MIL-I-26600(USAF)
AMENDMENT 2
9 May 1960
Superseding
AMENDMENT 1
17 June 1959

MILITARY SPECIFICATION
INTERFERENCE CONTROL REQUIREMENTS, AERONAUTICAL EQUIPMENT

This amendment forms a part of Military Specification MIL-I-26600(USAF) dated 2 June 1958

Page 1, paragraph 2.1: Add "MIL-I-6181 Interference Control Requirements, Aircraft Equipment."

Page 4, paragraph 3.5.1: Delete and substitute:

"3.5.1 Class I. - Class I equipment is electrical or electronic equipment including special purpose test equipment installed in or closely associated with airborne weapons systems. This class shall be subdivided into two subclasses, defined as follows:

"3.5.1.1 Class Ia. - This subclass applies to equipment and subsystems intended for installation in manned aircraft that do not carry missiles as operational combat armament. The interference control requirements for this class shall be in accordance with MIL-I-6181.

"3.5.1.2 Class Ib. - Class Ib equipment shall be all class I equipment (see 3.5.1) other than that included in class Ia (see 3.5.1.1). Requirements and tests for class Ib shall be in accordance with figure 1. Class Ib specifically includes the following equipments:

a. Ground support equipment.

b. Air vehicles carrying missiles as operational combat armament.

c. All missiles."

Page 5, Figure 1, delete "Class I" heading and substitute "Class Ib."

Page 15, Add new paragraph:

"3.5.4 Class IV. - Class IV equipment consists of machine tools and electrically powered portable hand tools. Examples are:

a. Machine tools such as lathes, drill presses, shapers, table saws, stamping presses, handsaws, grinders, etc.

b. Hand tools such as drills, sabre saws, circular saws, riveting guns, polishers, vacuum cleaners, impact wrenches, screwdrivers, etc.

"3.5.4.1 Class IV Limits. - A 40 db relaxation or increase in limits applies to figure 8 for radiated limits and to figures 3 and 5 for conducted limits. Figures 2, 4, 6, 7 and 9 do not apply to class IV equipment. Radiated interference shall be measured at 3 feet over the frequency range of 0.15 to 400 mc. Conducted interference shall be measured over the frequency range of 0.15 to 25 mc. No measurements are required above 400 mc and no susceptibility tests shall be made."

Page 44, paragraph 6.2.4: Delete and substitute:

"6.2.4 Antenna System Correction. - The antenna system correction factor should be specified by the interference measurement instrument manufacturer."

Page 46, paragraph 6.6: Add the following: "Nonadjustable antennas are available in certain frequency ranges that can be used in lieu of the tuned dipole. The purpose of these antennas is to reduce measurement time by eliminating time spent in adjusting the dipoles. Only nonadjustable antennas, furnished by interference instrument manufacturers and approved for use by the procuring activity, should be used. Information as to which antennas have been approved should be obtained from the instrument manufacturer and not the procuring activity."

MIL-I-26600(USAF)
2 June 1958
Superseding
MIL-I-006181C(USAF)
6 June 1957

MILITARY SPECIFICATION

INTERFERENCE CONTROL REQUIREMENTS, AERONAUTICAL EQUIPMENT

1. SCOPE

1.1 This specification covers design requirements, interference test procedures and limits for electrical and electronic aeronautical equipment, including ignition systems, to be installed in or associated with weapon systems or support systems.

1.2 Classification. - The test procedures which are specified cover the following types of tests:

a. Interference Tests: Conducted and radiated tests which measure the magnitude of the interference signals emanating from the equipment under test.

b. Susceptibility Tests: Conducted, radiated, intermodulation and front-end rejection tests which determine whether an equipment will operate satisfactorily when exposed to external interference signals.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids, form a part of this specification:

SPECIFICATIONS

Military

MIL-I-6051	Interference Limits and Methods of Measurements, Electrical and Electronic Installation in Airborne Weapons Systems and Associated Equipment
MIL-T-9107	Test Reports, Preparation Of
MIL-S-10379	Suppression, Radio Interference, General Requirements for Vehicles (and Vehicular Subassemblies)

FSC-None

(Copies of documents required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 General

3.1.1 Operation. - Electrical and electronic equipment shall operate satisfactorily, not only independently but also in conjunction with other such equipment which may be placed nearby. This requires that the operation of all such equipment shall not be adversely affected by interference voltages and fields reaching it from external sources, and also requires that such equipment shall not, in itself, be a source of interference which might adversely affect the operation of other equipments. The limits specified herein are established to ensure that the weapons system will meet the requirements of MIL-I-6051 or other applicable system specification.

3.1.2 Short Duration Interference. - Interference resulting from manual operation of switches, but not including any electrical or electromechanical operations resulting from the manual switching, may deviate from the limits as indicated below. Ignition components used only during engine starting may deviate from the limits by 20 db. Other short duration interference may deviate from the limits as indicated below. Approval shall be obtained from the procuring activity before using these deviations.

Maximum Duration	Maximum Recurrence	Deviation Permitted
1 second	Once in 3 minutes	20 db
3 seconds	Twice per normal operational period	No limitation

3.1.2.1 The deviations permitted for short-duration interference shall not apply to equipments which are intended for use in unmanned weapons systems unless specifically authorized by the procuring activity.

3.2 Design

3.2.1 Interference-Free Design. - Interference control shall be considered in the basic design of all electronic and electrical equipment, components, assemblies, and systems. This design shall be such that, before interference control components are applied, the amount of interference in-

herently generated and propagated is the minimum achievable. The application of interference control components that must be used, such as filtering, shielding, and bonding, shall conform to good engineering practice and, whenever possible, shall be an integral part of the system. Whenever additional interference control components are necessary, the use of miniaturized components is preferred.

3.2.2 Susceptibility. - The equipment shall be designed to minimize susceptibility to interference from other sources. The enclosing case construction shall be designed not only to minimize interference propagation, but also to minimize interference pickup from external sources. Where conducted energy on the power leads or any external leads might cause interference, the leads shall be isolated from other leads to avoid coupling, and, where necessary, shall have line filters at their entry into the enclosing case. Receiving antenna inputs, or any other low-level signal circuits shall be low impedance, or of balanced design, so that coaxial or other shielded transmission lines can be used to insure an interference-free installation. Routing of receiving antenna input or any low-level signal circuit within the equipment shall be so designed and installed that interference is not picked up from power or control leads due to circuit coupling. Antenna or low-level signal circuit return paths or ground paths shall be so arranged that interference will not occur due to common conductive paths with other circuits, or with the enclosing case grounding path.

3.2.3 Case Shielding. - The number of mechanical discontinuities in the case (such as covers, inspection plates, and joints) shall be kept to a minimum. All necessary mechanical discontinuities in the case shall be electrically continuous across the interface of the discontinuity so as to provide low impedance current path. Multiple-point spring-located contacts are suggested as a desirable method of obtaining low impedance continuity. Ventilation openings shall be designed to permit conformance to the radiated interference limits. Electrical bonding shall be provided where access doors or cover plates form a part of the shielding. Hinges, in themselves, are not considered satisfactory conductive paths.

3.2.4 Chassis, Case, and Mounting Continuity. - The mating surface of the chassis, case, and mounting shall be free of all insulating finishes in order to provide a continuous electrical bond between these items and to enable the installing activity to accomplish bonding contact to the basic structure. Such surfaces shall be covered with removable protective coating to prevent corrosion prior to assembly. This requirement shall take precedence over any conflicting requirements in specifications on finishes.

3.2.5 Component Placement. - Components shall be placed and circuitry arranged to obtain minimum undesired coupling and to require a minimum number of filter components.

3.2.6 Line Shielding. - It is preferred that interference reduction be accomplished inside the equipment when such means give results equal to or better than the use of a shielded line. Any line shielding used shall be approved by the procuring activity and shall be prescribed as an installation requirement.

3.2.6.1 Under no condition shall line shielding be used for primary power leads to equipment.

3.2.6.2 Equipment requiring antennas, but not employing waveguides, shall be designed to utilize shielded coaxial cable as lead-in. When it has been determined that a single braid shield is not adequate, a double or triple braid or a solid shield shall be used as required.

3.2.7 Interference Control Components. - When additional interference control components are required after careful design in accordance with the foregoing paragraphs, components shall be used that conform to the environmental requirements for the equipment. Hermetically sealed interference control components shall be used even though the equipment is not hermetically sealed. Separately installed and external components shall not be used unless specifically authorized by the procuring activity.

3.2.8 Vehicles and Vehicular Subassemblies. - The requirements of MIL-S-10379 shall be applicable in lieu of the requirements of this specification for vehicles and vehicular subassemblies. This applies only to the equipment necessary for operation of the vehicle itself; any electronic equipment or ground support equipment installed or used in the vehicle and all equipment installed or used in trailers, vans et cetera, shall meet the requirements of this specification.

