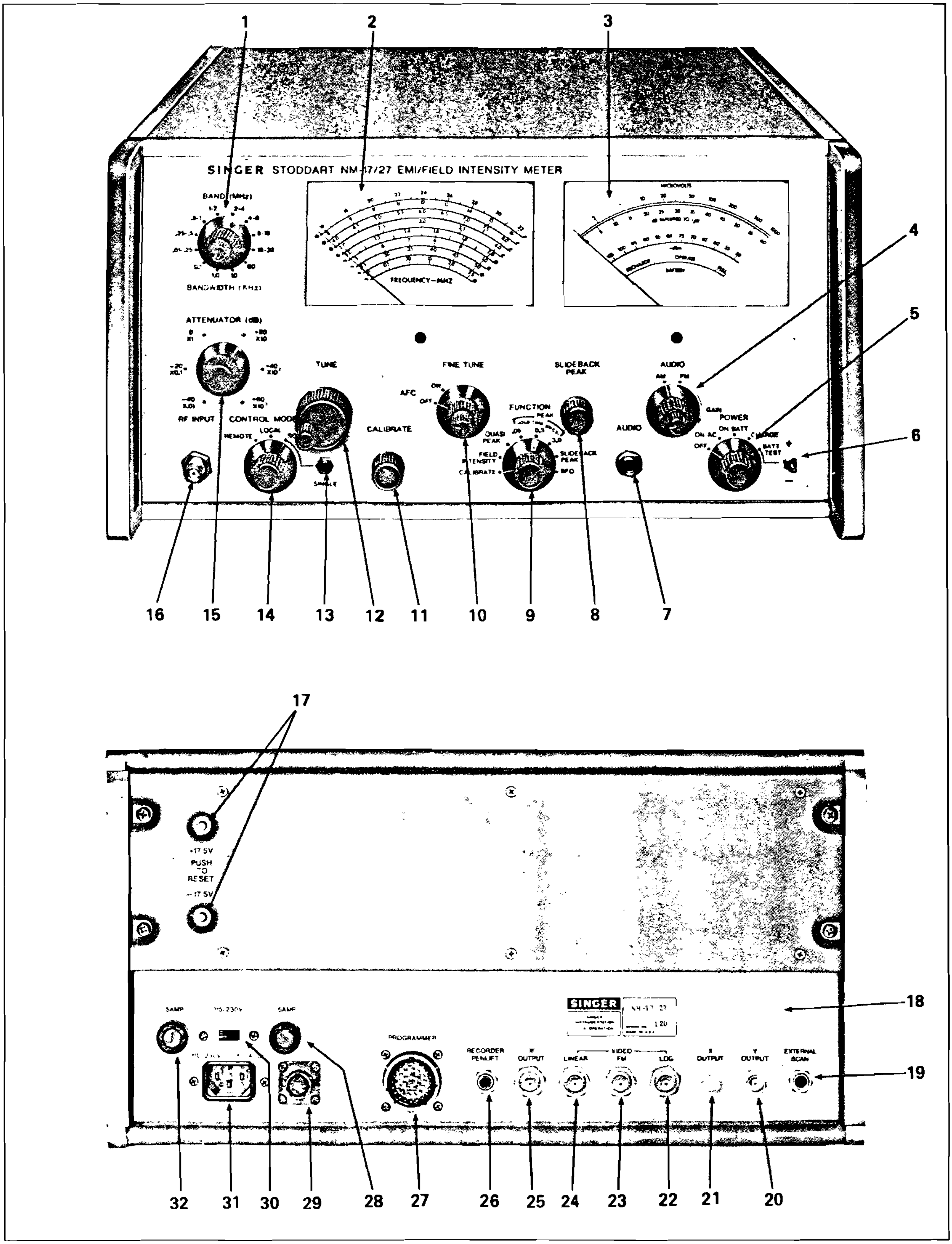


Figure 4-1. Operating Controls, Indicators, and Receptacles, Model NM-17/27

Table 4-1. Controls, Indicators and Receptacles

(Keyed to Figure 4-1)

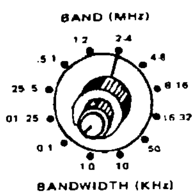
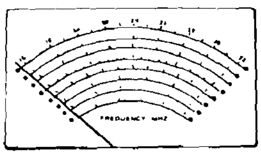
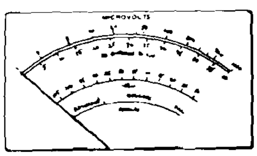
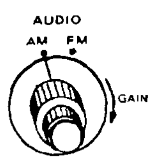
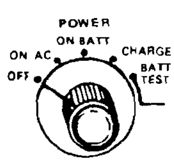
Item	Panel Marking	Description	Function
1		4-position rotary switch (inner knob) (S3)	Provides selection of four calibrated bandwidths of 0.1 kHz, 1.0 kHz, 10 kHz and 50 kHz.
		8-position rotary switch (outer knob) (S2)	Provides selection of appropriate RF tuner and IF circuit for the frequency band desired. Also causes the red indicators on the selected band scale of the Frequency meter to illuminate.
2		Frequency meter (A47)	Provides eight scales to indicate frequency from 10 kHz to 32 MHz. A pair of red indicators are illuminated on the frequency scale in use.
3		Output meter (A46)	Provides display of logarithmic microvolt scale from 1 to 1000 uV, a linear dB scale from 0 to 60 dB referred to 1 uV, and a linear dBm scale from –107 to –47 dB referred to 1 milliwatt. An additional scale displays the charge condition of the batteries when the POWER switch is set at CHARGE or BATT TEST position and the BATT TEST switch is set at + or – position. Although this meter has no panel designation, it will be referred to as the Output meter throughout this manual.
4		Variable resistor (inner knob) (R4)	Provides adjustment of the audio output level.
		2-position rotary switch (outer knob) (S7)	Provides selection of AM or FM audio for output at AUDIO receptacle.
5		5-position rotary switch (S9)	Provides selection of the following power-related functions: <u>OFF</u> – Disconnects power source. <u>ON AC</u> – Operates equipment from ac line power and connects trickle charger to batteries. <u>ON BATT</u> – Operates equipment from internal batteries. <u>CHARGE</u> – Connects full output of battery charger to batteries and removes power from remainder of instrument. <u>BATT TEST</u> – Connects test circuit for checking charge condition of batteries.
6		2-position toggle switch (S11)	Provides selection of + or – batteries for test and display of condition on battery scale of Output meter when POWER switch is set to either CHARGE or BATT TEST.
7		Phone jack (J12)	Provides headphone audio output.
8		Variable resistor (R3)	Provides adjustment of the voltage to the slideback peak detector for an aural null indication.

Table 4-1. Controls, Indicators and Receptacles (Cont.)
(Keyed to Figure 4-1)

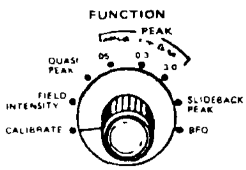
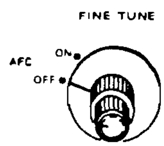
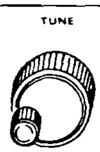
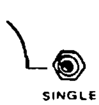
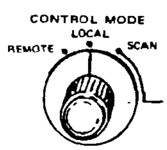
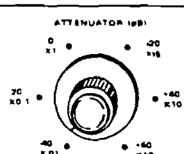
Item	Panel Marking	Description	Function
9		8-position rotary switch (S5)	Provides selection of the measurement functions as follows: CALIBRATE – Disconnects RF input and energizes impulse generator to standardize receiver gain. FIELD INTENSITY – Weights signal to permit measurement of average carrier values. QUASI-PEAK – Weights signal to permit measurement near the peak value of input signals. PEAK – Responds to peak value of signal. Three positions provide selectable hold time of 0.05, 0.3, and 3.0 seconds. SLIDEBACK PEAK – Applies manually controlled reverse bias to detector for slideback peak signal measurements with aural null indication. BFO – Activates beat frequency oscillator to permit audible reception of CW signals.
10		Variable resistor (inner knob) (R2)	Provides control of fine tuning of the EMI/FI Meter when the AFC switch is at OFF position.
		2-position rotary switch (outer knob) (S6)	Provides selection of automatic frequency control.
11		Variable resistor (R6)	Provides adjustment of the IF gain of EMI/FI Meter.
12		Variable resistor (R1)	Provides tuning of EMI/FI Meter in the selected band.
13		Momentary pushbutton switch (S8)	Provides initiation of a single 60-second scan of the frequency band in use when the CONTROL MODE switch is in the SCAN position.
14		3-position rotary switch (S1)	Provides selection of local or remote control of band selection, frequency tuning, bandwidth selection, detector function, and receiver gain. In the SCAN position the internal frequency scanning circuits are enabled.
15		6-position rotary switch (S4)	Provides selection of 100 dB attenuation to be inserted in 20 dB steps.
16		BNC receptacle (J1)	Provides RF signal input.
17	+17.5 V PUSH TO RESET –17.5 V	Circuit breakers (A44CB1) (A44CB2)	Provides protection of internal batteries from overload. Press to reset.
18		BNC receptacles (8)	Provide LO option outputs.

