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IEEE Std 213-1987
Supersedes ANSI/IEEE Std 213-1961 and IEEE Std 214-1961

IEEE Standard Procedure for Measuring Conducted Emissions in the Range of 300 kHz to 25 MHz from Television and FM Broadcast Receivers to Power Lines

Sponsor
Standards Committee
of the
Electromagnetic Compatibility Society

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IEEE Standards Board

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American National Standards Institute

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Foreword

(This Foreword is not a part of ANSI/IEEE Std 213-1987, IEEE Standard Procedure for Measuring Conducted mission in the Range of 300 kHz to 25 MHz from Television and FM Broadcast Receivers to Power Lines.)

This standard is a revision of ANSI/IEEE Std 213-1961 (R 1974), Radio Interference: Methods Measurement of Conducted Interference Output to the Power Line from FM and Television Broadcast Receivers in the Range of 300 kHz to 25 MHz and also incorporated is IEEE Std 214-1961 (R 1985), IEEE Standard Construction Drawings of Line Impedance Network Required for Measurement of Conducted Interference to the Power Line from FM and Television Broadcast Receivers in the Range of 300 kHz to 25 MHz as Specified in IEEE Std 213-1961 .

This standard is specifically written to outline the procedures for testing television and FM broadcast receivers. The user is cautioned that this method might not be appropriate for conducted emissions testing of systems or products other than televisions or FM receivers. Other more general methods exist and it is suggested that they be used for review. These include but are not limited to ANSI C63.4-1981 , American National Standard Methods of Measurement of Radio Noise Emission from Low:Voltage Electrical and Electronic Equipment in the Range of 10 kHz to 1 GHz.

At the time of approval of this standard the members of the working group were as follows:

Michael J. Hart, *Chair*

Richard Fabina

At the time of approval of this standard the members of the Electromagnetic Compatibility Society Standards Committee were as follows:

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IEEE Standard Procedure for Measuring Conducted Emissions in the Range of 300 kHz to 25 MHz from Television and FM Broadcast Receivers to Power Lines

1. Introduction

Television and FM broadcast receivers are frequently potential sources of interference to other television and FM broadcast receivers and to receivers in other services. This standard defines a method for obtaining a measure of the emissions conducted by the power line from these potential interference sources in the frequency range of 300 kHz to 25 MHz. This standard describes standard input signals, the equipment setup, and measurement techniques.

2. Equipment Required and Method of Installation

2.1 Equipment Required

To perform the measurements described in this standard the following equipment is required:

1) Shielded room
2) A power line impedance stabilization network (LISN)
3) A source of a standard rf input signal
4) A tuned voltmeter
5) A picture carrier intermediate frequency (IF) signal source (for television receivers only)

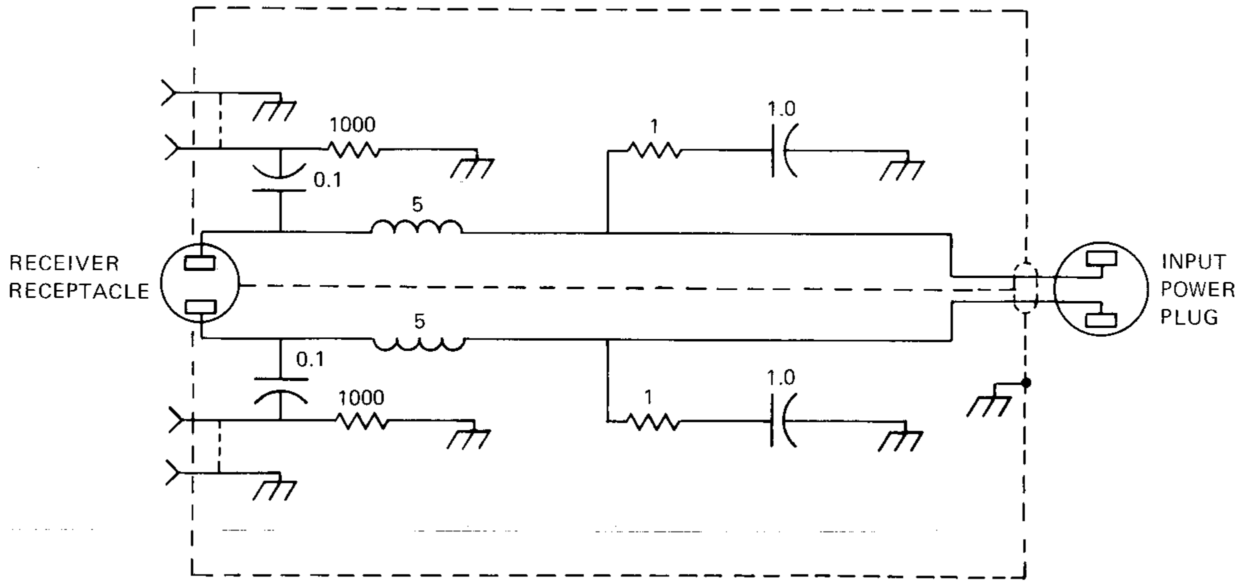
2.1.1 Shielded Room

A shielded room large enough to meet the requirements of 2.2.1 with adequate shielding and filtering to eliminate external interference. A typical size is 8 ft high by 8 ft wide by 10 ft long.

2.1.2 A Power Line Impedance Stabilization Network (LISN)

The purpose of this network is to present a standard value of power line impedance to the receiver under test regardless of the local power-line conditions.

1) The line impedance stabilization network is schematically illustrated in Fig 1. The purpose of the 1 Ω (nonreactive) resistor is to limit any possible resonance effects of the series circuit of the 5 μH inductor and the 1.0 μF capacitor. The purpose of the 1000 Ω resistors is to limit the line voltage that may appear at the coaxial connectors.



NOTES: (1) Resistance values (Ω)
(2) Capacitance values (μF)
(3) Inductance values (μH)

Figure 1—Power Line Impedance Stabilization Network Schematic

2) The impedances of the line network measured from each side of the receiver receptacle to chassis must conform within ±5% to the characteristic shown in Fig 2 (For this requirement the power plug is open circuited and both measurement outlets terminated in 50 Ω as shown in Fig 3).
3) A suitable method of measuring the magnitudes of impedances is shown in Fig 3. This measurement technique is a substitution method. The reference resistor is chosen so that the voltage drop across the resistor is equal to the voltage across the line impedance stabilization network at each frequency of measurement. The value of the resistor is then taken as the absolute value of the impedance. Since the impedance of the line network is considerably less than that of the 470 Ω isolation resistors, the generator impedance has a negligible effect on the measurements. The accuracy of the voltmeter is unimportant since it is only used to hold the voltage constant when the switch is changed. It is important to keep the lead lengths as short as possible.

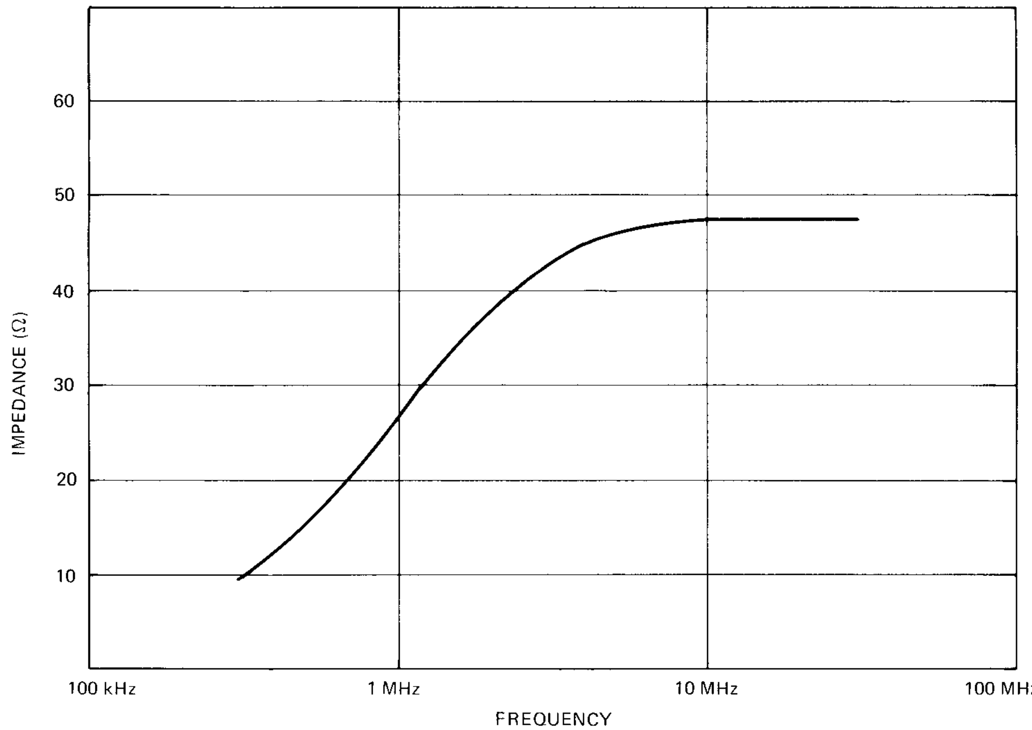


Figure 2—Impedance Magnitude Characteristic of Line Measured from Either Side of the Receiver Receptacle to Chassis