3.3 Subsystems. - When the procuring activity requires that this specification be applied to a group of units or equipments that are designed to operate together, the group shall be tested as a subsystem, and each individual item does not have to be tested separately.

3.4 Interference Control Plan. - The contractor shall submit a detailed plan describing his interference control program and the engineering design aspects of the interference control program shall be emphasized. Such information shall be included as the circuits to be shielded and filtered, methods of eliminating spurious emanations and responses, methods of

eliminating spurious resonances, method of obtaining continuous shielding on equipment using pressure or hermetic seals, thickness of case material required to provide adequate shielding on high power r-f equipment, selection of interference-free components to be used on equipment, and any other pertinent information. This plan shall be submitted to the procuring activity within 90 days after the award of a contract.

3.5 Interference Control Requirements. - All equipment tested for compliance with this specification shall conform to the interference control requirements set forth in figure 1 for the appropriate equipment class. For the purposes of this specification, all unwanted signals shall be considered as continuous wave (cw), pulsed cw, or broadband impulsive interference.

3.5.1 Class I. - Class I equipment is electrical or electronic equipment including special purpose test equipment, installed in or closely associated with airborne weapons systems.

3.5.2 Class II. - Class II equipment is a collection of electronic and electrical devices which operate together as a support system and is intended to directly support airborne weapons systems; examples are early warning systems, guidance systems, control and communications systems, and tracking systems. These systems are usually installed in buildings, shelters, vans, et cetera.

3.5.3 Class III. - Class III equipment is the individual electrical and electronic equipment which is used with a surface system. Included are:

a. Electronic equipment such as receivers, transmitters, teletypewriters, countermeasures equipment, navigation and identification, wire terminal equipment, radio relay equipment, modulators, and associated power supplies and subassemblies.

b. Electrical equipment used in conjunction with electronic systems such as heaters, air conditioning units, lighting equipment, et cetera.

c. Electrical power equipment such as generators, converters, rectifiers used to furnish power to electronic equipment.

3.6 Interference Measuring Instruments. - The instruments used to perform the measurements required by this specification shall be the best commercial equipment available that are capable of peak and field intensity measurements. All suitable commercially available instruments approved by the Air

TEST	INTERFERENCE TESTS AND LIMITS					
	CLASS I		CLASS II		CLASS III	
	PARAGRAPH	FIGURE	PARAGRAPH	FIGURE	PARAGRAPH	FIGURE
a. CONDUCTED						
1. STABILIZATION NETWORK	4.3.1.1	2,3	4.3.1.1	2,3	4.3.1.1	2,3
2. CURRENT PROBE	4.3.1.2	4,5	4.3.1.2	4,5	4.3.1.2	4,5
b. RADIATED						
1. MEASURED AT 1 FOOT	4.3.2	6,7,8,9	NOT REQUIRED		NOT REQUIRED	
2. MEASURED AT 3 FEET	NOT REQUIRED		NOT REQUIRED		4.3.2	6,7,8,9
3. MEASURED AT 25 FEET	NOT REQUIRED		4.3.2	6,7,8,9	NOT REQUIRED	
c. ANTENNA CONDUCTED						
1. TRANSMITTER KEY-UP OR RECEIVER	4.3.3.1		NOT REQUIRED		4.3.3.1	
2. TRANSMITTER KEY-DOWN	4.3.3.2		NOT REQUIRED		4.3.3.2	
d. SUSCEPTIBILITY						
1. RADIO FREQUENCY CONDUCTED	4.3.4.1.1		NOT REQUIRED		4.3.4.1.1	
2. AUDIO FREQUENCY CONDUCTED	4.3.4.1.2		NOT REQUIRED		4.3.4.1.2	
3. RADIO FREQUENCY RADIATED	4.3.4.2		NOT REQUIRED		4.3.4.2	
4. INTERMODULATION	4.3.4.3		NOT REQUIRED		4.3.4.3	
5. FRONT END REJECTION	4.3.4.4	10	NOT REQUIRED		4.3.4.4	10

FIGURE 1. INTERFERENCE CONTROL REQUIREMENTS

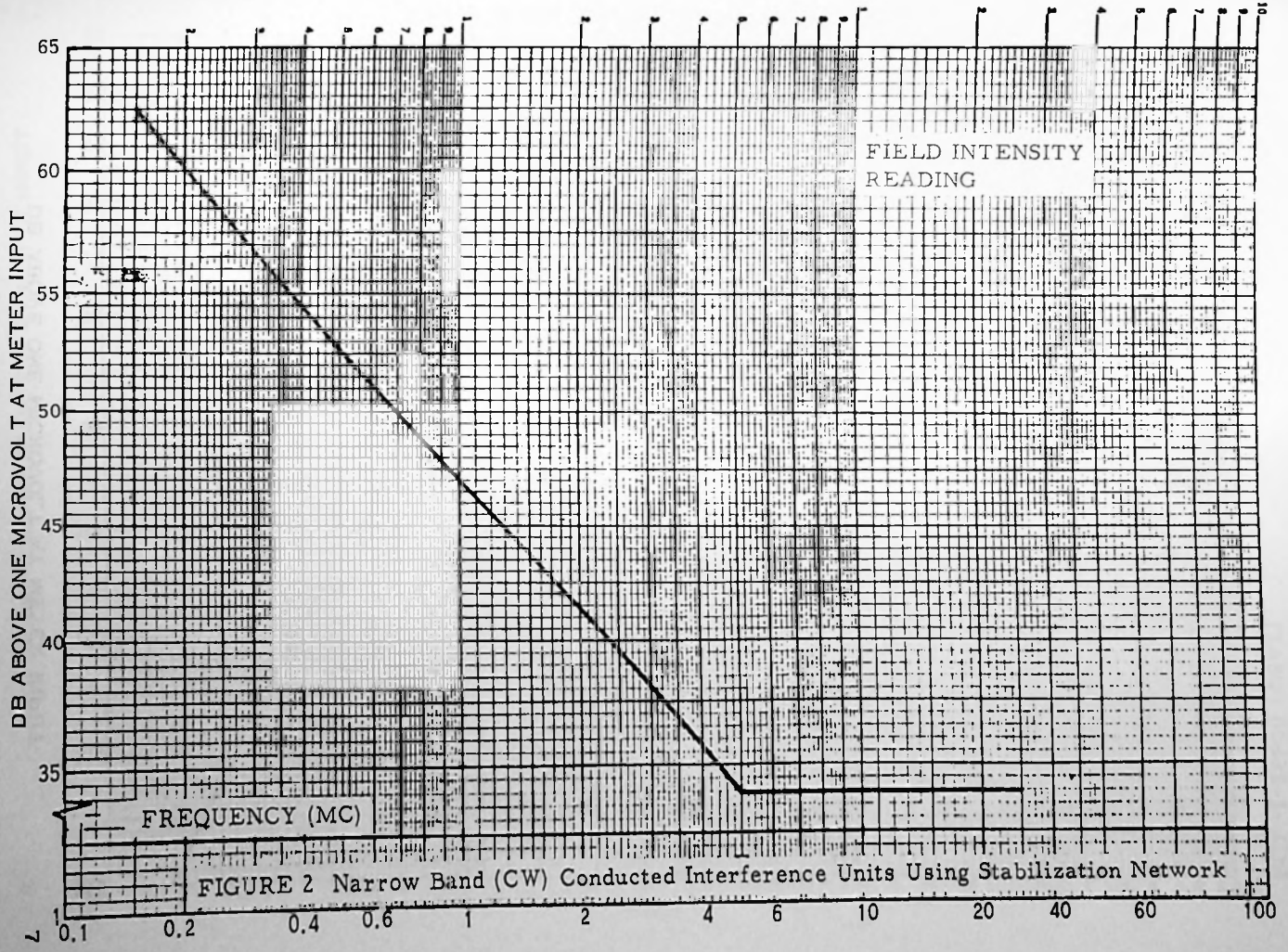


FIGURE 2 Narrow Band (CW) Conducted Interference Units Using Stabilization Network