Table 4-1. Controls, Indicators and Receptacles (Cont.)

(Keyed to Figure 4-1)

Item	Panel Marking	Description	Function
19	EXTERNAL SCAN	Phone jack (J8)	Provides frequency scan voltage input from external source when CONTROL MODE switch is at SCAN position.
20	Y OUTPUT	BNC receptacle (J11)	Provides a dc voltage representing signal level.
21	X OUTPUT	BNC receptacle (J6)	Provides a dc voltage representing frequency in each band.
22	VIDEO – LOG	BNC receptacle (J3)	Provides detected video output of log IF amplifier.
23	VIDEO – FM	BNC receptacle (J2)	Provides detected video output of FM discriminator.
24	VIDEO – LINEAR	BNC receptacle (J10)	Provides detected video output of linear IF amplifier.
25	IF OUTPUT	BNC receptacle (J4)	Provides 455 kHz IF output for application to auxiliary signal processing equipment.
26	RECORDER PENLIFT	Phone jack (J7)	Provides output for X–Y recorder pen lift control; used in conjunction with electronic scanning.
27	PROGRAMMER	41 pin receptacle (J9)	Provides remote control input for programmable functions. See table 5-1 for details.
28	.5 AMP .25 AMP	Fuse (F1)	Provides ac line fuse. Use 0.5 ampere fuse for 115 V operation and 0.25 ampere fuse for 230 V operation.
29	AUX PWR	6 pin receptacle (J14)	Provides power output for Model SCU-7.
30	115V 230V	Slide switch (S10)	Provides selection of power line voltage available – 115 V or 230 V.
31	115–230V 50–400 Hz	3-pin receptacle (J5)	Provides ac power input.
32	.5 AMP .25 AMP	Fuse (F2)	Provides ac line fuse. Use 0.5 ampere fuse for 115 V operation and 0.25 ampere fuse for 230 V operation.

Ground Plane is not large enough to constitute a true signal ground. The ground plane may be enlarged by attaching a network of radial wires or equivalent conductors. Up to 24 radial wires may be attached to the ground plane and the length of each wire must equal, or exceed, the physical height of the antenna. The Rod Antenna correction factors are more accurate when a true signal ground is used.

Connect the Antenna Coupler RF OUTPUT receptacle to the Model NM-17/27 RF INPUT receptacle using the Model 92191-1 RF Transmission Line. For automatic switching of the eight bands by the Model NM-17/27, connect the Model 94594-1 Antenna Control Cable between the Antenna Coupler and the PROGRAMMER receptacle on the rear panel of the Model NM-17/27, and rotate the Antenna Coupler BAND (MHz) switch to the AUTO position. Manual band switch operation may be accomplished by providing 12 V across the two banana plug terminals mounted on the side of the Antenna Coupler case and rotating the BAND (MHz) switch to the desired frequency range.

CAUTION

Do not use the Model 94594-1 Antenna Control Cable during manual band switch operation because the 12 V may interfere with the Model NM-17/27 circuitry.

Each Rod Antenna and Antenna/Coupler is individually calibrated and antenna correction factor (ACF) versus frequency curves are provided in the Calibration Charts (P/N 1-403550-001) supplied with the Model NM-17/27 equipment. The ACF's are in dB values which are to be added to the Model NM-17/27 Output meter indications when calculating RF field strength in terms of dB referred to 1 uV/meter.

4.4.3 Antenna Coupler, Model 94592-1 (for High Impedance Measurements)

The Model 94592-1 Antenna Coupler may be used for performing two-terminal high impedance measurements. Connect the Model 94592-1 Antenna Coupler RF OUTPUT receptacle to the Model NM-17/27 RF INPUT receptacle using the Model 92191-1 RF Transmission Line. Add the Banana to BNC Adapter (P/N 1-910210-001) to the banana jack receptacles on the top of the Antenna Coupler. Connect signal sources to be measured to the BNC jack on the Adapter. The Model 94592-1 Antenna Coupler must be switched to frequency of measurement either automatically or manually as detailed in Paragraph 4.4.2.

CAUTION

The peak input voltage applied to the Antenna Coupler high impedance terminals must not exceed 500 volts dc.

Signal levels in dB referred to 1 uV may be calculated by adding a dB correction factor to the sum of the Output meter indication in dB and the ATTENUATOR setting in dB. The correction factor is provided in the Calibration Charts (P/N 1-403550-001) supplied with Model NM-17/27 equipment. Refer to the vertical scale on the left side of ACF chart for the Model 94592-1 Antenna Coupler.

4.4.4 Loop Probe, Model 90799-3

The Loop Probe is used primarily in localizing electromagnetic leakage and may be used over the full frequency range of the Model NM-17/27. Its main advantage is that it can be used in areas where limited accessibility prevents the use of other signal pickup devices. Since the loop probe housing is insulated, it may be safely used as a hand-held probe in close proximity to the signal source. The maximum signal intensity pickup for vertically polarized signals is obtained when the plane of the loop is vertical and in line with the signal source. The loop probe is coupled to the Model NM-17/27 RF INPUT RECEPTACLE using the Model 92191-1 RF Transmission Line.

Antenna correction factors are not provided for the loop probe because it is intended for relative indications, rather than absolute signal level measurement.

4.4.5 RF Current Probes, Models 91550-1, 91550-2 and 91197-1

These Current Probes are clamp-on types of RF current transformers useable in the frequency range of the Model NM-17/27. These probes may be clamped around a conductor (or group of conductors) having a maximum diameter of 1-¼ inches. The Current Probe is coupled to the Model NM-17/27 RF INPUT receptacle using the Model 92191-1 RF Transmission Line. Instruction Manuals containing individual calibrated transfer impedance curves and full instructions for use are provided with each RF Current Probe.

The individual current probe features are:

Model 91550-1 – Has a maximum transfer impedance of 5.5 ohms that provides best sensitivity from 50 kHz to 100 MHz. Can tolerate up to 350 amperes dc or 350 amperes, 50 Hz to 1500 Hz, ac current before core saturation affects RF measurements.

Model 91550-2 – Same as Model 91550-1 except internally loaded and compensated to provide a substantially constant transfer impedance of one ohm from 150 kHz to 150 MHz. (0 dB above one ohm) Can tolerate up to 350 amperes dc or 50 Hz to 400 Hz ac current before internal load reaches thermal limit.

Model 91197-1 – Has a maximum transfer impedance of 0.33 ohms that is substantially constant from 5 kHz to 2 MHz. Can tolerate up to 350 amperes dc or 350 amperes, 50 Hz to 1500 Hz, ac current before core saturation affects RF measurements.

4.5 MAXIMUM SAFE INPUT LEVELS

To avoid possible damage to the input circuits of the Model NM-17/27, the input signal level measured at the RF INPUT receptacle must not exceed the limits set forth in Table 4-2.