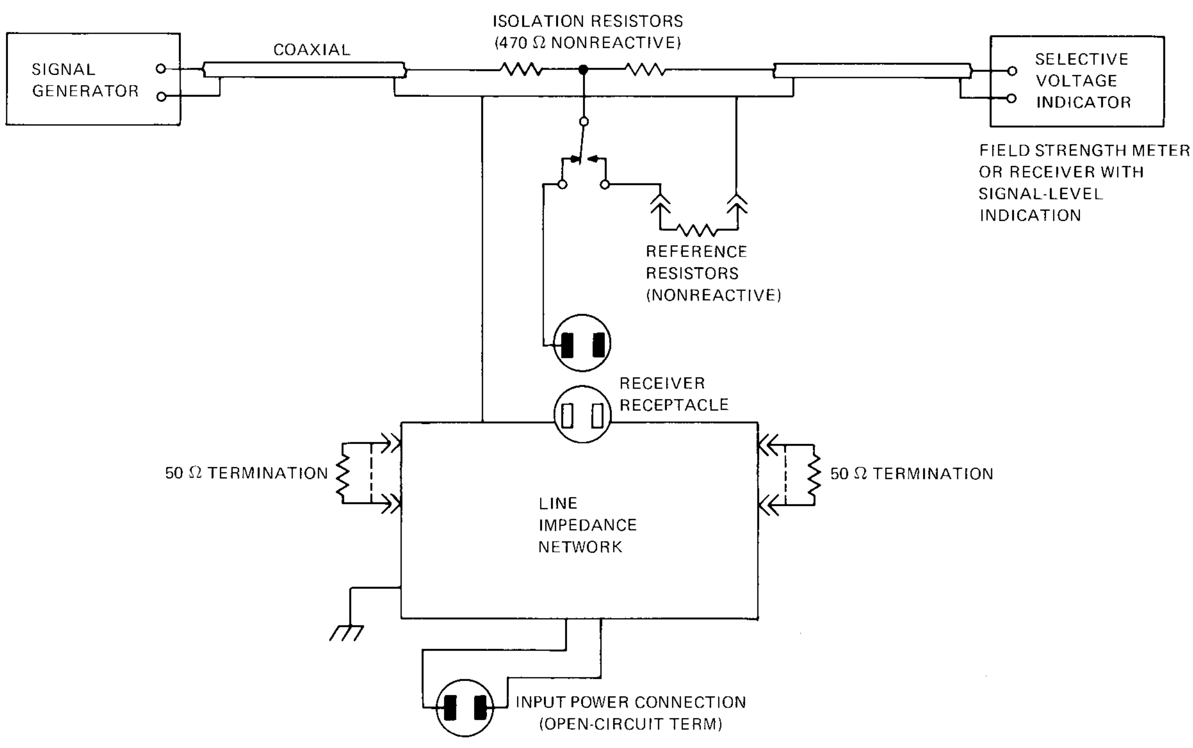


Figure 3—Circuit for Measurement of Impedance

4) To minimize variations, which might occur among different line impedance stabilization networks, and to permit more uniformity in test facilities, detailed construction drawings of a suitable network, of which assembly drawings are shown in Fig 4 (a) and (b), have been prepared. A network constructed according to these drawings should nevertheless be tested so as to ensure that it meets the requirements of 2.1.2(2).

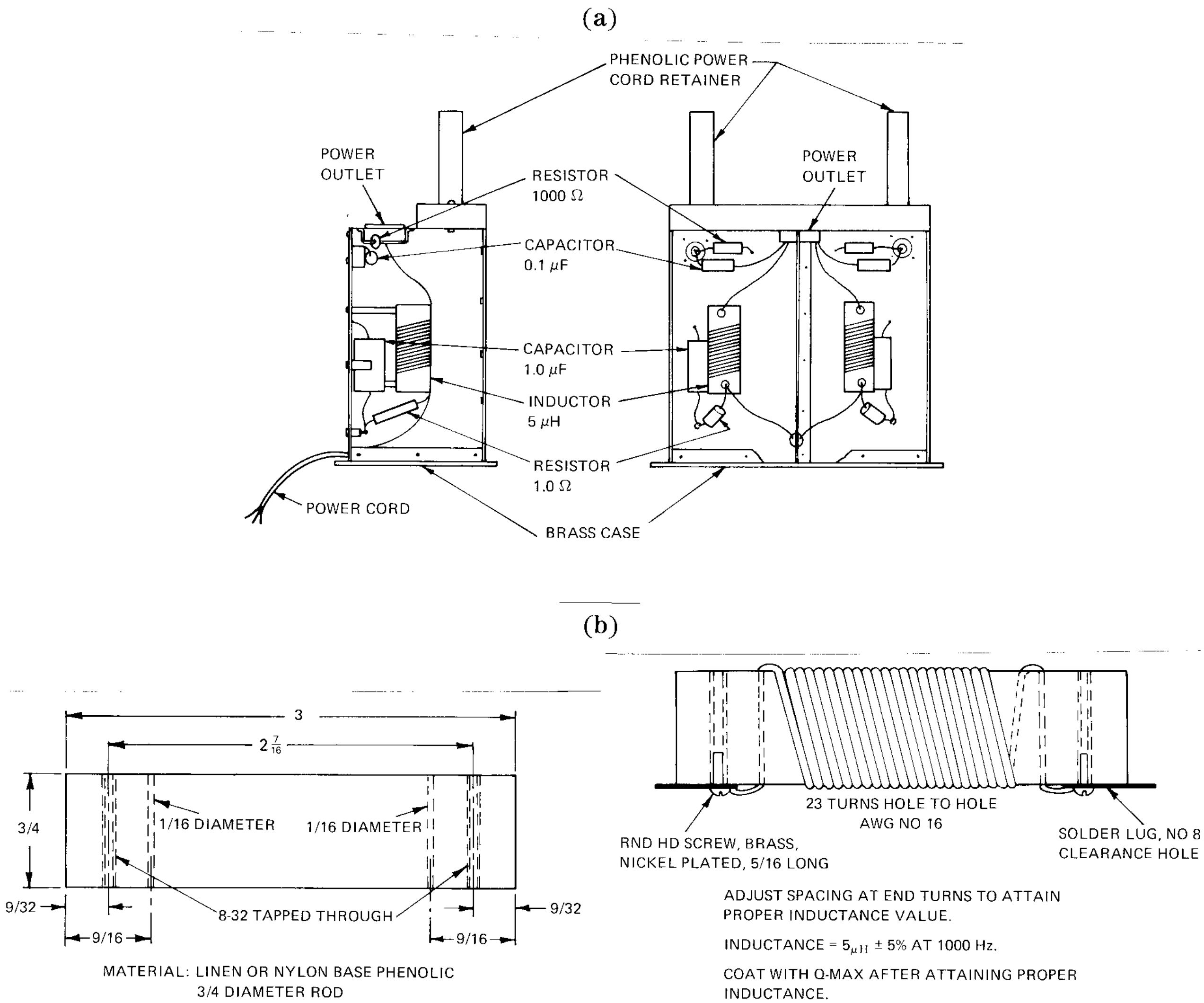


Figure 4—(a) Line Impedance Assembly (b) Inductor 5 μH

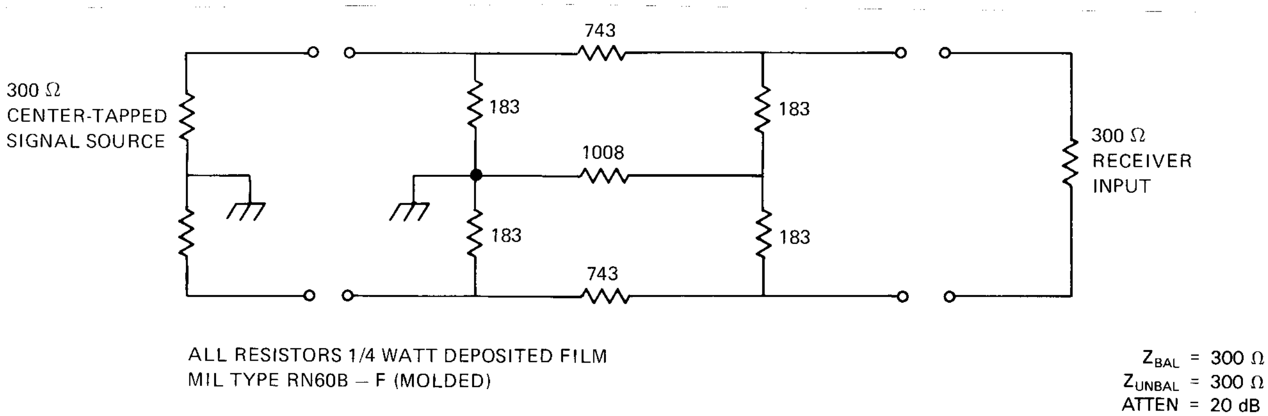
2.1.3 A Source of a Standard RF Input Signal

1) The rf signal shall be supplied to the receiver under test through a 20 dB, 300 Ω antenna coupling pad. This network, details of which are shown in Fig 5, is designed to have an impedance of 300 Ω balanced and 300 Ω unbalanced (impedance between the two output terminals connected together and ground). When the signal generator is not located within the shielded room, adequate filters should be installed at the signal input to the screen room to exclude undesired signals in the frequency band of interest.
If the receiver has a built-in antenna, it shall be disconnected from the antenna terminals during these tests. If the signal generator does not have a nominal 300 Ω center-tapped output impedance, a suitable matching network shall be provided between the signal generator and the pad.