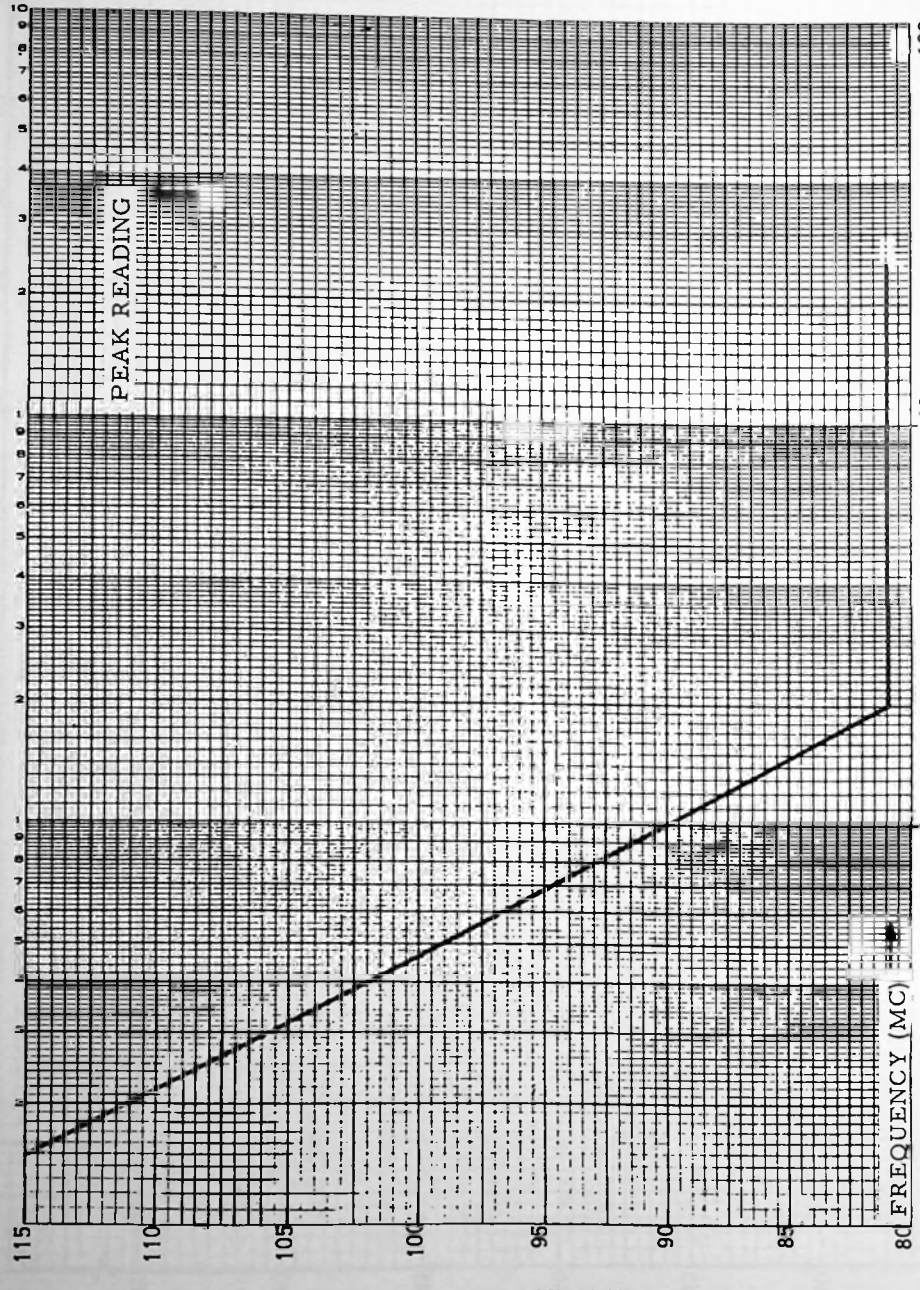


FIGURE 3 Broadband And Pulsed CW Conducted Interference Limits Using Stabilization Network