Table 4-2. Maximum Safe Input Levels

Signal Type	ATTENUATOR Switch Position	Limit at RF INPUT Receptacle
Dc or peak	Any	±400V
Ac (to 70 Hz)	Any	230 V rms
Ac (to 400 Hz)	Any	115 V rms
Impulsive	Any	1.0V/MHz (+120 dBuV/MHz)
CW	+20,+40,+60dB	0.25 watt (+27 dBm)
	–40, –20, 0 dB	0.02 watt (+13 dBm)

4.6 GAIN CALIBRATION (GAIN STANDARDIZATION)

The Model NM-17/27 may be calibrated (gain standardized) at the desired measurement frequency as follows:

a. Set the FUNCTION switch to the CALIBRATE position and the CONTROL MODE switch to the LOCAL position.

NOTE

When the FUNCTION switch is in the CALIBRATE position, the ATTENUATOR (dB) switch and the BANDWIDTH (kHz) switch are automatically disabled and may be left in any position.

b. Obtain the proper calibration figure for the specific frequency band in use from the Calibration Charts (P/N 1-403550-001) supplied with the Model NM-17/27 equipment.

c. Adjust the CALIBRATE control so the Output meter indicates the correct calibration figure on the dB REFERRED TO 1 uV scale.

d. Return the FUNCTION switch to its original position.

4.7 NARROWBAND SIGNAL MEASUREMENTS

A narrowband (NB) signal is defined as a signal having a spectral power distribution that is narrow compared to the 6 dB bandwidth of the Model NM-17/27. The following signals are classified as NB:

a. Continuous wave (CW) or unmodulated carrier.

NOTE

This equipment is calibrated in terms of rms of a sine wave (0.707 of true peak of a sine wave) for any detector function selected by the FUNCTION switch. Therefore, for unmodulated RF carriers the FIELD INTENSITY (FI), QUASI-PEAK (QP), DIRECT PEAK (DP), and SLIDEBACK PEAK (SP) detector functions will provide identical Output meter readings. This is in accordance with the instrument design criteria set forth in EMI measurement specifications.

b. Amplitude modulated (AM) or single sideband (SSB) modulated carrier.

c. Frequency modulated (FM) carrier, depending upon the bandwidth of the Model NM-17/27.

NOTE

Theoretically, an FM signal produces an infinite number of sidebands and would not qualify as an NB signal. The bandwidth of the significant sidebands, however, is approximately $2(\Delta f+f_m)$, where Δf = peak frequency deviation and f_m = modulation frequency. If $2(\Delta f+f_m)$ is less than the 6 dB bandwidth of the receiver in use, for measurement purposes the FM signal may be considered as NB.

4.7.1 Selection of Bandwidth

In the examples for narrowband signal measurement outlined in the following paragraphs, a 10 kHz bandwidth is recommended for ease of tuning. However, any of the four bandwidths may be used for narrowband signal measurement at the discretion of the operator. Use of a narrower bandwidth provides greater CW signal sensitivity. For example, using the 100 Hz bandwidth, the Model NM-17/27 CW signal sensitivity is approximately 20 dB better than with the 10 kHz bandwidth, and approximately 27 dB better than with the 50 kHz bandwidth.

NOTE

The 50 kHz bandwidth is specified only for frequencies above 250 kHz; however, it may be used at lower frequencies with reduced measurement accuracy. Below a signal frequency of approximately 70 kHz for the 50 kHz bandwidth and 20 kHz for the 10 kHz bandwidth, RF tuner local oscillator leakage causes a signal-like indication on the Output meter.

4.7.2 Field Intensity Measurements

Conducted or radiated NB signals may be measured in terms of the rms value of the average carrier levels. Perform the measurements as in the following steps:

a. Connect the appropriate pickup device to the RF INPUT receptacle of the Model NM-17/27.

b. Set the FUNCTION switch to the FIELD INTENSITY position, the BANDWIDTH (kHz) switch to the 10 kHz position, and the AFC switch to the OFF position.

c. Tune the Model NM-17/27 for maximum response to the signal as indicated by the maximum indication of the Output meter, adjusting the ATTENUATOR (dB) switch as necessary to maintain the meter indication in the upper portion of the scale. Rotate the TUNE control back and forth; also use the FINE TUNE control to maximize the meter indication. Set the AFC switch to the ON position, if desired, to lock the instrument to the signal. Note the signal frequency.

NOTE

When a sine wave signal is being measured in the FIELD INTENSITY function in the presence of internal receiver noise or ambient interference of random nature, it is possible to determine the actual value of the signal with Chart 3 of the supplied Calibration Charts (P/N 1-403550-001).

d. Calibrate the instrument as described in Paragraph 4.6.

e. Note the Output meter indication on the scale of the units of measurement desired (microvolts, dB referred to 1 uV, or dBm).

f. Multiply the meter indication noted in Step e in microvolts by the ATTENUATOR factor (X 0.01 to X 1000) for a measurement in terms of microvolts across 50 ohms. Algebraically add the ATTENUATOR setting in dB (−40 to +60 dB) to the meter indication in dB to obtain the input signal level in terms of dB referred to 1 uV across 50 ohms. Algebraically add the ATTENUATOR setting in dB to the meter indication in dBm to obtain the input signal level in terms of dBm.

g. No further calculations are necessary for two-terminal RF voltage measurements across 50 ohms.

h. Refer to Paragraph 4.10 for calculation of signal levels when using pickup devices.

4.7.3 Quasi-Peak Measurements

Conducted or radiated NB signals having a relatively fast repetition frequency may be measured in terms of weighted rms values as in the following:

a. Connect the appropriate pickup device to the RF INPUT receptacle of the Model NM-17/27.

b. Set the FUNCTION switch to the QUASI-PEAK position, the BANDWIDTH (kHz) switch to the 10 kHz position, and the AFC switch to the OFF position.

c. Tune the Model NM-17/27 for maximum response to the signal as indicated by maximum indication of the Output meter, adjusting the ATTENUATOR (dB) switch as necessary to maintain the meter indication in the upper portion of the scale. Rotate the TUNE control back and forth; also use the FINE TUNE control to maximize the meter indication. Set the AFC switch to the ON position, if desired, to lock the instrument to the signal. Note the signal frequency.

d. Calibrate the instrument as described in Paragraph 4.6.

e. Note the Output meter indication on the scale of the units of measurement desired (microvolts, dB referred to 1 uV, or dBm).

f. Multiply the meter indication noted in Step e in microvolts by the ATTENUATOR factor (X 0.01 to X 1000) for a measurement in terms of microvolts across 50 ohms. Algebraically add the ATTENUATOR switch setting in dB (−40 to +60 dB) to the meter indication in dB to obtain the input signal level in terms of dB referred to 1 uV across 50 ohms. Algebraically add the ATTENUATOR switch setting in dB to the meter indication in dBm to obtain the input signal level in terms of dBm.

g. No further calculations are necessary for two-terminal RF voltage measurements across 50 ohms.

h. Refer to Paragraph 4.10 for calculation of signal levels when using pickup devices.

4.7.4 Peak Measurements

Conducted or radiated NB signals may be measured in rms values as in the following:

NOTE

The peak function is the best detector to use in the search for presence of signals because of its extremely fast response time. In the absence of signals, the Output meter will smoothly fluctuate with the rotation of the TUNE control. Interception of a signal, however, will cause the Output meter to rise sharply.

a. Connect the appropriate pickup device to the RF INPUT receptacle of Model NM-17/27.

b. Set the FUNCTION switch to the PEAK/0.05 SEC HOLD TIME position, the BANDWIDTH (kHz) switch to the 10 kHz position, and the AFC switch to the OFF position.

c. Tune the Model NM-17/27 for maximum response to the signal as indicated by maximum indication of the Output meter. Set the ATTENUATOR (dB) switch as necessary to maintain the meter indication in the upper portion of the scale. Rotate the TUNE control back and forth; also use FINE TUNE control to maximize the meter indication. Set the AFC switch to the ON position, if desired, to lock the instrument to the signal. Note the signal frequency.

d. Calibrate the instrument as described in Paragraph 4.6.

e. Note the Output meter indication on the scale of the units of measurement desired (microvolts, dB referred to 1 uV, or dBm).

f. Multiply the meter indication noted in Step e in microvolts by the ATTENUATOR factor (X 0.01 to X 1000) for a measurement in terms of microvolts across 50 ohms. Algebraically add the ATTENUATOR setting in dB (−40 to +60 dB) to the meter indication in dB to obtain the input signal level in terms of dB referred to 1 uV across 50 ohms. Algebraically add the ATTENUATOR setting in dB to meter indication in dBm to obtain the input signal level in terms of dBm.

g. No further calculations are necessary for two-terminal RF voltage measurements across 50 ohms.

h. Refer to Paragraph 4.10 for calculation of signal levels when using pickup devices.