When the receiver is designed for use with an unbalanced shielded transmission line, a line having the characteristics recommended by the receiver manufacturer shall be used in place of the twin-lead shown in Figs 5 and 7. The input terminals of the transmission line are connected to the output terminals of the pad. In addition, a resistor is connected in shunt with the output terminals of the pad so that the combination of the pad and the resistor matches the nominal input impedance of the receiver.

2) For a television receiver, the input signal shall consist of simulated sound and picture signals on any standard television channel.

(a)



(b)

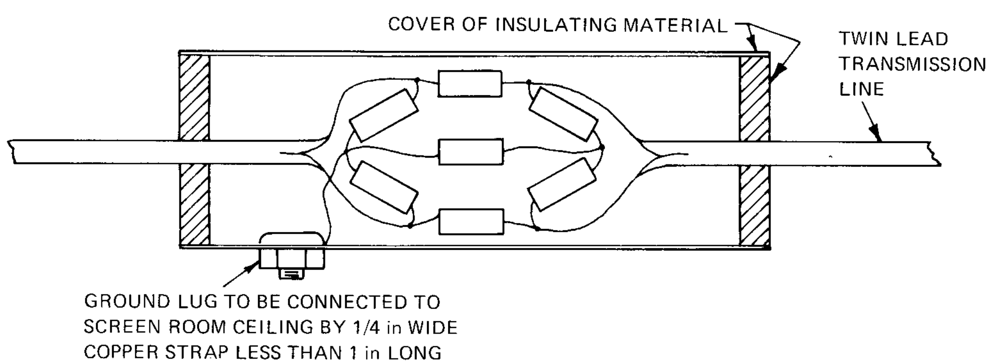


Figure 5—Antenna Coupling Pad (a) Schematic Diagram (b) Drawing of Typical Configuration

a) The modulation of the picture signal shall consist of the mixture of the following signals as shown in Fig 6 (observed on a double-sideband detector of equivalent, with a video frequency response that is uniform within ±0.5 dB through 3.58 MHz).

   i) Pulses of 5 μs width at a repetition rate of 15 750 pulses per second to represent horizontal synchronizing pulses.
   The pulse amplitude shall be sufficient to modulate the picture carrier so that the level between pulses is 37.5% of the peak level during pulses.

   ii) A sine wave of 2.0 MHz to represent video modulation.
   The amplitude of this modulation shall be sufficient to produce one percent peak-to-peak modulation during the time interval between the synchronizing pulses. This sine wave may be allowed to run through the synchronizing pulse period (A method of obtaining one percent

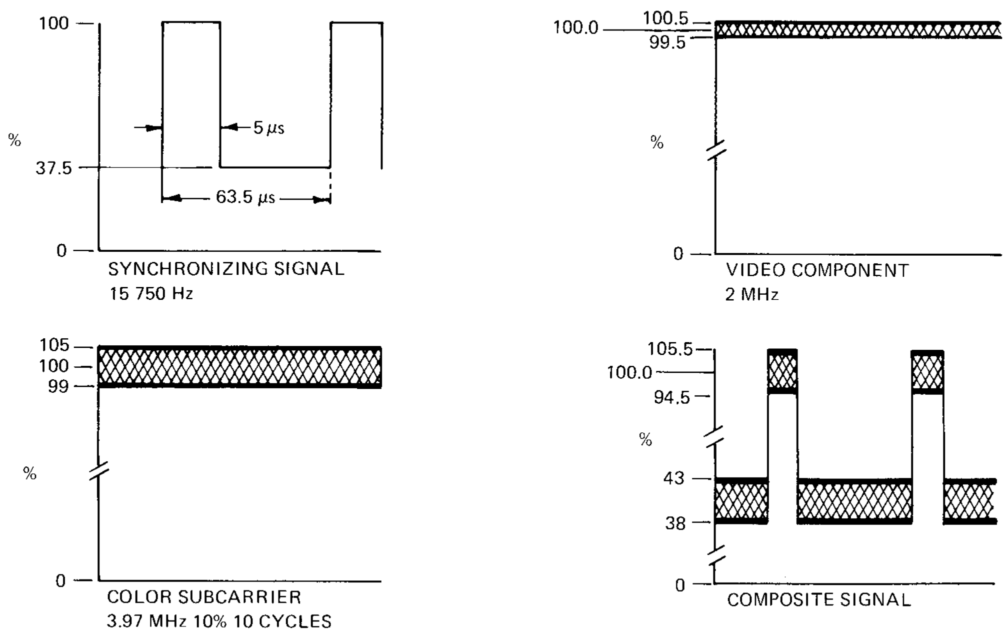
modulation is to adjust the modulation level for 10% to permit observation on an oscilloscope and then to reduce the modulating 2.0 MHz signal by 20 dB).

iii) A sine wave of 3.58 MHz to represent color signal modulation. The amplitude of this modulation shall be sufficient to produce 10% peak-to-peak modulation between the synchronizing pulses. This sine wave may be allowed to run through the synchronizing pulse period.

b) No modulation of the sound signal is employed.

c) The peak level of the picture carrier delivered at the output terminals of the 300 antenna coupling pad shall be nominally 3200 μV rms open circuit. The open-circuit sound level shall be 3 dB below the peak level of the modulated picture carrier.

3) For a FM broadcast receiver the input signal shall be delivered from the 300 Ω antenna coupling pad at a nominal open-circuit level of 1000 μV rms at a frequency for 98 MHz. No modulation will be employed.



NOTE: See 2.1.3 (a)

Figure 6—Modulation of Picture Signal

2.1.4 A Suitable Tuned Voltmeter (Field-Strength Meter)

1) The tuned voltmeter shall have a nominal 50 Ω input impedance and be tunable over at least the frequency range of interest. The nominal bandwidth of the voltmeter shall not exceed 10 kHz. Means shall be provided for either internal or external calibration. The instrument shall be adequately shielded and the power leads filtered to prevent spurious pickup.
2) The tuned voltmeter shall indicate the rms carrier level of the signal to which it is tuned. This measurement is normally designated as *field intensity* or *carrier*.
3) Reference is made to ANSI C63.2-1980 , American National Standards Specifications for Electromagnectic Noise and Field Strength Instrumentation, 10 kHz to 1 GHz, for further discussion of the voltmeter.

2.1.5 A Reference Picture IF Signal Source (For Television Receivers)

This shall consist of a signal source at the nominal picture carrier intermediate frequency. The signal is injected into the television receiver as a reference to facilitate the proper tuning of the receiver as described in 3.1.1.

2.1.6 A Regulated Source of Primary Input Power

Unless otherwise specified, the line voltage at the receiver receptacle shall be maintained at 117 V ± 2 V. The harmonic content of this line voltage shall be less than 5%.

2.2 Installation of Equipment

1) All portions of the receiver under test shall be at least 30 in (75 cm) from the wall of the shielded enclosure. Floor model receivers shall be placed on a nonmetallic platform 18 in (45 cm) above the metallic floor of the shielded enclosure, and table models placed on a nonmetallic platform 30 in (75 cm) above the floor. If the receiver is equipped with remote cables, these should be connected to the receiver and terminated either with the normal equipment or with a dummy load. They should be coiled and located on top of the receiver.
2) The power line impedance stabilization network shall be located on the floor of the shielded room directly below the back of the cabinet of the receiver under test. The center line of the power line impedance stabilization unit shall be coincident with the center line of the receiver back. Similarly, the rf signal coupling pad shall be mounted at the ceiling of the shielded room directly above the power line impedance stabilization network. The standard arrangement is shown in Fig 7.
3) The power line impedance stabilization network shall be bonded to the metallic floor by means of four, solid copper straps as shown in Fig 8 (bond impedance should be less than 2.5 mΩ dc). The width-to-length ratio of each strap shall be at least l:5, and the thickness of the strap shall be at least 0.025 in (0.0625 cm). In the unit shown in Fig 8, four holes have been provided for this purpose. The connection from the power line impedance stabilization network to the power source should be kept close to the walls or to the floor of the shielded room when inside the enclosure.