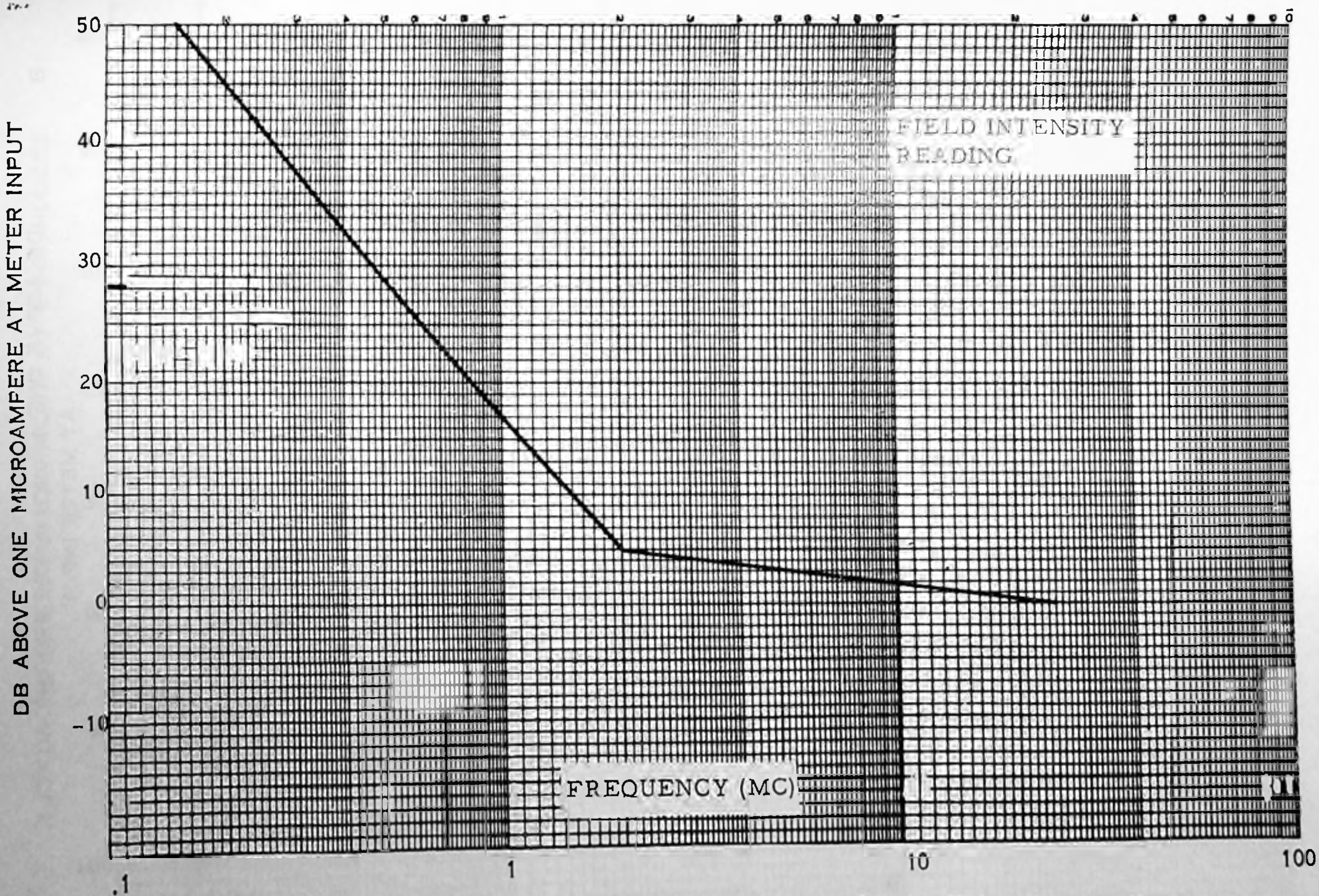


FIGURE 4 Narrow Band (CW) Conducted Interference Limits Using Current Probe

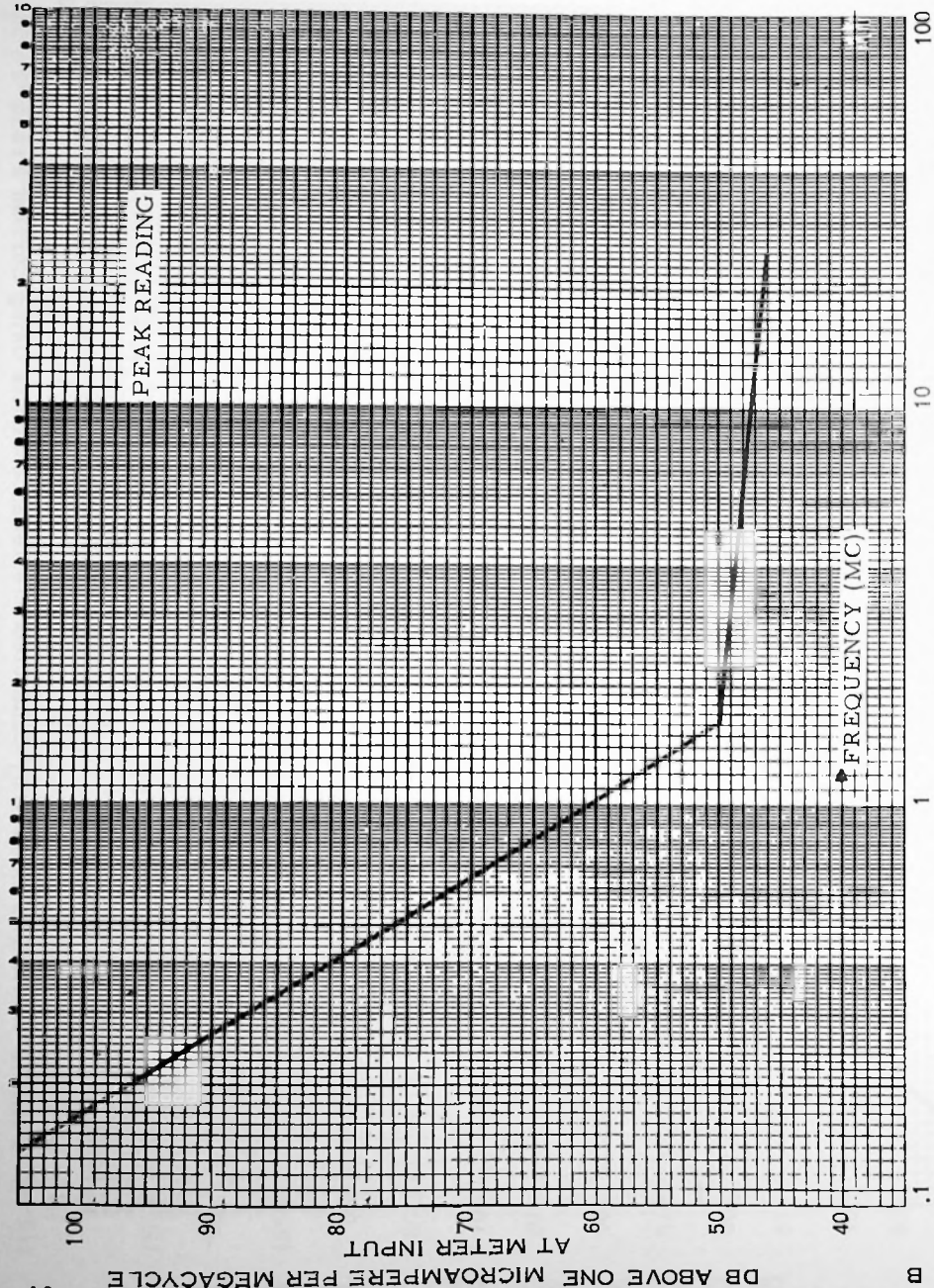


FIGURE 5 Broadband And Pulsed CW Conducted Interference Limits Using Current Probe