4.7.5 Slideback Peak Measurement

Conducted or radiated NB signals may be measured in rms values using the aural null indication as in the following:

a. Connect the appropriate pickup device to the RF INPUT receptacle of the Model NM-17/27.

b. Set the FUNCTION switch to the PEAK/0.3 SEC HOLD TIME position, the BANDWIDTH (kHz) switch to the 10 kHz position, and the AFC switch to the OFF position.

c. Tune the Model NM-17/27 for maximum response to the signal in the FIELD INTENSITY mode as indicated by maximum indication of the Output meter, setting ATTENUATOR switch as necessary to maintain the meter deflection in the upper portion of the scale. Rotate the TUNE control back and forth; also use the Fine Tune control to maximize meter indication. Set switch back to the PEAK/0.3 SEC HOLD TIME mode. Set the AFC switch to the ON position, if desired, to lock the instrument to the signal. Note the signal frequency.

d. Calibrate the instrument as described in Paragraph 4.6.

e. Set the FUNCTION switch to the SLIDEBACK PEAK position and rotate SLIDEBACK PEAK control fully counterclockwise.

f. Connect a set of headphones to the AUDIO receptacle. Set the AUDIO switch to the AM position, and adjust the AUDIO GAIN control to the desired sound level.

g. Rotate the SLIDEBACK PEAK control slowly clockwise until the signal in the headphones is cut off. Note the Output meter indication at this threshold level.

h. Multiply the meter indication noted in Step e in microvolts by the ATTENUATOR factor (X 0.01 to X 1000) for a measurement in terms of microvolts across 50 ohms. Algebraically add the ATTENUATOR setting in dB (−40 to +60 dB) to the meter indication in dB to obtain the input signal level in terms of dB referred to 1 uV across 50 ohms. Algebraically add the ATTENUATOR setting in dB to the meter indication in dBm to obtain the input signal level in terms of dBm.

i. No further calculations are necessary for two-terminal RF voltage measurements across 50 ohms.

j. Refer to Paragraph 4.10 for calculation of signal levels when using pickup devices.

4.8 BROADBAND SIGNAL MEASUREMENTS

Broadband (BB) signals are defined as those having a spectral power distribution that is broad compared to the impulse bandwidth of the Model NM-17/27. Broadband interference may be considered as being composed of short pulses, the pulse repetition frequency determining the character of the interference.

If the pulses are clearly separated, the interference is termed impulsive. Such interference is generated by motor brush sparking and by internal combustion engine ignition circuits. If the pulses are not clearly distinguishable and overlap, the interference is termed random. A good example of this is thermal noise.

Following is a list of signals, classified as broadband:

a. Pulse modulated CW (depending on receiver bandwidth)

b. Random noise

c. Impulsive noise from motor brushes

d. Impulsive noise from internal combustion engine ignition circuits

e. Corona discharge

4.8.1 Selection of Bandwidth

For a given broadband impulse signal level at the RF INPUT receptacle of the Model NM-17/27 the peak detected output varies directly with impulse bandwidth. Therefore, the wider bandwidths of 50 kHz and 10 kHz are preferred because of their greater response and better sensitivity to weak broadband signals. Because of the large range of bandwidths provided, from 50,000 Hz to 100 Hz (corresponding to a 500 to 1 response ratio), RF tuner overload occurs when using the 100 Hz and 1 kHz bandwidths for some combinations of ATTENUATOR settings and Output meter indications. See Figure 4-2 which displays the point of overload for various combinations of bandwidths, ATTENUATOR settings and Output meter indications available on the Model NM-17/27. Note that with the 50 kHz bandwidth and PEAK detection there is no possibility of overload for an on-scale Output meter indication for any combination of parameters. The 10 kHz bandwidth is also typically free from overload problems, although close to marginal under conditions of the worst combination. The 100 Hz and 1 kHz bandwidths may be used at Output meter indication levels, generally, less than full-scale, as dictated by Figure 4-2.

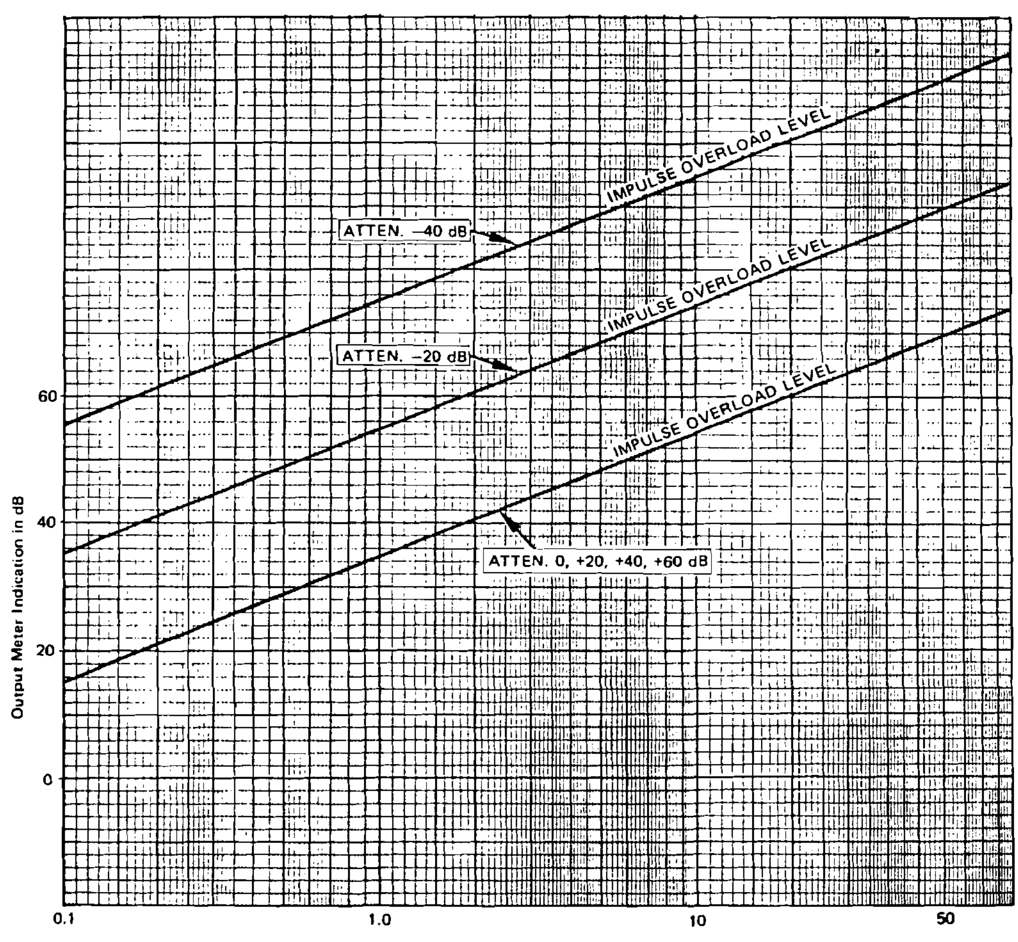


Figure 4-2. Selection of Broadband Bandwidths Chart

NOTE

The 50 kHz bandwidth is not specified at frequencies in Band 1 because of RF bandwidth constriction effects and reduction in sensitivity due to local oscillator feedthrough.