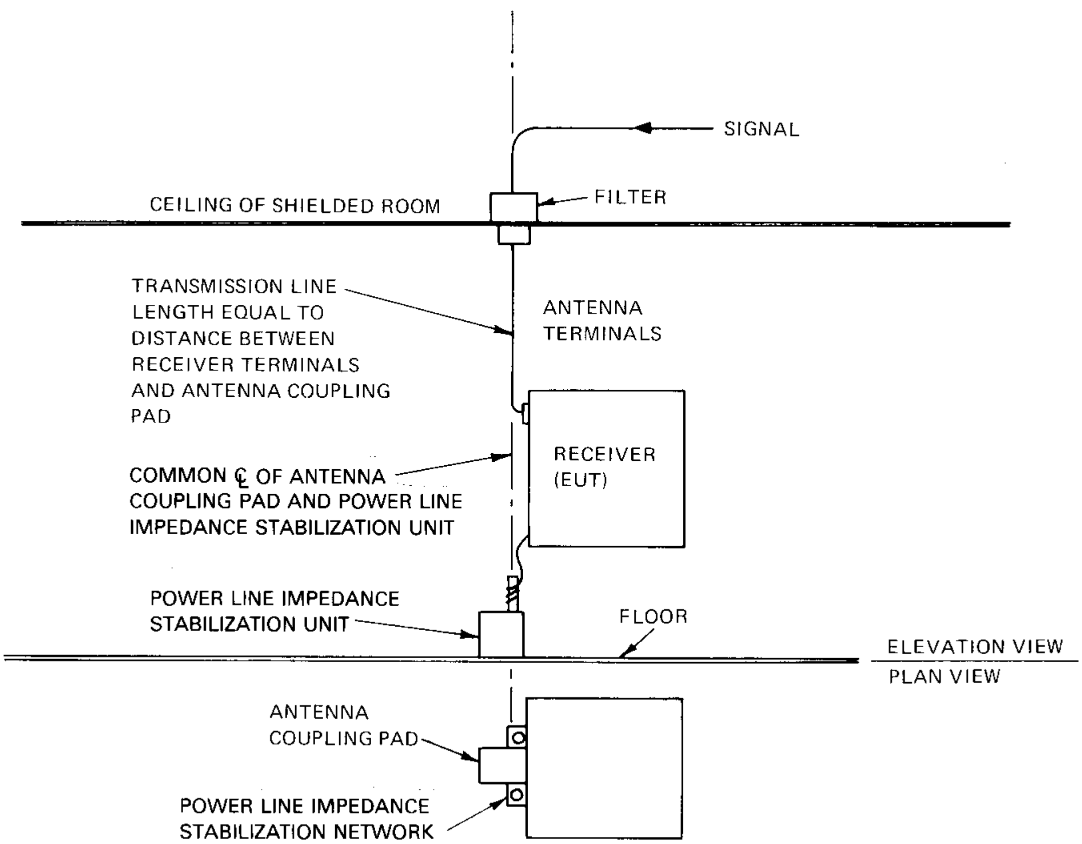


Figure 7—Signal Input System

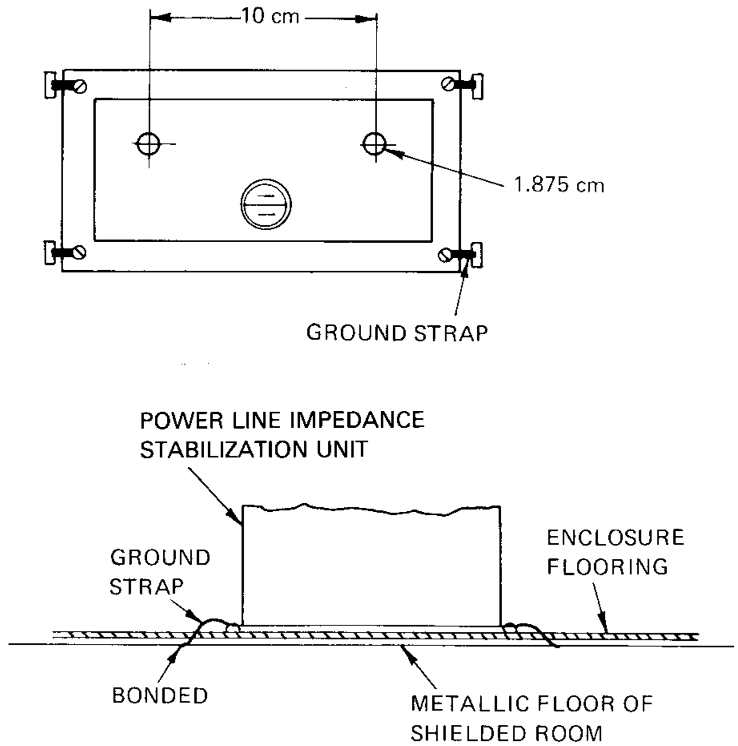


Figure 8—Suggested Method of Grounding the Power Line Impedance Stabilization Unit to the Shielded Room

4) A 50 Ω resistive load shall be connected to each of the two coaxial connectors of the line impedance stabilization network at all times. The voltages developed across these loads represent the conducted interference output of the receiver. A 50 Ω nonreactive resistor, a 50 Ω input impedance field-strength meter, or any combination of field-strength meter and external resistor to equal 50 Ω can be used as the resistive load.
5) The power-line cord from the receiver under test shall be dressed to the power line impedance stabilization network through the shortest possible path. The excess cord length shall be taken up by wrapping the cord in a figure-eight pattern around the two posts provided on top of the unit. The receiver power-line cord shall be plugged into the receptacle provided in the power line impedance stabilization network. This is shown in Fig 9. The disposition and length of the rf transmission line between the antenna coupling pad and the receiver are also important. As shown in Fig 7, the length of the transmission line shall be just sufficient to connect the receiver antenna terminals to the antenna coupling pad.

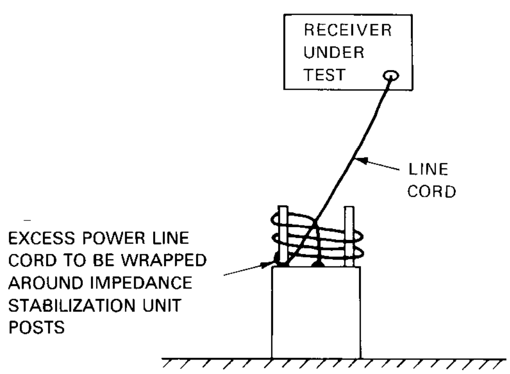


Figure 9—Method of Dressing the Receiver Power Line Cord

3. Measurement Procedure

3.1 Equipment Assembly and Initial Adjustments

The equipment is assembled in the prescribed manner, and the receiver under test is tuned to the appropriate signals.

1) For a television receiver, the correct tuning is determined by injecting a signal at the nominal intermediate picture carrier frequency and tuning the receiver local oscillator for a zero beat with the converted input picture carrier. This tuning point simulates normal operation and the emissions developed under normal operating conditions. If the receiver employs automatic local oscillator tuning means, the frequency of the converted IF picture carrier shall be recorded. When manual and automatic tuning are provided, measurements shall be recorded under both conditions.
2) For a FM receiver, the tuning is adjusted for maximum measured emission.

3.2 Emission Voltage Measurement

With the tuned voltmeter connected to one 50 Ω output of the power line impedance stabilization network, the voltage between this side of the power line and ground is measured at the frequencies of interest. The measurement is repeated with the voltmeter connected to the other 50 Ω terminal of the power line impedance stabilization network.