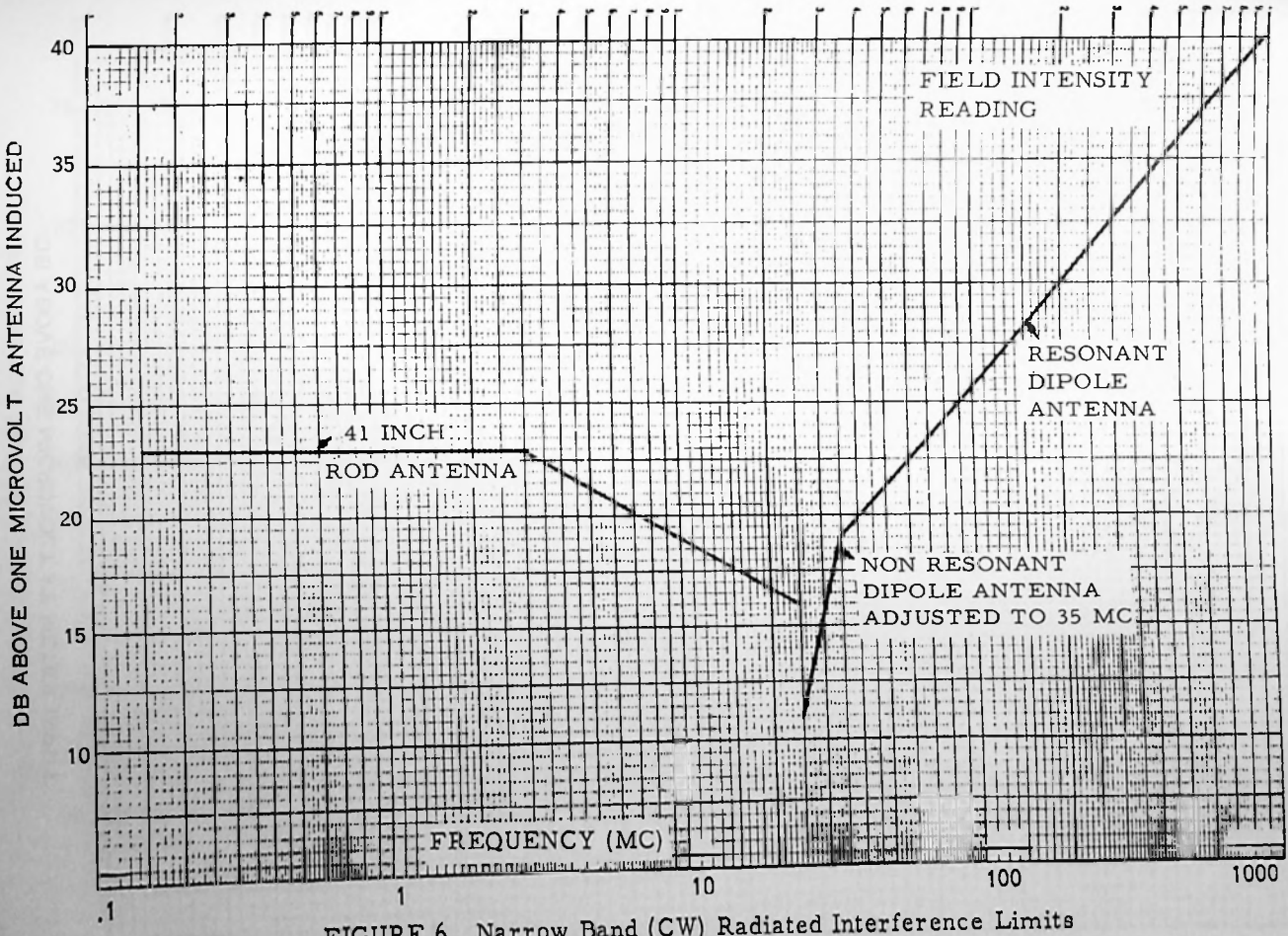


FIGURE 6 Narrow Band (CW) Radiated Interference Limits

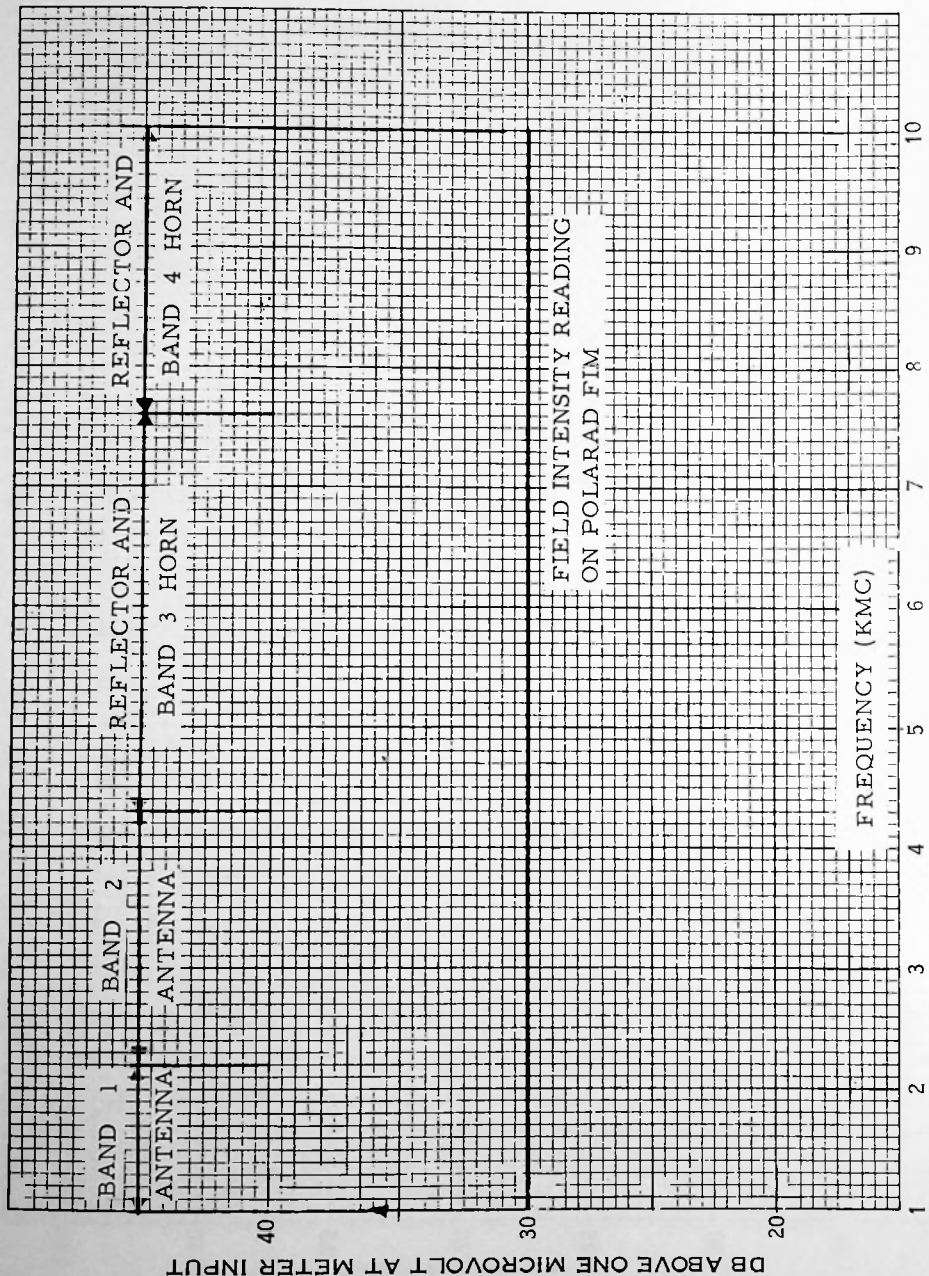


FIGURE 7 · Narrow Band (CW) Radiated Limits

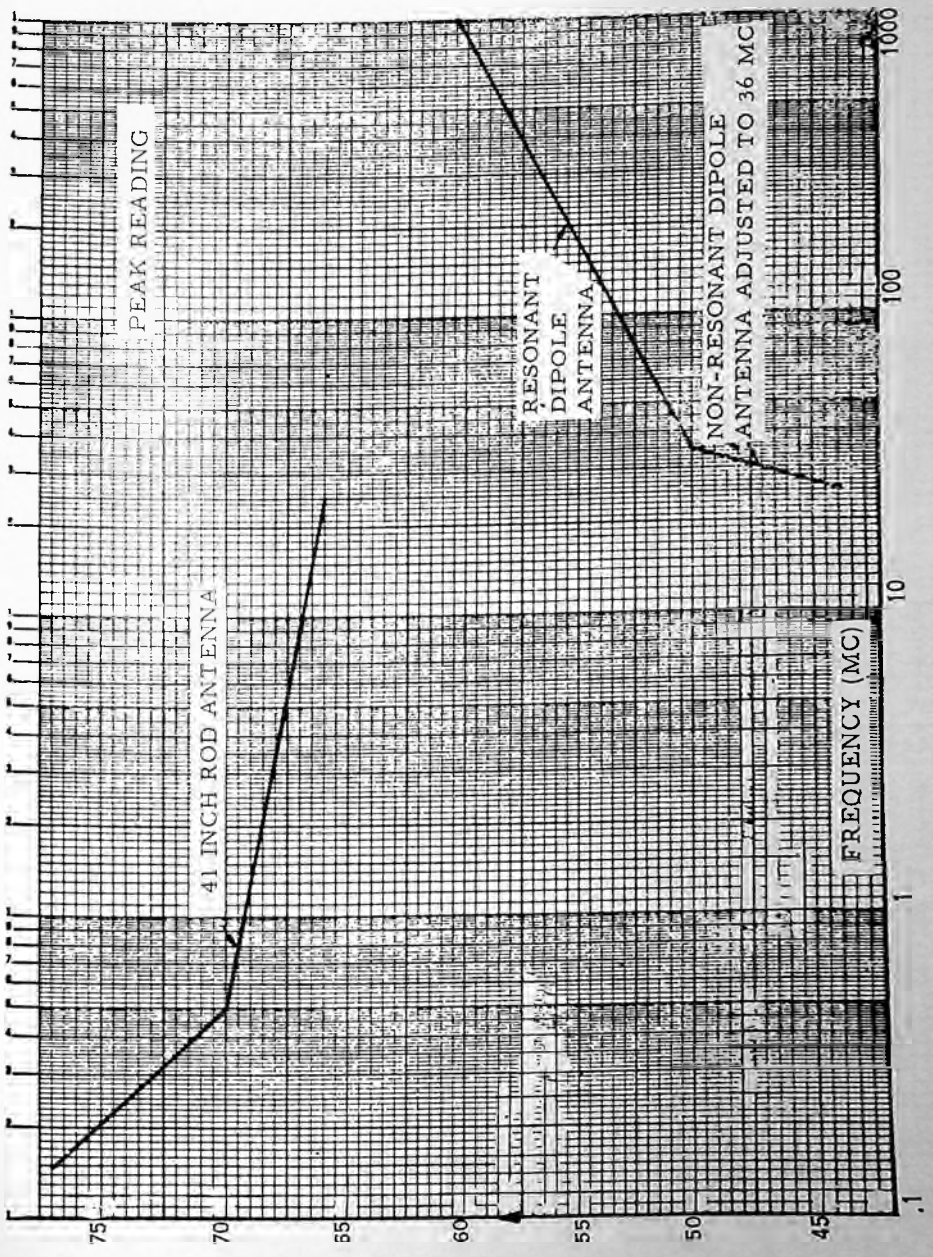


FIGURE 8 Broad Band and Pulsed CW Radiated Interference Limits

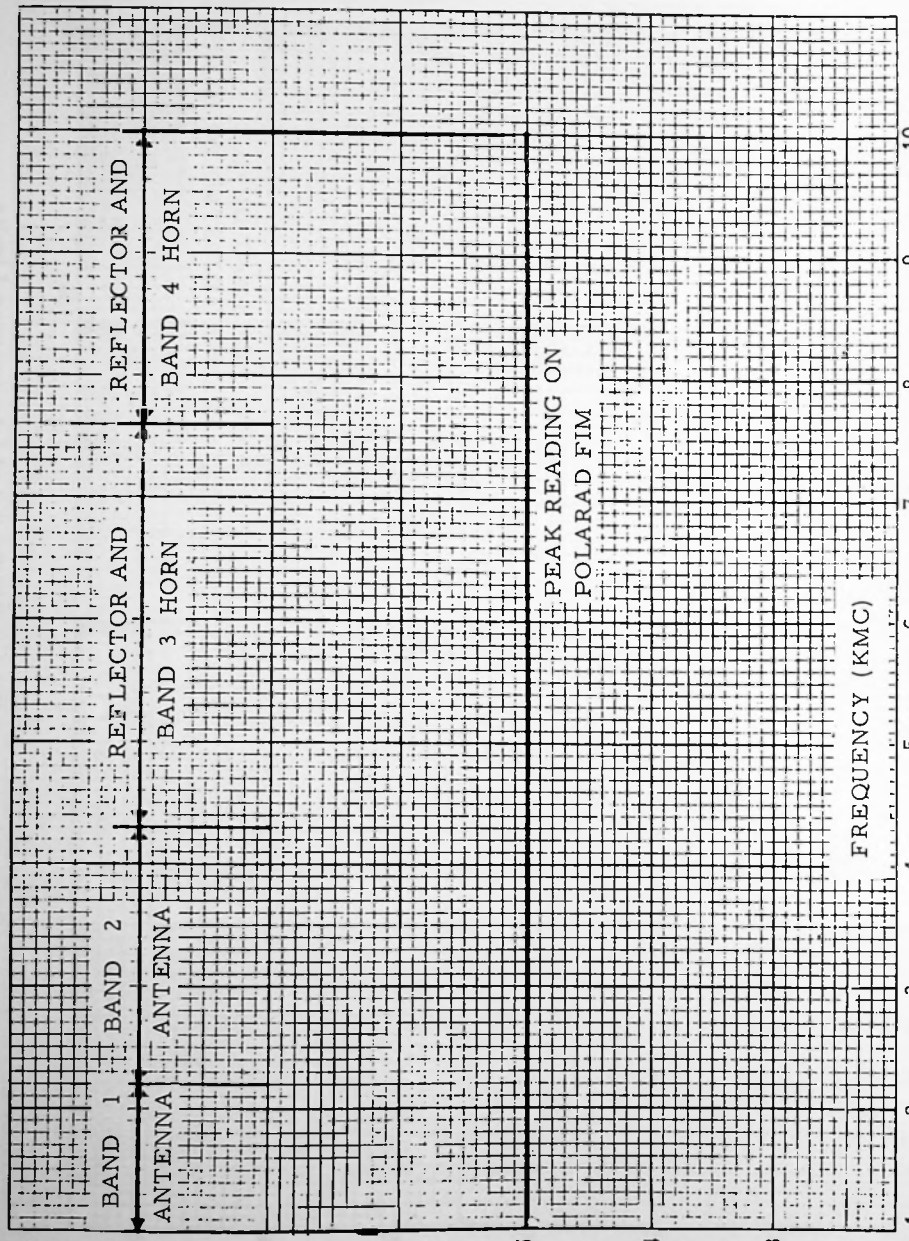


FIGURE 9 Broadband And Pulsed CW Radiated Limits

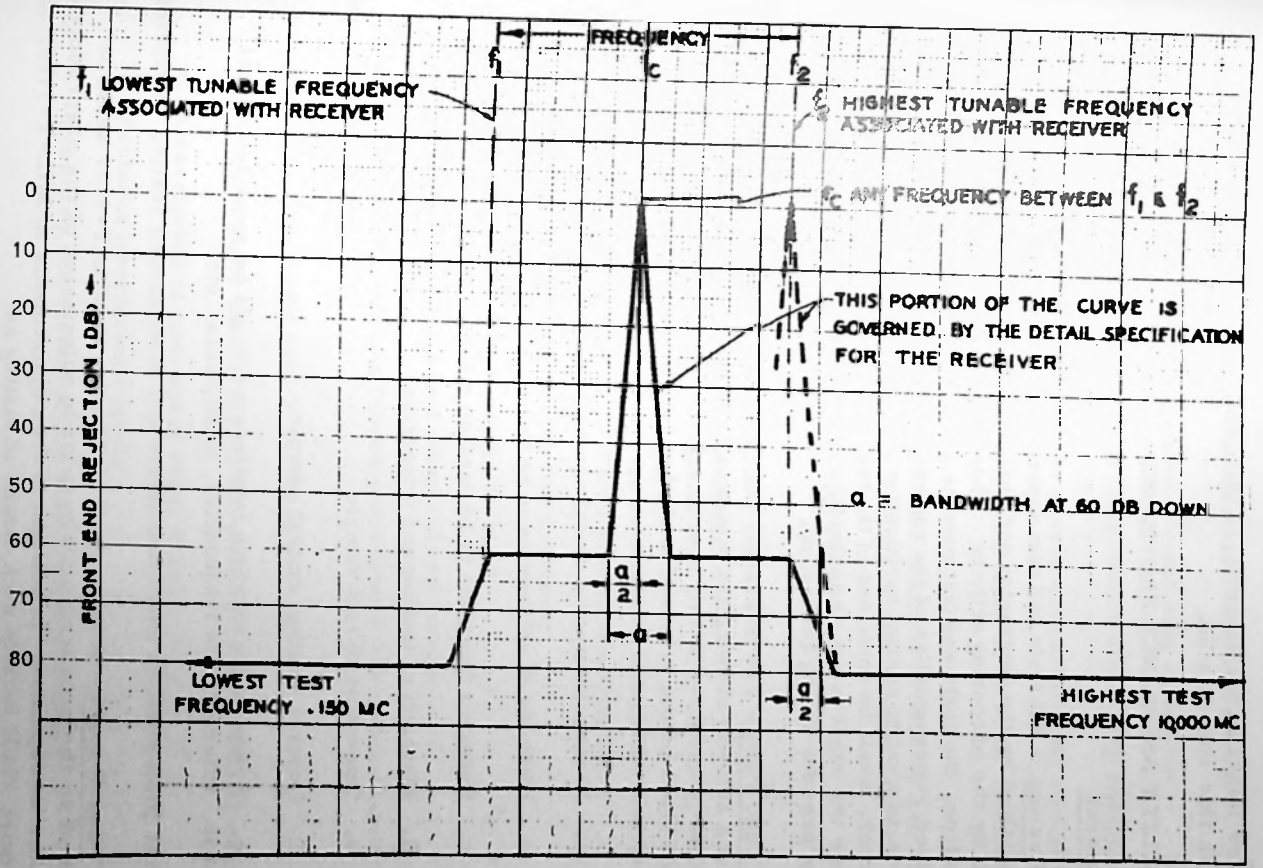


FIGURE 10 Receiver Front End Rejection

Force are listed in 6.2 according to their ability to determine compliance with this specification.

4. QUALITY ASSURANCE PROVISIONS

4.1 General

4.1.1 Testing. - All tests and test reports specified herein shall be accomplished by the contractor and shall be subject to approval and verification by the procuring activity. When the procuring activity waives verification, the tests and test reports shall be approved and verified by a qualified representative of the contractor's quality Control department. Evidence of quality control verification and approval, either Government or contractor, shall be contained in the test report. The Government further reserves the right to have a technical representative of the procuring activity present during the testing.

4.1.2 Test Plan. - The contractor shall submit a detailed test plan to the procuring activity showing the means of implementation and the application of the test procedures in this specification to the equipment being procured. Included shall be the proposed method of testing for the requirements in figure 1, and additional details such as:

a. Nomenclature and serial numbers of test equipment to be used

b. Methods of calibration to be used

c. Detector functions to be used on measuring equipment

d. Methods of loading and triggering

e. Operation of test sample

f. Control settings on test sample

g. Frequencies at which interference might be expected, local oscillator, intermediate frequencies, multipliers, etc.

This test plan shall be submitted before any interference testing is started.

4.1.3 Test Report. - A test report conforming to MIL-T-9107 shall be submitted to the procuring activity prior to submission of the preproduction model for acceptance. In addition to the requirements in MIL-T-9107, the test report shall include such details of testing as:

a. Nomenclature of interference measuring equipment

b. Serial number of interference measuring equipment

c. Date of last calibration of interference measuring equipment

d. Detector functions used on interference measuring equipment

e. Internal noise level of instrument used on detector function at each test frequency

f. Descriptions of procedures used (methods of loading and triggering, etc, operation of and control settings on test sample, etc.)

g. Measured line voltages to test sample

h. Test frequencies

i. Method of selection of test frequencies

j. Type of interference measured

k. Measured level of interference at each test frequency

l. Specification limit at each test frequency

m. Graphs showing items e, h, k, and l

n. Photographs of the test setup and test sample

o. Sample calculations (showing how item k was obtained for all antennas used).

p. Description and size of screened enclosure

q. Ground plane used if test is not performed in screened enclosures

r. Description of open space area, if used

s. Ambient interference levels

t. Measured impedance of line stabilization network.

4.1.3.1 Examples of Sample Calculation

a.

Interference measuring equipment	NF-105
Frequency of cw measurement	460 mc
Antenna factor (DM Antenna)	+8 db
Cable loss correction factor at 460 mc	+3 db
Meter reading	+40 db