4.8.2 Peak Measurements

Measure the peak value of conducted or radiated BB signals in terms of rms as in the following steps:

a. Connect the appropriate input device to the RF INPUT receptacle of the Model NM-17/27.

b. Set the FUNCTION switch to the PEAK/0.3 SEC HOLD TIME position, the BANDWIDTH (kHz) switch to the 10 kHz position, and the AFC switch to the OFF position.

c. Tune the Model NM-17/27 to the broadband signal, as indicated by maximum deflection of the Output meter. Set the ATTENUATOR (dB) switch for an indication in the upper position of the scale. Precise tuning is not possible for random or impulsive signals, but the interference level may be measured at any frequency within the spectral range of the signal. Note the frequency of measurement.

d. Calibrate the instrument as described in Paragraph 4.6.

e. Multiply the meter indication in microvolts by the ATTENUATOR switch factor (X 0.01 to X 1000) and by 100 (bandwidth ratio, 1 MHz/10 kHz) to obtain the signal level in microvolts per MHz (uV/MHz). Add the ATTENUATOR switch setting in dB to the meter indication in dB and add 40 dB to obtain the signal level in dB referred to I uV/MHz (dBuV/MHz).

NOTE

If the 1.0 kHz bandwidth is used, bandwidth ratio becomes 1000:1 or 60 dB. If the 50 kHz bandwidth is used, the bandwidth ratio becomes 20:1 or 26 dB.

f. Refer to Paragraph 4.10 for calculation of signal levels.

4.8.3 Quasi-Peak Measurements

Measure the weighted value of conducted or radiated BB signals in terms of rms as follows:

a. Connect the appropriate input device to the RF INPUT receptacle of the Model NM–17/27.

b. the Set FUNCTION switch to the QUASI-PEAK position, the BANDWIDTH switch to 10 kHZ position, and the AFC switch to the OFF position.

c. Tune the Model NM-17/27 to the broadband signal, indicated by maximum deflection of the Output meter. Set the ATTENUATOR switch for an indication in the upper portion of the scale. Precise tuning is not possible for random or impulsive signals, but the interference level may be measured at any frequency within the spectral range of the signal. Note the frequency of measurement.

d. Calibrate the instrument as described in Paragraph 4.6.

e. Multiply the meter indication in microvolts by the ATTENUATOR switch factor (X 0.01 to X 1000) and by 100 (bandwidth ratio, 1 MHz/10 kHz) to obtain the signal level in microvolts per MHz (uV/MHz). Add the ATTENUATOR switch setting in dB to the meter indication in dB and add 40 dB to obtain the signal level in dB referred to 1 uV/MHz (dBuV/MHz).

NOTE

If the 1.0 kHz bandwidth is used, the bandwidth ratio becomes 1000:1 or 60 dB. If the 50 kHz bandwidth is used, the bandwidth ratio becomes 20:1 or 16 dB.

f. Refer to Paragraph 4.10 for calculation of signal levels.

4.8.4 Slideback Peak Measurements

Measure the peak value of conducted or radiated BB signals in terms of rms using the aural null indication as follows:

a. Connect the appropriate pickup device to the RF INPUT receptacle of the equipment.

b. Set the FUNCTION switch to the PEAK/0.3 SEC HOLD TIME position, the BANDWIDTH switch switch to the 1.0 MHz position, and the AFC switch to OFF position.

c. Tune the Model NM-17/27 to the broadband signal, indicated by maximum deflection of the Output meter. Set the ATTENUATOR switch for an indication in the upper portion of the scale. Precise tuning is not possible for random or impulsive signals, but the interference level may be measured at any frequency within the spectral range of the signal. Note the frequency of measurement.

d. Calibrate the instrument as described in Paragraph 4.6.

e. Set the FUNCTION switch to the SLIDEBACK PEAK position and rotate the SLIDEBACK control fully counterclockwise.

f. Connect a set of headphones to the AUDIO receptacle. Set the AUDIO switch to the AM position, and rotate the AUDIO GAIN control to the desired sound level.

g. Rotate the SLIDEBACK PEAK control slowly clockwise until the signal in the headphones is cut off. Note the Output meter indication at this threshold level.

h. Multiply the meter indication in microvolts by the ATTENUATOR switch factor (X 0.01 to X 1000) and by 100 (bandwidth ratio, 1 MHz/10 kHz) to obtain the signal level in microvolts per MHz (uV/MHz). Add the meter indication in dB to the ATTENUATOR switch setting in dB and add 40 dB to obtain the signal level in dB referred to 1 uV/MHz (dBuV/MHz).

NOTE

If the 1.0 kHz bandwidth is used, the bandwidth ratio becomes 1000:1 or 60 dB. If the 50 kHz bandwidth is used, the bandwidth ratio becomes 10:1 or 26 dB.

i. Refer to Paragraph 4.10 for calculation of signal levels.

4.9 DETERMINATION OF SIGNAL TYPES

To determine if the signal is narrowband, random noise or impulsive interference, when the Model NM-17/27 is accurately tuned to the signal frequency, change the BANDWIDTH switch from 10 kHz to 1.0 kHz. If the signal is narrowband, the meter deflection remains unchanged. If the signal is random noise, the meter deflection will decrease by approximately 10 dB. If the signal is impulsive, the meter deflection will decrease by approximately 20 dB.

A signal type of special interest is pulsed CW. Although classified as a broadband signal in military interference specifications, a pulsed CW signal has some characteristics that resemble narrowband signals. For example, a CW pulse may be thought of as having a distinct carrier frequency much as an AM signal has. The spectral power distribution of a carrier modulated with a rectangular pulse in principle extends from the carrier frequency to infinity and to zero. The frequencies of the components are given by $f = f_c + nf_r$, where f_c = carrier frequency, f_r = pulse repetition frequency and n = 0, 1, 2, 3. . . The relative amplitude of the components is given by:

$$\frac{\sin 2\pi fT}{2\pi fT}$$

where T = pulse width.

Since the detector of the usual receiver ignores phase information, the actual spectral information available will show the absolute amplitude of the various components. A CW pulse train will have a wide spectral distribution with the first zero at 1/T on each side of the carrier frequency and zero recurring at 1/T intervals as far on each side of the carrier as the power is detectable. Actual pulses are never rectangular and the spectral distribution is somewhat different from the ideal case, the exact spectral envelope being determined by the nature of the pulse shape. An oscilloscope may also be used to determine if the signal is random or impulsive by connecting the LINEAR VIDEO receptacle to the oscilloscope. In the case of random noise, "grass" will be displayed on the oscilloscope. In the case of an impulsive signal, individual pulses will be displayed on the oscilloscope. The audio output available in the headphones also helps to determine the nature of the interference. Random noise yields a hissing sound, and impulsive interference results in a popping sound.

4.10 SIGNAL LEVEL CALCULATIONS

Typical methods for calculating signal levels of radiated and conducted RF interference in various units of measurement are described in the following paragraphs.

NOTE

If a coaxial cable of such length that insertion losses are significant is used to connect a signal pickup device to Model NM-17/27 during measurements, the loss factor of the cable should be determined at the test frequency and included in the following calculations.

4.10.1 Calculation of Conducted NB Interference (50-ohm Direct Connection)

When the Model NM-17/27 is used as a two-terminal RF microvoltmeter and connected across a 50-ohm signal source; the measurement procedures given in Paragraph 4.7.2 thru 4.7.5 yield signal levels in microvolts or in dB referred to 1 uV and no further calculations are necessary.

4.10.2 Calculation of Conducted NB Interference (High Impedance Connection)

When the Model NM-17/27 is used as a high impedance two-terminal RF microvoltmeter with Model 94592-1 Antenna Coupler as described in Paragraph 4.4.3, use the measurement procedures given in Paragraphs 4.7.2 thru 4.7.5 for conducted measurements, then correct the measurement as follows:

a. Refer to Chart 1 of the Calibration Charts (P/N 1-403550-001) supplied with the Model NM-17/27.

b. Determine the Antenna Coupler two-terminal high impedance factor in dB at the frequency of measurement using the vertical scale on the left side of the chart.

c. Add the factor in dB of Step b to the RF signal imput level in dB referred to 1 uV as described in Paragraphs 4.7.2 thru 4.7.5.

d. To convert the signal level in dB referred to 1 uV to microvolts or millivolts, refer to Table 4-4 or Chart 4 of the Calibration Charts.