3.3 Adjustment of Operating Controls

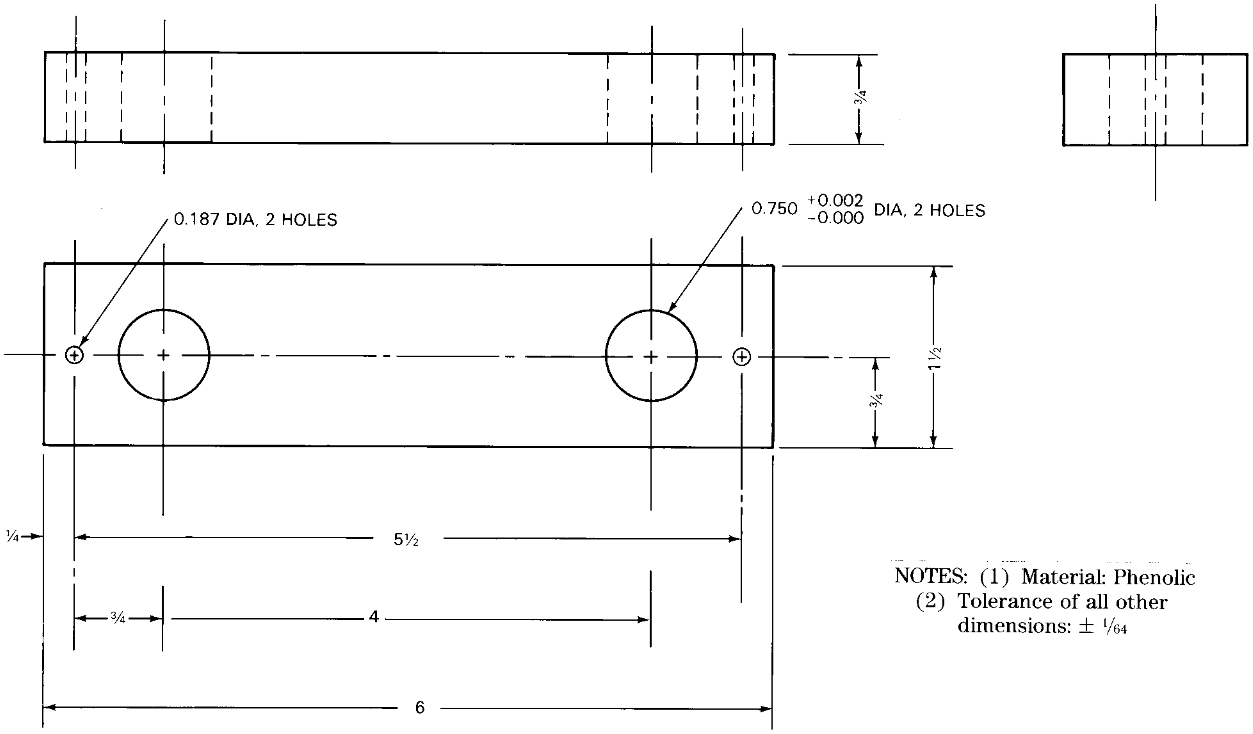
The customer-operated controls of the receiver, with the exception of the tuning adjustments, may be placed at any setting. In general, the range of these controls should be searched to determine the setting that produces the maximum interference value at each frequency of interest.

3.4 Recording of Measured Data

The emission voltage is recorded separately for each side of the power line at each frequency of interest. It should be noted that variations in source and load impedances cause actual emission voltages to differ from those measured with the power line impedance stabilization network.

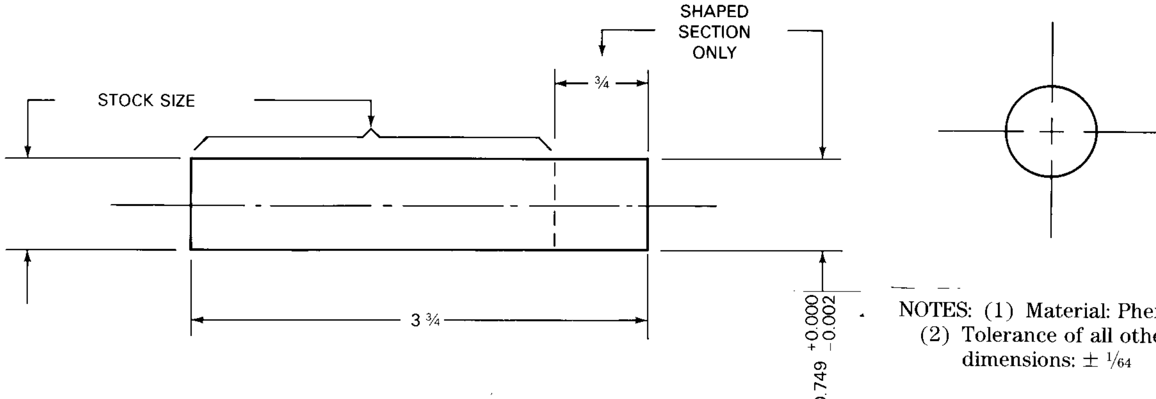
4. Construction Drawings of Line Impedance Stabilization Network Required for Measurement of Conducted Interference to the Power Line from FM and Television Broadcast Receivers in the Range of 300 kHz to 25 MHz

See Figs 10 through 20.



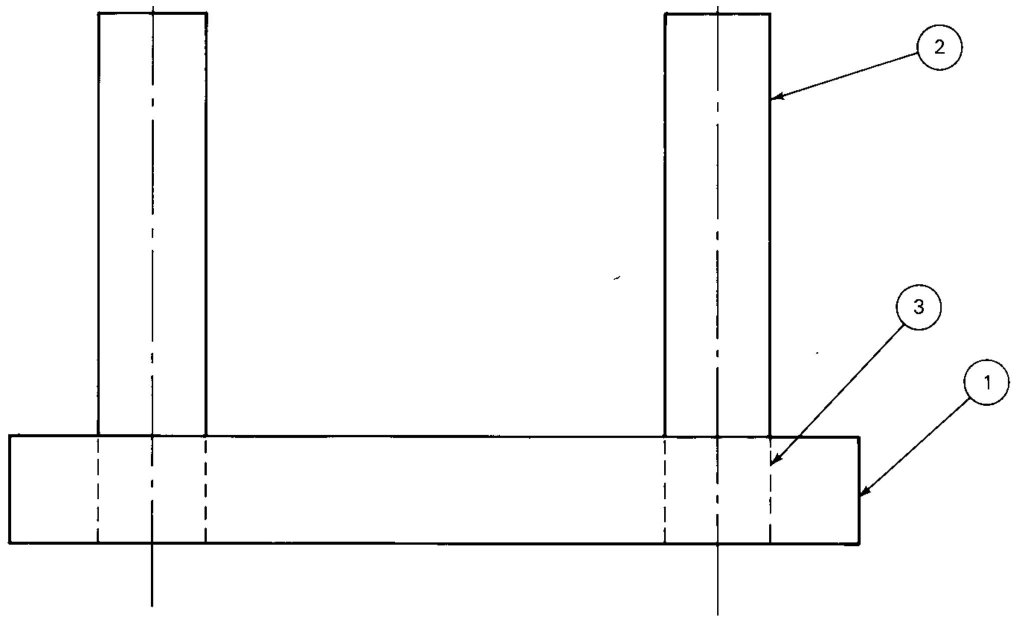
NOTES: (1) Material: Phenolic
(2) Tolerance of all other dimensions: ± 1/64

Figure 10—Base, Line Cord Retainer Assembly



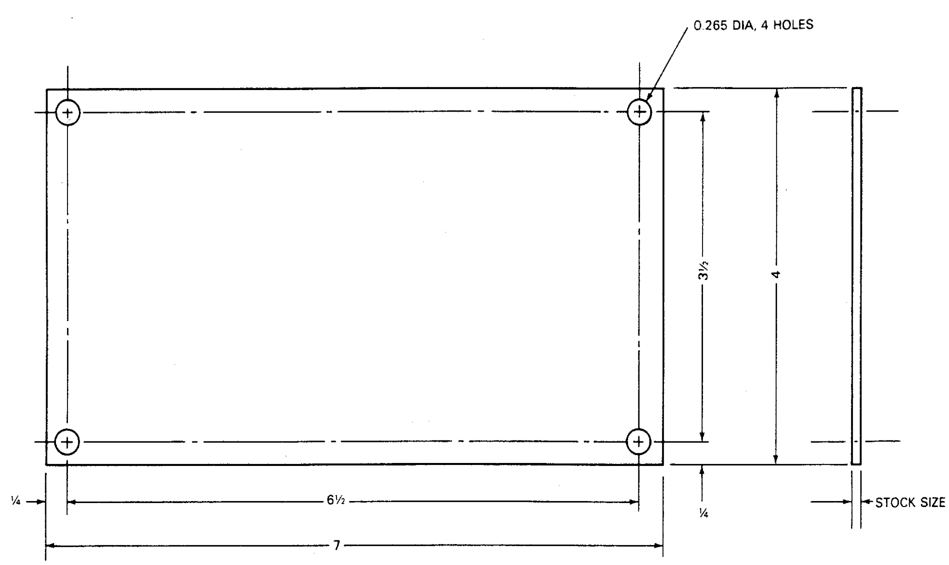
NOTES: (1) Material: Phendic
(2) Tolerance of all other dimensions: ± 1/64