Interference level = meter reading + cable loss + antenna factor = 40 + 3

+ 8 = 51 db

b.

Interference measuring equipment	NM-20B
Frequency of broadband radiated measurement	500 kc
Antenna factor	0 db or 1
Cable loss correction factor	0 db or 1
Meter reading	9 microvolts
Effective random bandwidth	3400 cps

Impulse bandwidth = 1.4 x 3400 = 4760 cps = 4760 kc

$$\text{Interference level} = \frac{\text{meter reading + antenna factor + cable loss}}{\text{impulse bandwidth}}$$

$$= \frac{9 \times 1 \times 1}{4.76} = 1.89 \ \frac{\text{Antenna induced microvolts}}{\text{kc}}$$

= 65.5 db above 1 microvolt per mc (antenna induced)

4.1.3.2 Identification of Test Sample. - The test sample shall be completely identified in the test report with complete nomenclature, manufacturer, and serial number. All suppression work performed on the test sample during the interference tests shall be fully described in words as well as by the test data in the test report.

4.1.4 Operation of Measuring Instruments. - For both conducted and radiated interference measurements, the instruments used shall be calibrated and operated as indicated in their respective instruction manuals, unless otherwise permitted by this specification.

4.1.4.1 Calibration. - Interference measuring instrumentation shall be maintained in a known condition of accuracy. Periodic checks on the calibration accuracy shall be made with laboratory generators. Recalibration shall be accomplished when the standardized gain setting fails to reflect a meter reading within plus or minus 20 percent of the known input signal. Substitution type measurements can be used in lieu of the calibrated method.

4.1.4.2 Generator Accuracy. - Laboratory-type signal generators and impulse generators capable of an output voltage accuracy of at least 20 percent shall be used to calibrate interference measuring instruments and for substitution measurements.

4.1.4.3 Broadband Interference Measurement. - Broadband interference shall be measured by using an impulse generator with the substitution technique, or by calibrating the interference measuring instrument so that it reads directly in decibels above one microvolt per unit bandwidth. The peak detector function on the interference measuring instruments shall be used for broadband and pulsed cw measurements.

4.1.4.4 CW Interference Measurements. - CW interference shall be measured by calibrating the interference measuring instrument so that it reads directly in decibels above one microvolt or by using a signal generator with a substitution technique.

4.1.4.5 Pulsed CW Interference Measurements. - Pulsed cw shall be measured in accordance with the procedures and limits used for broadband interference.

4.1.5 Bonding Measuring Instrument. - Interference measuring instruments utilizing dipole antennas shall be bonded to the ground plane or shielded enclosure with the ground clip on the power cord. Instruments used for conducted measurements shall not be bonded to the ground plane except through the interconnecting coaxial cable.

4.1.5.1 The counterpoise on rod antennas shall be bonded to the ground plane with a strap of such length that the rod antenna can be positioned correctly. The strap shall be as wide as the counterpoise. This applies to rod antennas utilizing the interference measuring instrument as a counterpoise, and to rod antennas mounted on a separate counterpoise.

4.1.5.2 The interference measuring instruments shall be physically grounded with only one connection. If the copper strap is used, neither the ground clip, the ground terminals, nor the power supply shall be connected to ground.