4.10.3 Calculation of Radiated NB Interference

To obtain the RF field strength in dB referred to one microvolt per meter (dBuV/m), the antenna correction factor (ACF) in dB for the particular antenna used in achieving the measurement must be *added* to the input signal level in dB obtained in Paragraphs 4.7.2 thru 4.7.5. Perform the calculation as follows:

a. Determine the RF signal input level in dB referred to 1 uV as described in Paragraphs 4.7.2 thru 4.7.5.

b. Determine the ACF in dB from the calibration chart for the antenna used at test frequency (refer to P/N #1-403550-001 Calibration Charts).

c. Algebraically add the results of Steps a and b to obtain the RF field strength of the radiated NB interference in dB referred to 1 uV/m.

d. To convert the signal level in dB referred to 1 uV/m to microvolts or millivolts per meter, refer to Table 4-4 or to Chart 4 of the Calibration Charts (P/N 1-403550-001).

4.10.4 Calculation of Conducted NB Interference Measured with the RF Current Probe

Signal levels of conducted NB interference may be computed in terms of dB referred to one microampere (dBuA) when the RF Current Probe is employed as a signal pickup device. The transfer impedance in dB referred to one ohm must be *subtracted* from the input signal level in dB obtained in Paragraphs 4.7.2 thru 4.7.5. Perform the calculation as follows:

a. Determine the RF signal input level in dB referred to 1 uV as described in Paragraphs 4.7.2 thru 4.7.5.

b. Determine the transfer impedance of the current probe in dB at the test frequency from the chart furnished with the Current Probe.

c. Algebraically *subtract* the transfer impedance figure obtained in Step b from the measured signal level in dB determined in Step a to obtain a value of the conducted NB interference in terms of dB referred to 1 uA in the test conductor.

NOTE

The transfer impedance in dB may have a positive or negative sign, depending upon whether it is above (positive) or below (negative) the one ohm reference. *Observe the sign* when subtracting in Step c.

d. To convert the signal level in dB referred to 1 uA into microamperes or milliamperes, refer to Table 4-3 or to Chart 4 of the Calibration Charts (P/N 1-403550-001) and substitute "A" for "V" in units provided in the table headings.

Table 4-3. Conversion of Units (Continued)

dB Referred to 1 μV	μV
−20	0.100
−19	0.112
−18	0.126
−17	0.141
−16	0.159
−15	0.178
−14	0.200
−13	0.224
−12	0.251
−11	0.282
−10	0.316
− 9	0.355
− 8	0.398
− 7	0.447
− 6	0.501
− 5	0.562
− 4	0.631
− 3	0.708
− 2	0.794
− 1	0.891
0	1.00
1	1.12
2	1.26
3	1.41
4	1.59
5	1.78
6	2.00
7	2.24
8	2.51
9	2.82
10	3.16
11	3.55
12	3.98
13	4.47
14	5.01
15	5.62

dB Referred to 1 μV	μV
16	6.31
17	7.08
18	7.94
19	8.91
20	10.00
21	11.20
22	12.60
23	14.30
24	15.90
25	17.80
26	20.00
27	22.40
28	25.10
29	28.20
30	31.60
31	35.50
32	39.80
33	44.70
34	50.10
35	56.20
36	63.10
37	70.80
38	79.40
39	89.10
40	100.00

dB Referred to 1 μV	mV
41	0.112
42	0.126
43	0.141
44	0.159
45	0.178
46	0.200
47	0.224
48	0.251
49	0.282
50	0.316
51	0.355
52	0.398
53	0.447
54	0.501
55	0.562
56	0.631
57	0.708
58	0.794
59	0.891
60	1.00
61	1.12
62	1.26
63	1.41
64	1.59
65	1.78
66	2.00
67	2.24
68	2.51
69	2.82
70	3.16

Table 4-3. Conversion of Units (Continued)

dB Referred to 1 μV	mV
71	3.55
72	3.98
73	4.47
74	5.01
75	5.82
76	6.31
77	7.08
78	7.94
79	8.91
80	10.00
81	11.20
82	12.60
83	14.10
84	15.90
85	17.80
86	20.00
87	22.40
88	25.10
89	28.20
90	31.60
91	35.50
92	39.80
93	44.70
94	50.10
95	56.20
96	63.10
97	70.80
98	79.80
99	89.10
100	100.00
dB Referred to 1 μV	**Volts**
101	0.112
102	0.126
103	0.141
104	0.159
105	0.178
106	0.200
107	0.224
108	0.251
109	0.282
110	0.316
111	0.355
112	0.398
113	0.447
114	0.501
115	0.562
116	0.631
117	0.708
118	0.794
119	0.811
120	1.000

4.10.5 Calculation of Conducted BB Interference (50-ohm Direct Connection)

When the Model NM-17/27 is used as a two-terminal RF microvoltmeter and connected across a 50-ohm signal source, the procedures given in Paragraphs 4.8.2 thru 4.8.4 provide signal levels in uV/MHz or in dB referred to 1 uV/MHz and no further calculations are necessary.

4.10.6 Calculation of Conducted BB Interference (High Impedance Connection)

When the Model NM-17/27 is used as a high impedance two-terminal RF microvoltmeter with Model 94592-1 Antenna Coupler as described in Paragraph 4.4.3, use the measurement procedures given in Paragraphs 4.8.2 thru 4.8.4 for conducted measurements, then correct the measurement as follows:

a. Refer to Chart 1 of the Calibration Charts (P/N 1-403550-001) supplied with the Model NM-17/27.

b. Determine the Antenna Coupler two-terminal high impedance factor in dB at the frequency of measurement using the vertical scale on the left side of the chart.

c. *Add* the factor of dB of Step b to the RF signal input level in dB referred to 1 uV/MHz as described in Paragraphs 4.8.2 thru 4.8.4.

d. To convert the signal level in dB referred to 1 uV/MHz to uV/MHz or mV/MHz, refer to Table 4-3 or to Chart 4 of the Calibration Charts.

4.10.7 Calculation of Radiated BB Interference

To obtain the RF field strength in dB referred to 1 uV/m/MHz, the ACF in dB for the antenna used must be added to the input signal level in dB obtained in Paragraphs 4.8.2 thru 4.8.4. Perform the calculation as follows:

a. Determine the RF signal input level in dB referred to 1 uV/MHz as described in Paragraphs 4.8.2 thru 4.8.4.

b. Determine the ACF in dB from Calibration Chart for antenna used at the test frequency (refer to Calibration Charts (P/N 1-403550-001).

c. Add the results of Steps a and b to obtain the RF field strength of the radiated BB interference in dB referred to 1 uV/m/MHz.

d. To convert the signal level in dB referred to 1 uV/m/MHz directly into uV/m/MHz or mV/m/MHz, refer to Table 4-3 or to Chart 4 of the Calibration Charts (P/N 1-403550-001).

4.10.8 Calculation of Conducted BB Interference Measured with the RF Current Probe

Signal levels of conducted BB interference as measured with the RF Current Probe may be computed in terms of dB referred to 1 microampere per MHz (dBuA/MHz). The transfer impedance in dB above or below one ohm must be *subtracted* from the input signal level in dB obtained in Paragraph 4.8.2 thru 4.8.4. Perform the calculation as follows:

a. Determine the RF signal input level in dB referred to 1 uV/MHz as described in Paragraphs 4.8.2 thru 4.8.4.

b. Determine the transfer impedance of the Current Probe in dB at the test frequency from the chart furnished with the Current Probe.

c. Algebraically *subtract* the transfer inpedance figure obtained in Step b from the measured signal level in dB determined in Step a to obtain the value of the conducted BB interference in terms of dB referred to 1 uA/MHz in the test sample conductor.

NOTE

The transfer impedance in dB may have a positive or negative sign, depending upon whether it is above (positive) or below (negative) the one ohm reference. *Observe the sign* when subtracting in Step c.

d. To convert the signal level in dB referred to 1 uA/MHz into uA/MHz or mA/MHz, refer to Table 4-3 or to Chart 4 of Calibration Charts (P/N 1-403550-001) and substitute "A" for "V" in the units provided in the table headings.

4.10.9 Calculation of Conducted Signal Levels in Picowatts

The methods described in Paragraphs 4.7.2 thru 4.7.5 are used to measure conducted NB signals in terms of uV or dB referred to 1 uV. Signal levels may also be expressed in picowatts, considering the 50 ohm input impedance of Model NM-17/27. If E is the RF signal level in uV, then the input power P in picowatts is: $P = \frac{E^2}{50}$.