Figure 11—Post, Line Cord Retainer



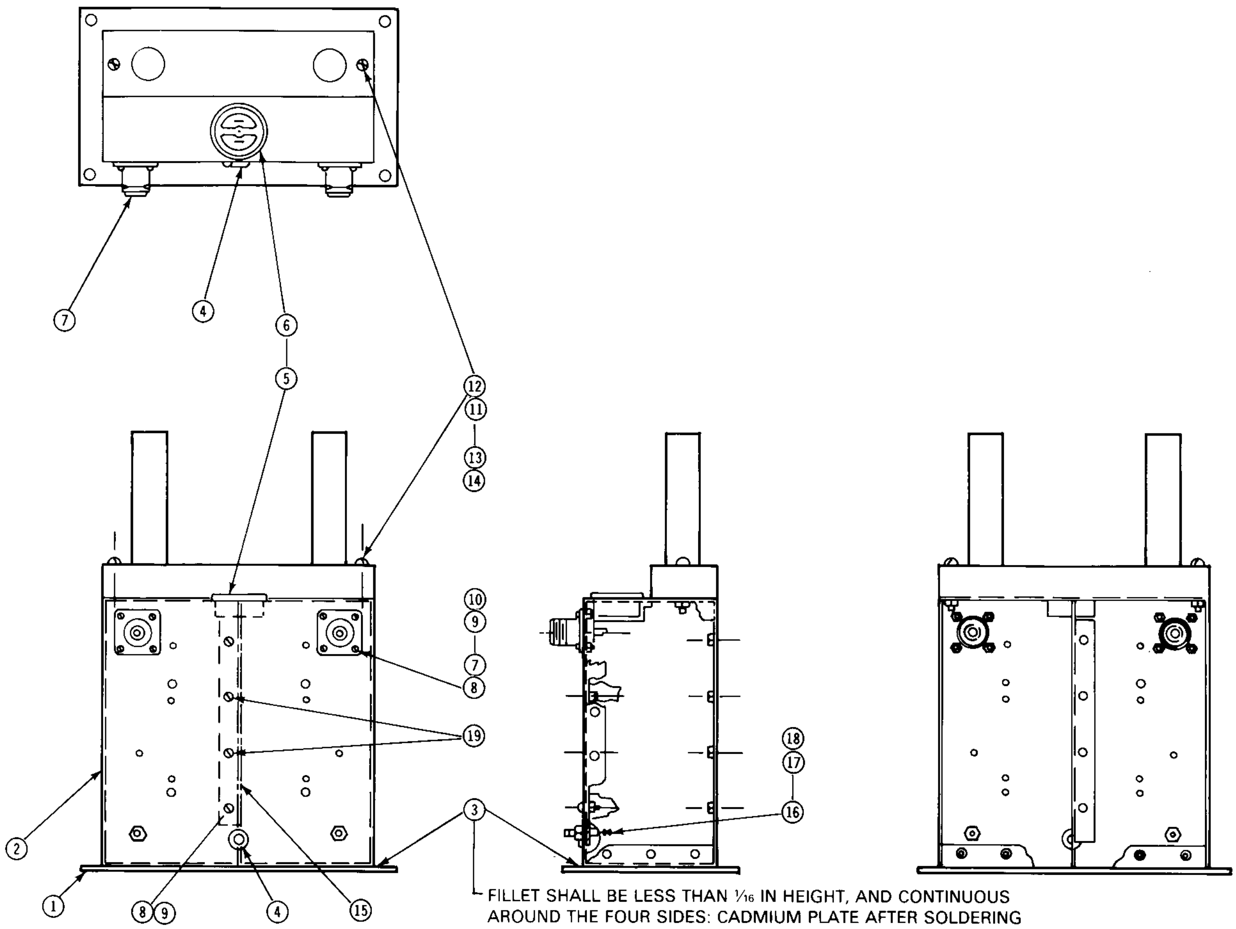
ITEM NUMBER	DESCRIPTION	QTY
1	BASE	1
2	POST	2
3	BOSTIK ADHESIVE	AR

Figure 12—Line Cord Retainer Assembly



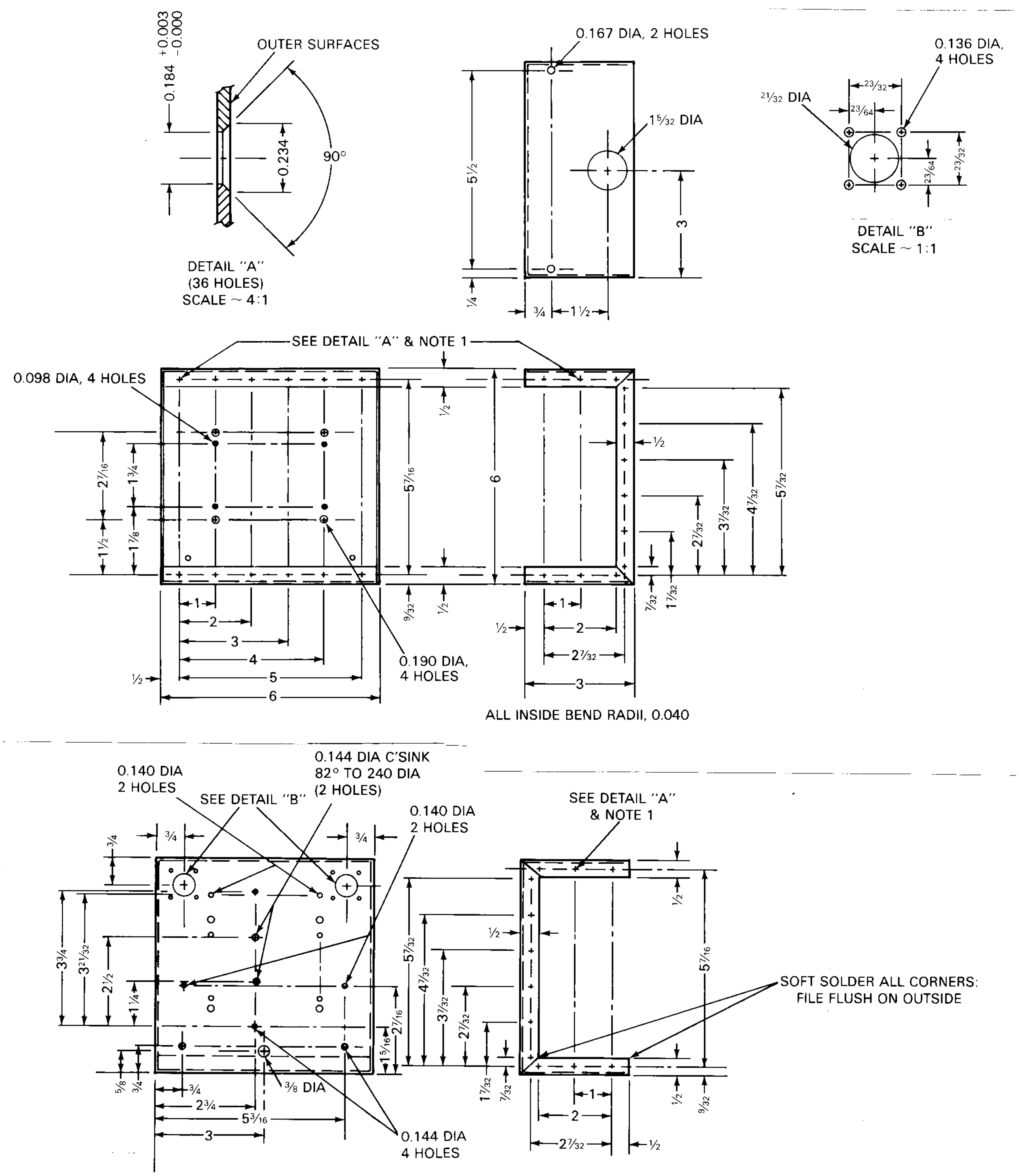
NOTES: (1) Material: Brass, 3/32 thick
(2) Tolerances:
DEC DIM ± 0.005
PRAC DIM ± 0.010

Figure 13—Mounting Plate



ITEM NUMBER	DESCRIPTION	QTY
1	MOUNTING PLATE	1
2	CASE ASSEMBLY	1
3	SOLDER, SOFT	AR
4	GROMMET, NEOPRENE	1
5	SOCKET, 125–250 V (AMPHENOL 61F)	1
6	SNAP RING (AMPHENOL 61F)	1
7	CONNECTOR, TYPE N, 50 Ω	2
8	SCREW, RD. HD., #4-40, BRASS, N.P., 5/16 LG.	10
9	LOCK WASHER, SPLIT, #4, PHOS. BZ., N.P.	10
10	NUT, HEX, #4-40, BRASS, N.P.	8
11	RETAINER ASSEMBLY, LINE CORD	1
12	SCREW, RD. HD., #8-32, BRASS, N.P., 1½ LG.	2
13	LOCK WASHER, SPLIT, #8, PHOS. BZ., N.P.	2
14	NUT, HEX, #8-32, BRASS, N.P.	2
15	DIVIDER, SHIELDING	1
16	TERMINAL, INSULATED, STAND-OFF	2
17	LOCK WASHER, SPLIT, #6, PHOS. BZ., N.P.	2
18	NUT, HEX, #6-32, BRASS, N.P.	2
19	SCREW, FL. HD., #4-40, BRASS, N.P., 5/16 LG.	2

Figure 14—Mechanical Subassembly



NOTES: (1) All holes designated Detail "A" shall have installed a press-in nut 4-40 thread, or equivalent provided material is 303 stainless steel or other non-magnetic metal.