4.1.6 Monitoring. - The interference measuring instrument shall be monitored with a headset, loudspeaker, oscilloscope, or other indicating devices, during all measurements. Precaution shall be taken to ensure that the monitoring does not influence the meter reading on the interference measuring equipment.

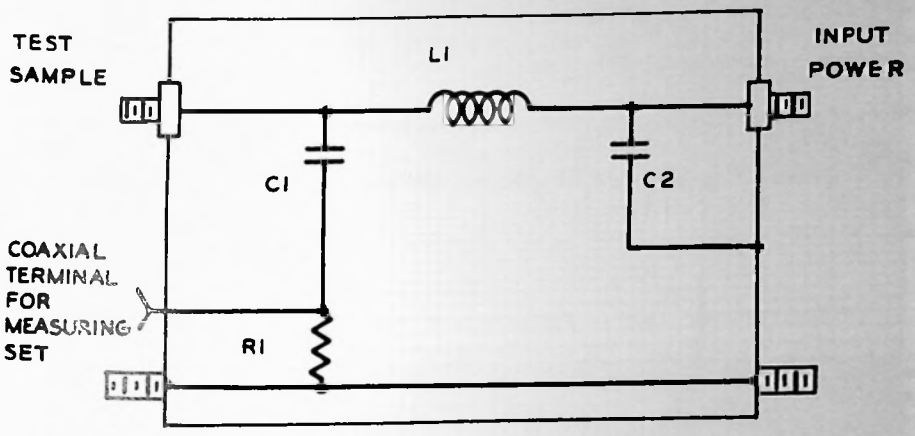
4.1.7 Test Frequencies. - The interference measuring instrument shall be slowly turned through each frequency octave and the frequencies at which maximum interference or susceptibility is obtained shall be selected as test frequencies. Test frequencies shall not be selected prior to the interference test. The witnessing official or Government representative shall certify in the test report that the test frequencies were selected after each octave was scanned. A minimum of three measurements shall be made in each frequency octave.

4.1.8 Tuning. - The interference measuring instrument shall be tuned to and measurements made at the fundamental frequency and all harmonics of equipment containing oscillator circuits. Additional checks shall be made by scanning for and measuring any signal or spurious response that can be anticipated.

4.1.9 Power Line Stabilization Network. - The power line stabilization network is shown in figure 11. One each network shall be inserted in each ungrounded power supply lead supplying power to the test sample, and shall be used for the complete radio interference tests. The network enclosure shall be bonded to the ground plane.

4.1.9.1 Performance Characteristics. - The current carrying capacity of the network shown is 50 amperes dc to 800 cycles ac. The maximum voltage drop at 50 amperes is not over 2 percent of the supply voltage. The performance characteristics of this device will permit measurements of test items at the following maximum voltage ratings:

dc	600 volts
60 cycles	440 volts
400 cycles	230 volts
800 cycles	115 volts



7- RESISTOR DATA: R_1 = 1000 OHM, 1 WATT CARBON

6 CAPACITOR DATA: C_1 = .1 MF, 600 VOLT DC, BATHTUB
C_2 = 1 MF, 600 VOLT DC, BATHTUB

5 CAPACITORS SHALL BE MOUNTED ON 1-INCH INSULATING BLOCKS

4 COIL DATA: L1 = 5 MICROHENRIES, 13 TURNS SINGLE LAYER, 4-IN WINDING LENGTH

3- WIRE DATA : AWG 6, 600 VOLT, .310 INCH DIA (OD)

2 FORM DATA: 5 1/4-IN LENGTH, 3-IN DIA. (OD), .125-IN WALL
DRILL 3/8-IN HOLE 7/16-INCH FROM EACH END.

1 ENCLOSURE DATA: 14 GAUGE (B&S) ALUMINUM
SUGGESTED SIZE 9 3/8-IN. x 4-IN. x 4-IN.

FIGURE 11 POWER LINE STABILIZATION NETWORK SCHEMATIC DIAGRAM

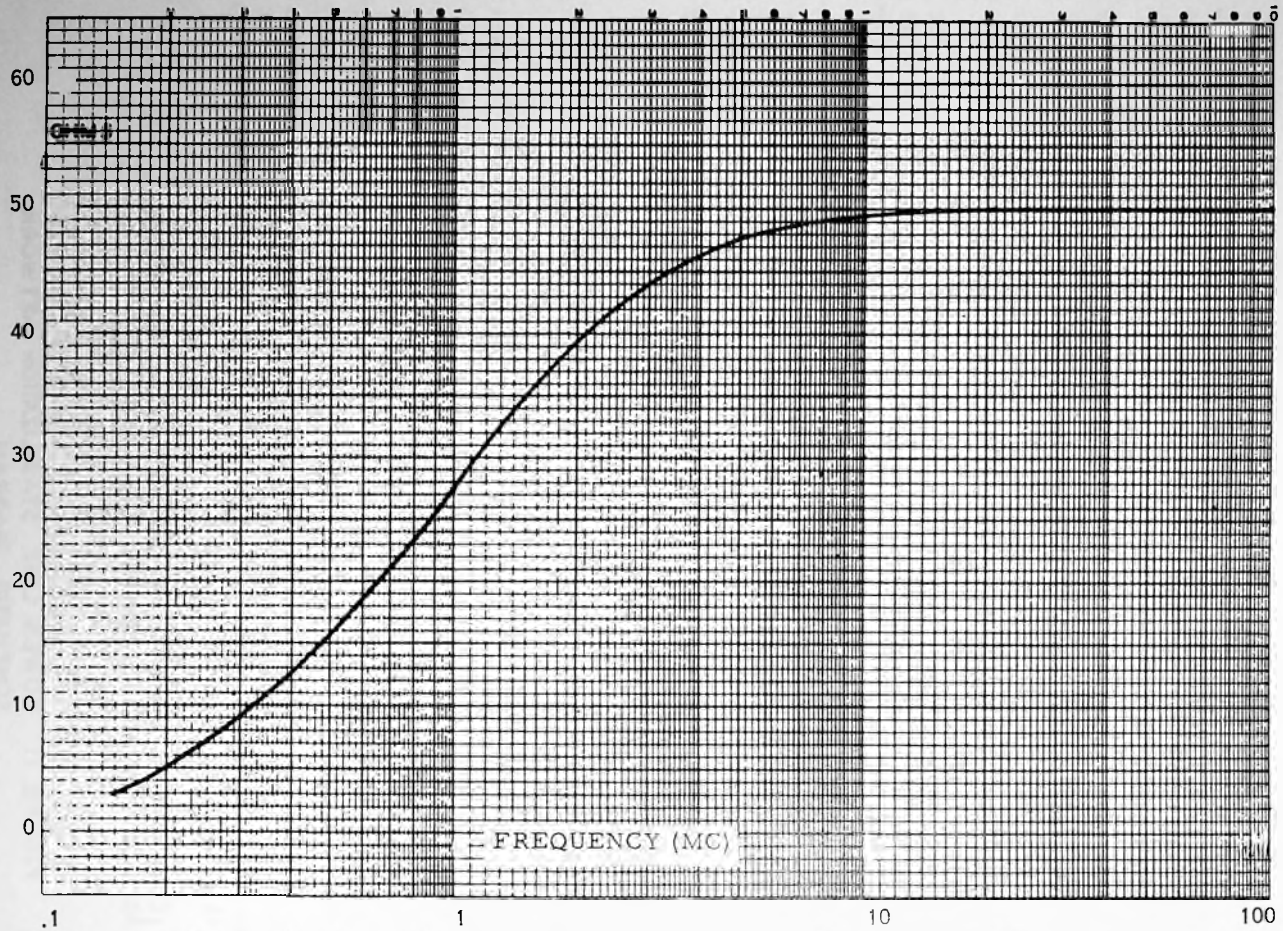


FIGURE 12 INPUT IMPEDANCE OF LINE STABILIZATION NETWORK

4.1.9.2 Design of Typical Network. - Working data and an electrical schematic drawing of this device are included in figure 11. The network shall have a nominal impedance, looking into the test sample terminal, within plus or minus 10 percent of that given in figure 12 when the power line terminal is open circuited, and when a 50-ohm termination is connected to the noise meter terminal. This is a network for currents up to 50 amperes; it is not anticipated that networks with a higher rating will be required since another measurement method using a current probe is available.

4.2 Test Conditions

4.2.1 Ambient Interference Level. - It is desirable that the ambient interference level during testing, measured with the test sample deenergized, be at least 6 db below the allowable specified interference limit. However, in the event that at the time of measurement the levels of ambient interference plus test item interference are not above the specified limit, the test item, etc. This requirement shall apply equally to both radiated and conducted ambient interference levels. A shielded enclosure can be used if necessary or desired. If a shielded enclosure is used, the minimum length shall be such that a 35-mc tuned dipole can be placed in the room with at least 12 inches clearance between the antenna extremities and the shielded enclosure.