Figure 4-3 is a graphical presentation of this equation providing the input signal in picowatts for any signal voltage from 1 uV to 1 V. Conducted NB signal levels may be also expressed in terms of dBm, (dB referred to 1 milliwatt). The RF signal level for 1 mW across 50 ohms is $(10^{-3} \times 50)^{1/2}$ = 0.223 V = 107 dB above 1 uV. To obtain the dBm value of a signal, subtract 107 dB from the signal measured in dB above 1 uV. This may be read directly from the dBm scale on the Output meter of the Model NM-17/27.

4.11 OPERATION WITH X–Y RECORDER

Signal amplitude may be plotted with respect to frequency, as in spectrum signature studies, by connecting an X–Y recorder to the Model NM-17/27. Any suitable X–Y recorder may be used that is compatible with the X–Y output characteristics of the Model NM-17/27 (refer to the specifications in Table 2-1). The X-output voltage of the Model NM-17/27 is proportional to the indicated frequency throughout each band, and the Y-output voltage is proportional to the signal level as indicated on the Output meter.

The internal scan feature of the Model NM-17/27 provides semiautomatic frequency tuning over each band in one minute, and also provides a contact closure during the scan period for use as a recorder pen lift control.

The instructions that follow are general and are intended as a guide for the particular test setup and X–Y recorder used. Proceed as follows:

a. Connect the X–Y cables (Model 90071-1) to the X–Y OUTPUT receptacles on the rear panel of the Model NM-17/27 and the corresponding input receptacles of the recorder.

b. Connect a suitable cable between the RECORDER PENLIFT phone jack on rear panel of the Model NM-17/27 and the appropriate receptacle on the recorder. A three-conductor phone plug (military type PJ-068 or equivalent) is required for the RECORDER PENLIFT connection.

c. Turn on the Model NM-17/27 and set the BAND (MHz) switch to the desired frequency range. Set the CONTROL MODE switch to the LOCAL position, the AFC switch to the OFF position, the BANDWIDTH switch to the 10 kHz position and the FUNCTION switch to the SLIDEBACK PEAK position.

d. Turn on and prepare the X–Y recorder for operation.

e. Rotate the TUNE control on the Model NM-17/27 to the low frequency end of the band in use and zero the recorder pen on the X-axis.

f. Temporarily disconnect the Y-axis to the recorder, and zero the recorder pen on the Y-axis. Reconnect the cable.

g. Rotate the TUNE control on the Model NM-17/27 to the high frequency end of the band in use. Adjust the recorder pen for full-scale deflection on the X-axis, then turn the TUNE control back to the low frequency end of the band.

h. Adjust the SLIDEBACK PEAK control on the Model NM-17/27 to obtain full-scale deflection of the Output meter. Adjust the recorder pen for full-scale deflection on the Y-axis, then turn the SLIDEBACK PEAK control back to the fully counterclockwise position.

i. Calibrate the Model NM-17/27 as described in Paragraph 4.6.

j. Connect the proper signal pickup device to the RF INPUT receptacle of the Model NM-17/27. Set the FUNCTION switch to the PEAK/0.3 SEC HOLD TIME position.

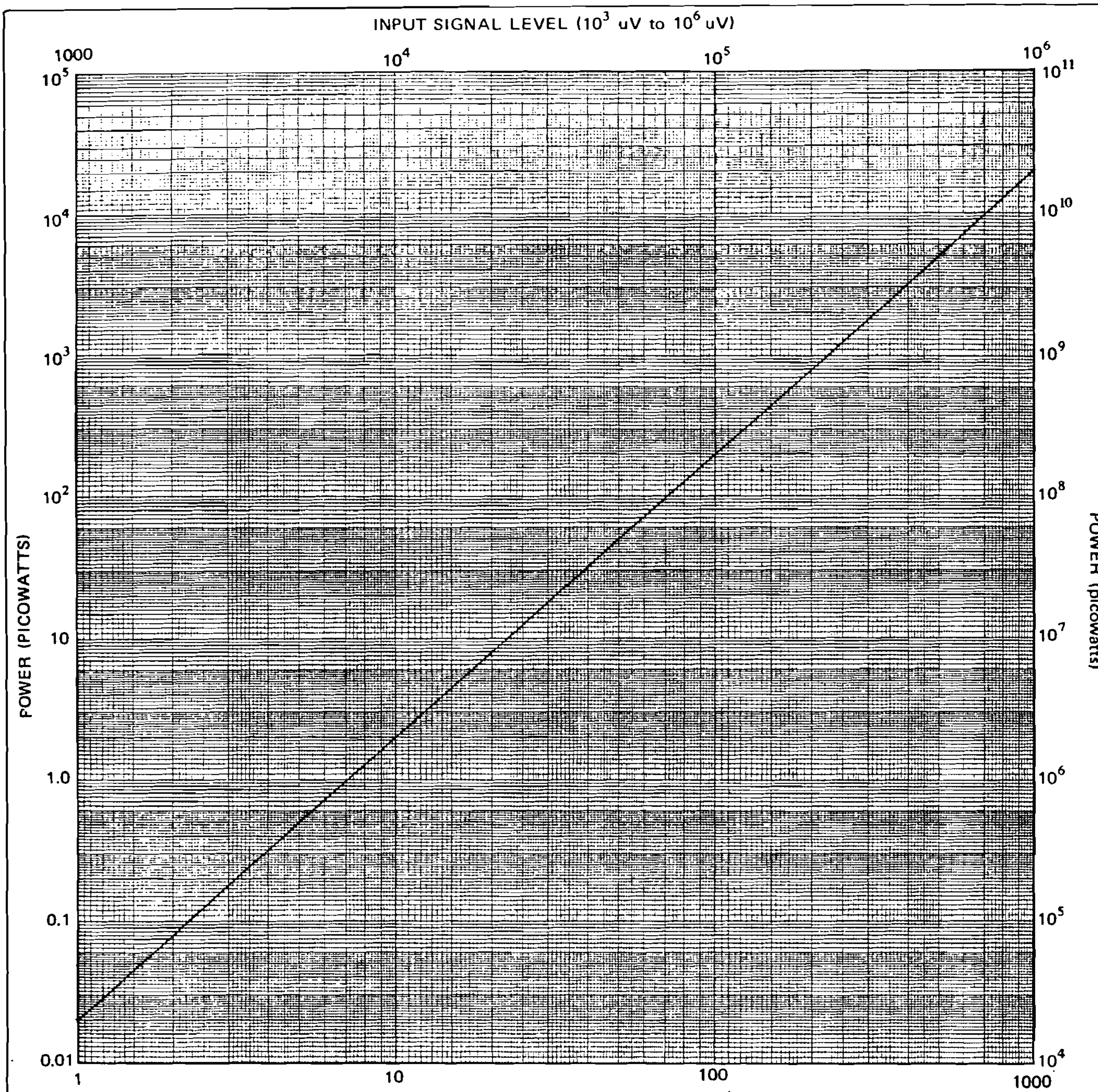
k. Tune the Model NM-17/27 slowly across the band in use and observe the Output meter deflection. Set the ATTENUATOR switch to maintain an on-scale deflection for the strongest signal encountered. Rotate the TUNE control back to the low frequency end of the band.

l. To record a spectral signature of the band, set the CONTROL MODE switch on the Model NM-17/27 to the SCAN position and press the SINGLE switch. The Model NM-17/27 will automatically sweep the full frequency range of the band in use in one minute, and will then return to the low frequency end of the band.

m. Repeat Steps i, k and l to record a spectrum signature of each band selected.

4.12 OPERATION WITH EXTERNAL SCAN INPUT

The frequency tuning of the Model NM-17/27 may be remotely controlled independently from remote programming of other functions by using the EXTERNAL SCAN input. This feature should be employed when the application requires a scan time other than one minute for X–Y recording, or when a spectral display is desired. For example, the Model SCU-7 Scan Control Unit or a low frequency function generator may be used as a tuning voltage source. To produce a finely detailed X–Y plot, the function generator may be adjusted to develop a 0 volt to +10 volt ramp function with a scan time of 1000 seconds.