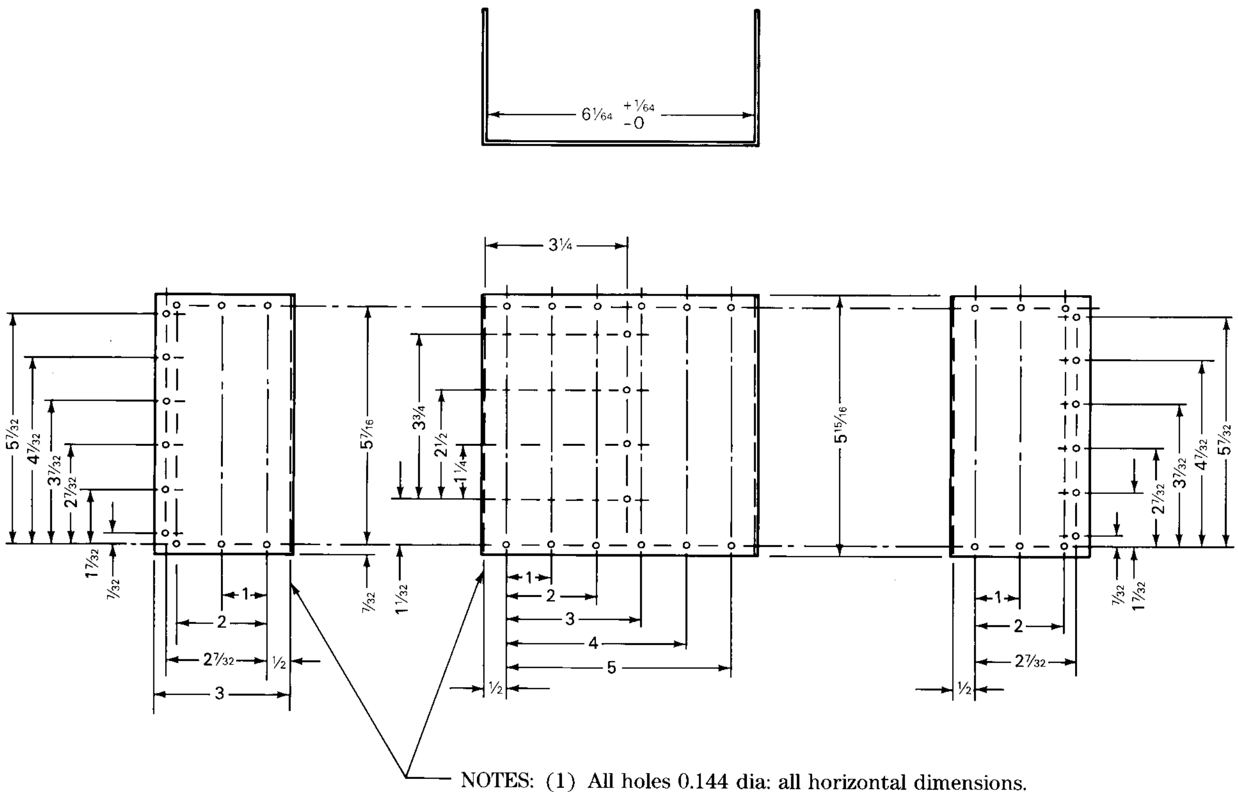
(2) Material: Brass 0.040 thick

(3) Tolerances:

DEC DIM ± 0.005

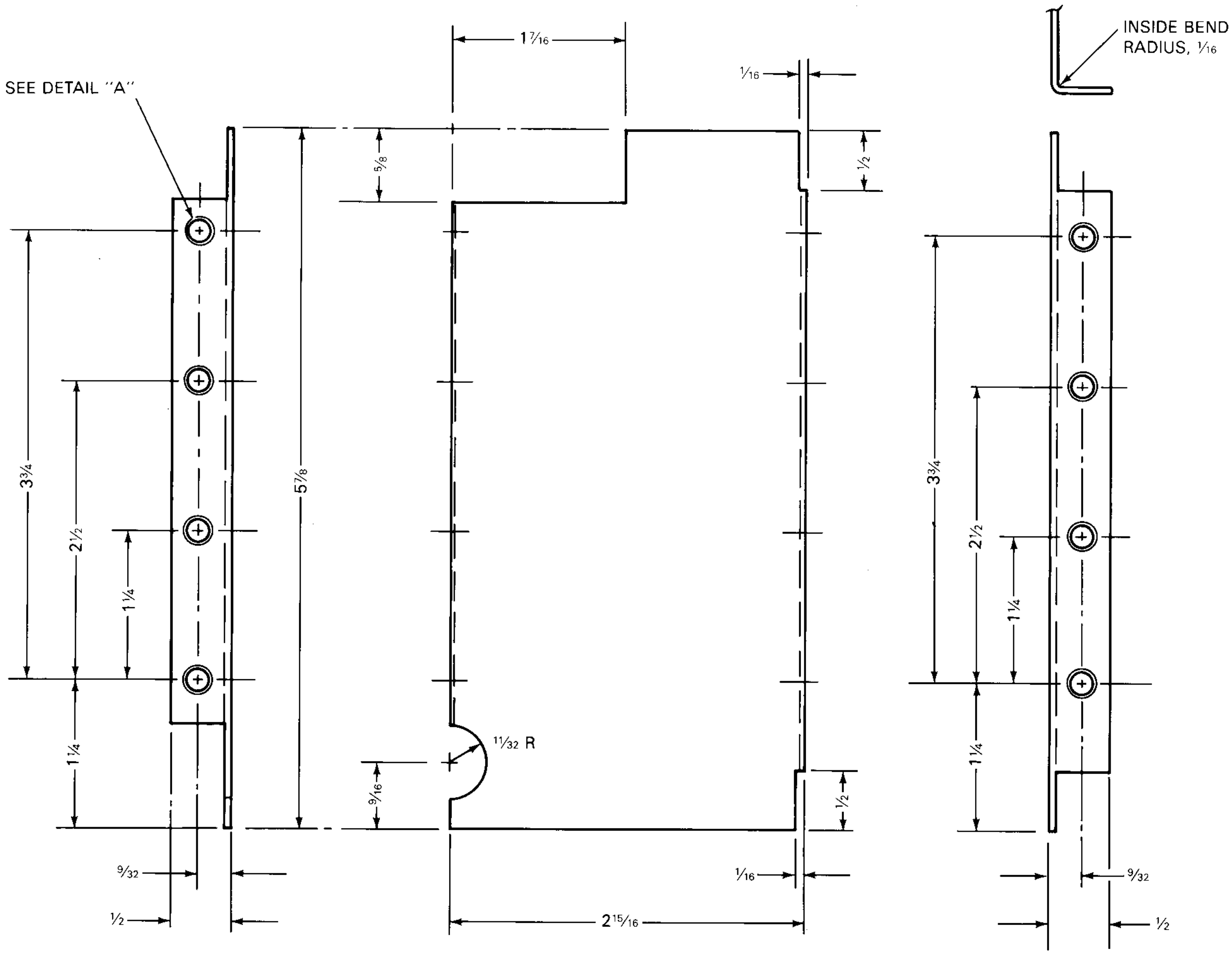
PRAC DIM ± 0.010

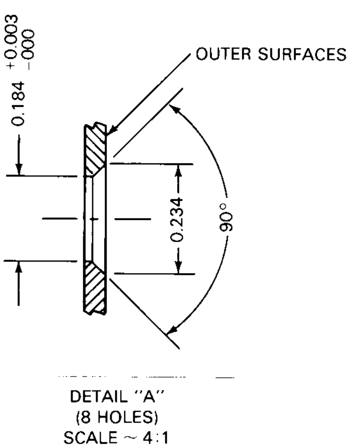
Figure 15—Case Assembly



NOTES: (1) All holes 0.144 dia: all horizontal dimensions. Refer to inside surfaces.
(2) Material: Brass 0.040 thick
(3) Tolerances:
DEC DIM ± 0.005
PRAC DIM ± 0.010

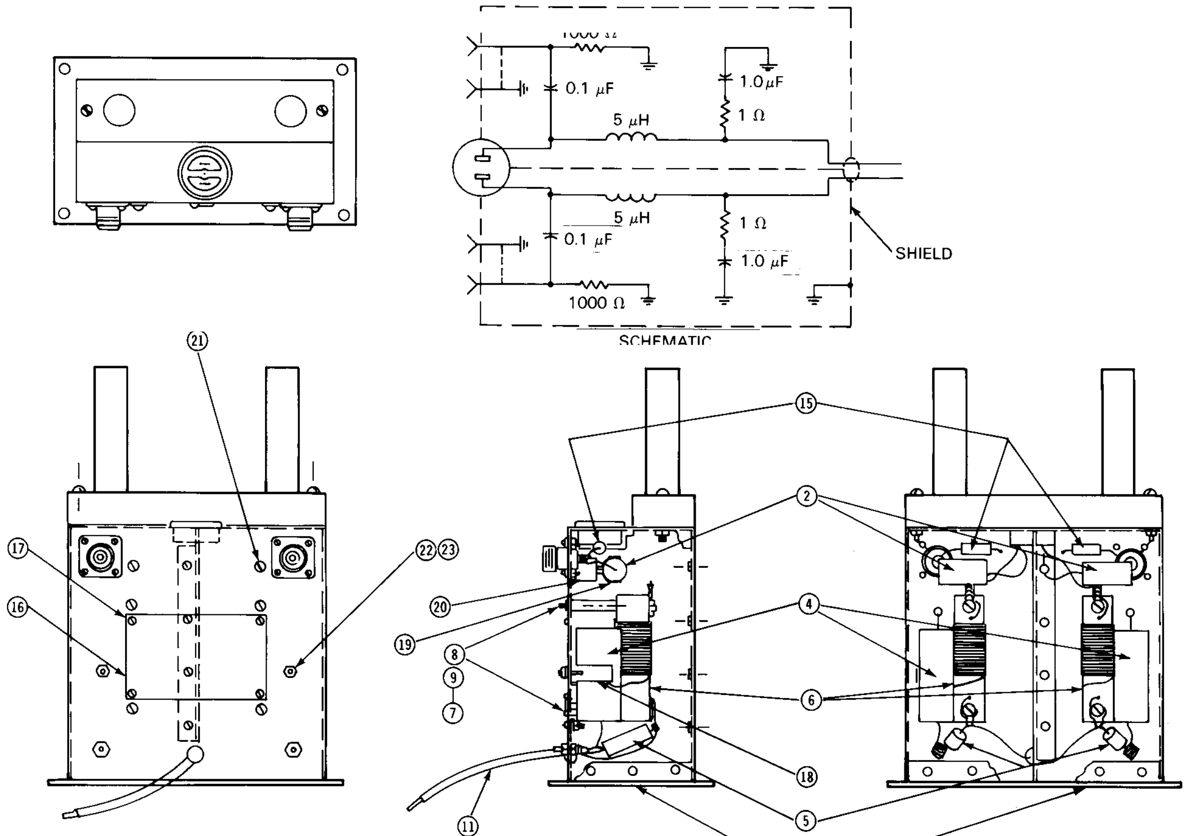
Figure 16—Cover





NOTES: (1) All holes shall have installed a press-in nut 4-40 thread, part number INN-90-1, or equivalent provided material is 303 stainless steel or other non-magnetic metal.
(2) Material: Brass 0.040 thick
(3) Tolerances:
DEC DIM ± 0.005
PRAC DIM ± 0.010

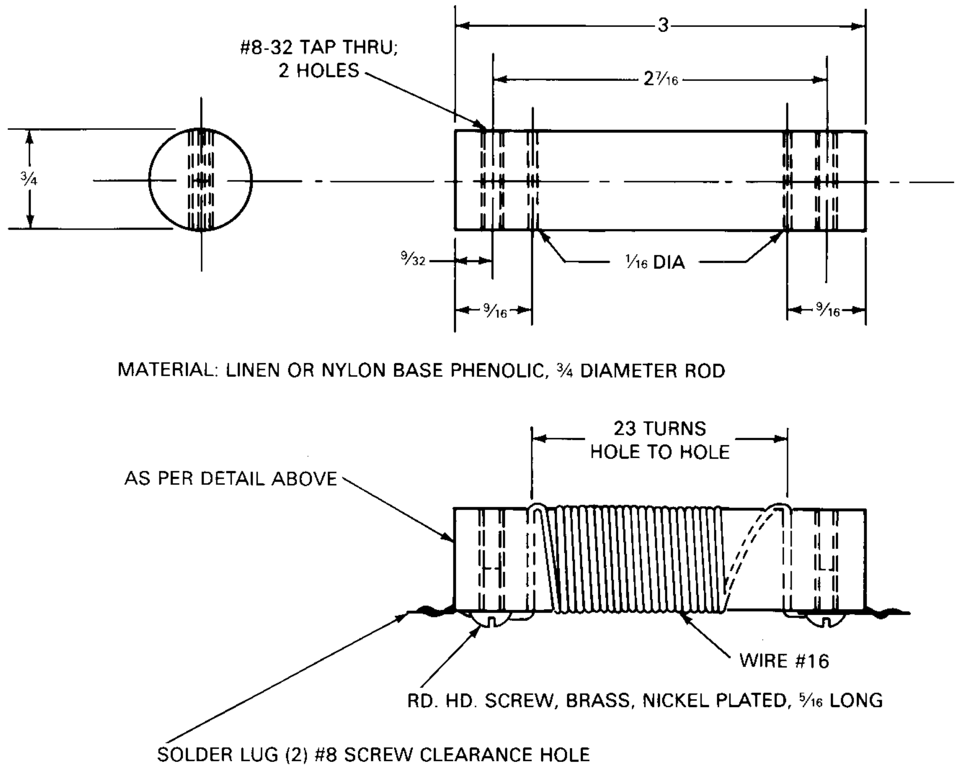
Figure 17—Shielding Divider Assembly



ITEM NUMBER	DESCRIPTION	QTY
1	SUB-ASSEMBLY, MECHANICAL	1
2	CAPACITOR, 0.1 μF, 400 V, ±5%	2
3	SOLDER, SOFT	AR
4	CAPACITOR, 1.0 μF, 400 V, ±5%	2
5	RESISTOR, 1.0 Ω ± 5%, 5 W, SIMILAR TO RW55J1R0, BUT NON-INDUCTIVE WOUND	2
6	COIL INDUCTANCE	2
7	SPACER	4
8	SCREW, RD. HD., #8-32, BRASS, N.P., 1½ LG.	4
9	LOCK WASHER, SPLIT, #8, PHOS. BZ., N.P.	4
11	LINE CORD, POT BROWN #16/HEAVY DUTY)	AR
12	COVER	1
13	SCREW, RD. HD., #4-40, BRASS, N.P., 5⁄16 LG.	40
14	LOCK WASHER, SPLIT, #4, PHOS. BZ., N.P.	40
15	RESISTOR, 2 W, 1000 Ω	2
16	PLATE, IDENTIFICATION	1
17	SCREW, SELF TAPPING	4
18	CLIP COMPONENT	2
19	CLIP COMPONENT	2
20	SPACER	2
21	SCREW, ROUND HD. MACH.	4
22	NUT, HEX	2
23	SCREW, ROUND HD. MACH.	2

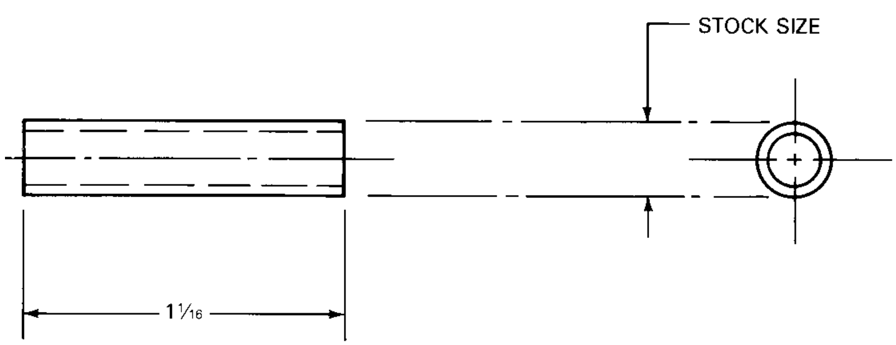
NOTE: Items 12, 13, and 14 not shown.

Figure 18—Final Assembly



NOTES: (1) Adjust spacing at end turns to attain proper inductance value.
(2) Inductance = 5 μH $\pm$ 5% measured at 1000 Hz.
(3) Coat with Q-max after attaining proper inductance.

Figure 19—Inductance Coil



NOTES: (1) Material: Brass tubing 1/4 OD, 1/32 wall thickness
(2) Tolerances:
DEC DIM $\pm$ 0.003
PRAC DIM $\pm$ 1/64

Figure 20—Spacer