NOTE: For input signal levels from 1 uV to 1000 uV, use the bottom and left-hand scales. For input signal levels from 1000 uV to 1,000,000 uV, use top and right-hand scales.

EXAMPLES: 10 uV = 2 pW
100,000 uV = 2×10^8 pW (or 0.1 V = 200 uW)

Figure 4-3. Signal Power Conversion Chart (Picowatts – Microvolts)

For spectral display on an oscilloscope, scan times as fast as 30 milliseconds may be employed. For X–Y recording with external scan, the following general procedure is recommended:

a. Connect and calibrate the equipment as directed in Paragraph 4.11.

b. Provide a tuning voltage source capable of delivering 0 volt to +10 volts across 2000 ohms with a scan time suitable for the application.

CAUTION

Do not exceed ±15 volts at the EXTERNAL SCAN receptacle of the Model NM-17/27 as the voltage comparator, A33U2, may be damaged.

c. Connect the tuning voltage source to the EXTERNAL SCAN receptacle on the Model

NM-17/27 rear panel. Use a standard phone plug (military type PJ-055 or equivalent) and shielded cable.

d. Set the CONTROL MODE switch to the SCAN position.

NOTE

Insertion of the phone plug into the EXTERNAL SCAN receptacle automatically disables the internal sweep circuit.

e. Proceed with the X–Y recording as in Paragraph 4.11.

4.13 REMOTE CONTROL

The interconnection requirements for remote controls via the PROGRAMMER receptacle on the rear panel of the Model NM-17/27 are described in the following paragraphs. Wiring diagrams (Figures 4-5 thru 4-9) that illustrate typical remote controls and a PROGRAMMER receptacle pin data list (table 5-1) are included.

4.13.1 Frequency Band Selection

A total of eight mutually exclusive contact closures are required for remote selection of the eight frequency bands covered by the Model NM-17/27. Switching potential is −12 V at 30 mA maximum current. See Figure 4-4.

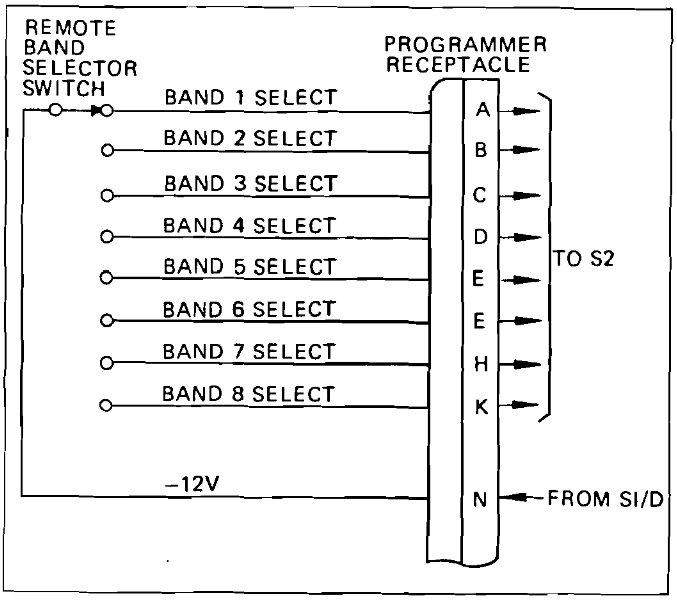


Figure 4-4. Remote Frequency Band Selection, Wiring Diagram

4.13.2 Bandwidth Selection

Remote selection of any of four bandwidths requires four mutually exclusive contact closures. Switching potential is +12 V at 12 mA maximum current. See Figure 4-5.

4.13.3 Frequency Tuning

Remote tuning of the Model NM-17/27 is accomplished by the application of a linear ramp voltage to the tuning circuit of the Model NM-17/27 as displayed in Figure 4-6. Scan

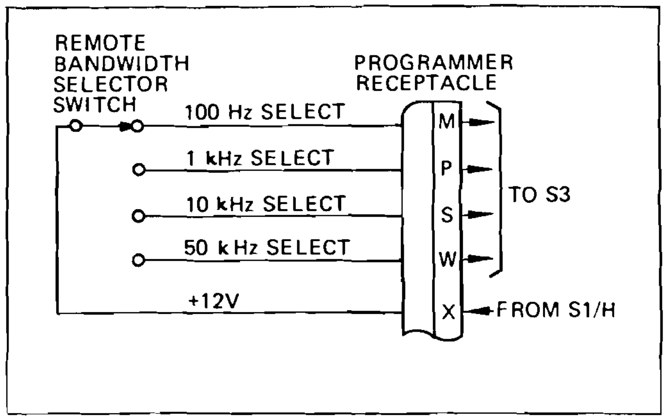


Figure 4-5. Remote Bandwidth Selection, Wiring Diagram

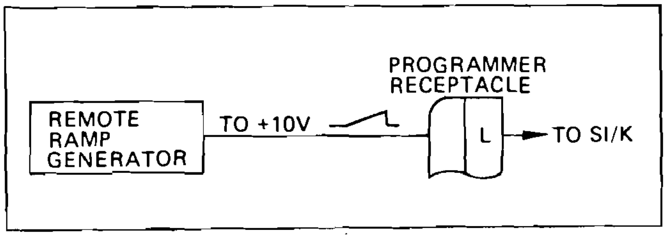


Figure 4-6. Remote Frequency Tuning, Wiring Diagram

time over the frequency band in use is determined by remote programming requirements. The remote ramp generator circuits must provide a sawtooth waveform from 0 volt to +10 volts to an input resistance of approximately 2 kilohms.

4.13.4 Gain (Calibrate)

Remote adjustment of the Model NM-17/27 IF gain for calibration purposes requires a device capable of supplying a continuously variable dc voltage ranging from 0 V to −6 V to an input resistance of 100 kilohms. See Figure 4-7.

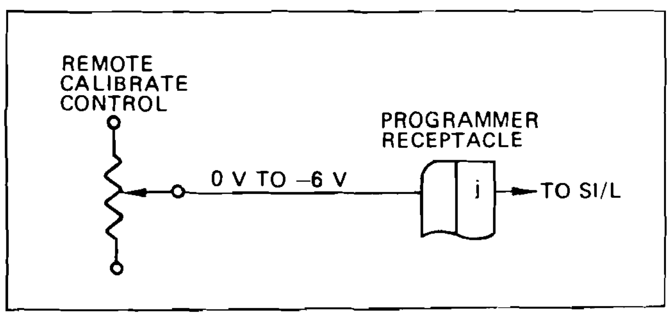


Figure 4-7. Remote Function Selection, Wiring Diagram

4.13.5 Detector Function Selection

Remote selection of detector functions requires six mutually exclusive contact closures. Refer to Figure 4-8. Switching potential is +12 V at 60 mA maximum current.

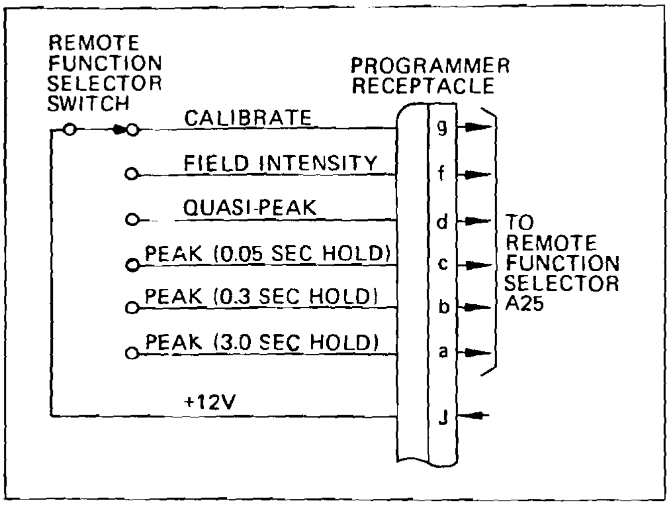


Figure 4-8. Remote Function Selection, Wiring Diagram