4.2.2. Ground Plane. - A copper or brass ground plane, 0.01 inch thick minimum for copper, 0.025 inch thick minimum for brass, 12 square feet or more in area with a minimum width of 30 inches, shall be used. In a screen room the ground plane shall be bonded to the shielded room at intervals no greater than 3 feet and at both ends of the ground plane. The ground plane and screen room walls may be considered equivalent to an aircraft fuselage for purposes of simulating a normal installation. For large equipment systems mounted on a metal test stand, the test stand may be considered, for testing purposes, to be a part of the ground plane and shall be bonded accordingly. When a shielded room is not used, the measuring equipment may be placed on a solid support for operation. The support may be solid earth, steel or iron flooring, metal bedplate, metal-covered planking, or the like.

4.2.3 Bonding. - Only the provisions included in the design of the equipment and specified in the installation instructions shall be used to bond units, such as equipment case and mount, together or to the ground plane. Where bonding straps are required to complete the test setup, they shall have a length not greater than 5 times the width, shall have a minimum thickness

of 0.025 inch, and shall be copper or brass metal straps, not braid. Connections made with such bond straps shall have clean metal-to-metal contact.

4.2.3.1 Shock and Vibration Isolators. - Test samples shall be secured to mounting bases incorporating shock or vibration isolators, if such mounting bases are used in the installation. The bonding straps furnished with the mounting base shall be connected to the ground plane. Where mounting bases do not incorporate bonding straps, bonding straps shall not be used in the test setup.

4.2.3.2 External Ground Terminal. - When an external terminal or connector pin is available for a ground connection on the test sample, this terminal shall be connected to the ground plane if the terminal is normally grounded in the installation. If the installation conditions are unknown, the terminal shall not be grounded.

4.2.3.3 Portable Equipment. - Portable equipment shall be tested while it is bonded to the ground plane and also when it is not bonded to the ground plane. Portable equipments that are intended to be grounded through a power cord shall not be bonded to the ground plane by other means.

4.2.4 Power Supply Voltage. - The power supply voltages shall be within the tolerance specified in the detail specification for the test sample. The voltages shall be measured at the power line terminals on the line stabilization networks. The test sample shall be operated at the line voltage, within the above tolerance, which causes maximum conducted interference or susceptibility at 0.5 mc.

4.2.5 Arrangement and Operating Conditions. - The general arrangement of equipment, interconnecting cable assemblies, and supporting structures shall be such as to simulate actual installation and usage insofar as practicable. The front surface of each unit shall be located 4 inches ± 1/2 inch from the edge of the ground plane; interconnecting cables shall be routed between the units and the edge of the ground plane. In those cases where equipment size exceeds the ground plane dimensions, or where more than two line stabilization networks are required, the above instructions shall be adhered to as closely as possible.

4.2.5.1 Dummy Antennas. - Any dummy antenna used shall have electrical characteristics which closely simulate those of the normal antenna, and should be shielded where possible. The dummy antenna shall be capable of handling the power required and shall contain any unusual components which are used in the normal antenna (such as filters, crystal diodes, etc). When the nominal antenna impedance is 50 ohms, a 50-ohm (± 20 percent from 0.15-1000 mc) dummy antenna shall be used.

4.2.5.1.1 A 5-foot length of double shielded coaxial cable shall be used between a transmitter and its dummy antenna.

4.2.5.2 Test Sample Leads. - The test sample leads to the power line stabilization network shall be 24 inches ± 1 inch in length and shall be so arranged that the distance between the leads and from each lead to ground or grounded enclosure is approximately 2 inches. In those cases where more than two power line stabilization networks are required, the above instructions shall be adhered to as closely as possible.

4.2.5.2.1 Interconnecting Leads. - Interconnecting leads between boxes comprising a test sample shall not be less than 2 feet and not more than 5 feet long. Leads between the test sample and external leads shall be 5 feet long.

4.2.6 Antenna Orientation and Positioning in Shielded Enclosures. - Those interference measuring instruments which use a rod antenna shall be so placed that the rod antenna is in a vertical position and the instrument panel or counterpoise is 6 inches below the level of the ground plane. The rod antenna shall be located at the point where maximum interference or susceptibility indications are obtained when it is moved along a line parallel with the edge of the ground plane. Those interference measuring instruments which use a resonant dipole antenna shall have the dipole positioned parallel with the front edge of the ground plane. Its height shall be 12 inches ± 1 inch above the level of the ground plane and its center shall be adjacent to the geometrical center of the units under test. The rod or the dipole antenna shall be located at the distance from the test sample specified in figure 1, and the typical test setups. When the dimensions of the dipole or directive antenna become smaller than the test layout, the antenna shall be moved parallel to the edge of the ground plane to keep its sensitive elements adjacent to the point of maximum leakage or susceptibility. At frequencies from 25 up to and including 35 megacycles, the measurements shall be taken with the dipole antenna adjusted to 35 mc. The dipole antenna shall be adjusted to the proper length at all frequencies above 35 mc.

4.2.7 Antenna Orientation and Positioning (Free Space). - Those interference measuring instruments which use a rod antenna shall be so placed that the rod antenna is in a vertical position. Those interference measuring instruments which use a dipole antenna shall be so placed that the antenna is parallel with the test sample and on the same level as the midpoint of the test sample. The antenna shall be at the distance from the test sample specified in figure 1. The antenna shall be located at a point around the perimeter of the test sample where maximum interference signal is received.

4.2.8 Loads. - The equipment under test shall be loaded with the full mechanical and electrical load, or equivalent, for which it is designed. This requirement specifically includes electrical loading of the contacts of mechanisms which are designed to control electrical loads even though such loads are physically separate from the equipment under test. Operation of voltage regulators and other circuits which operate intermittently is required. The loads used shall simulate the resistance, inductance, and capacitance of the actual load.

4.3 Test Methods

4.3.1 Conducted Interference. - Radio interference voltages, in the frequency range of 0.15 to 25 mc, generated by the equipment or system in excess of the values indicated in figures 2, 3, 4, and 5 shall not appear on any conductor, external to the system, which could conduct interference to other equipment. Typical test setups for these measurements are shown in figures 13 and 14. Measurements may be omitted on leads deemed incapable of conducting interference into other equipment by the procuring activity.

4.3.1.1 Conducted Interference Using Stabilization Network. - Conducted interference measurements on input power leads, 50 amperes and under shall be made by connecting the interference measuring instrument to the noise meter terminal on the line stabilization network with a 6-foot length of 50-ohm double-shield coaxial cable.

4.3.1.2 Conducted Interference Using Current Probe. - Conducted interference measurements on power lines over 50 amperes and other lines shall be made with a clamp-on interference current measuring device. Examples of cases where this requirement applies are measurement on electrical load lines, inverter output lines, high current (over 50 amperes) power lines, etc. Measurements might be required on shielded leads in some cases.

4.3.1.2.1 Position of Probe. - The current probe shall be positioned at the point of maximum interference on the lead to be tested. This maximum interference point shall be located at each test frequency. The location of the current probe shall be fully described in the test report.

4.3.2 Radiated Interference. - Radiated interference fields in excess of the values given in figures 6, 7, 8, and 9 shall not radiate from any unit, cable (including control, pulse, IF, video, antenna transmission and power cables), or interconnecting wiring over the frequency range of 0.15

to 10,000 mc for cw and pulsed cw interference and 0.15 to 400 mc for broadband impulsive interference. This requirement includes the transmitter fundamental spurious radiation, oscillator radiation, other spurious emanations, and broadband interference. This does not include radiation emanating from antennas. Test setups are illustrated in figures 15, 16, 17, 18, 19, 20, 21, 22, and 23. Equipments which do not utilize electronic circuits and which are incapable of producing oscillations, either intentional or unintentional, are exempt from measurements above 400 mc.

4.3.3 Antenna-Conducted Spurious Emanations

4.3.3.1 Transmitter Keyup or Receiver. - The rf output of any transmitter keyup or receiver shall not exceed 40 db above 1 microvolt for cw or 60 db above 1 microvolt per mc for impulse interference at any frequency between 0.15 and 10,000 mc. Measurements above 1000 mc will not be required providing the contractor can furnish satisfactory evidence to the procuring activity that such measurements do not result in any significant data.

4.3.3.2 Transmitter Keydown. - The transmitter shall be operated into a dummy load. A suitable coupling device shall be used to sample the transmitter output and protect the measuring equipment. Bridge "T" rejection networks, filter rejection network, or other adequate devices shall have the approval of the procuring activity. Attention should be given to oscillator frequency and harmonics, outputs from frequency multipliers and crystal saver circuits, beat frequency oscillator outputs, etc. External filters shall not be used unless approval is obtained from the procuring activity. Spurious emanations shall be below the fundamental power by the value obtained from the following formula at any frequency between 0.15 and 10,000 mc: Requirements in decibels below the fundamental = 80 + 10 log (transmitter power in watts). Measurements above 1000 mc will not be required providing the contractor can furnish satisfactory evidence to the procuring activity that such measurements do not result in any significant data.

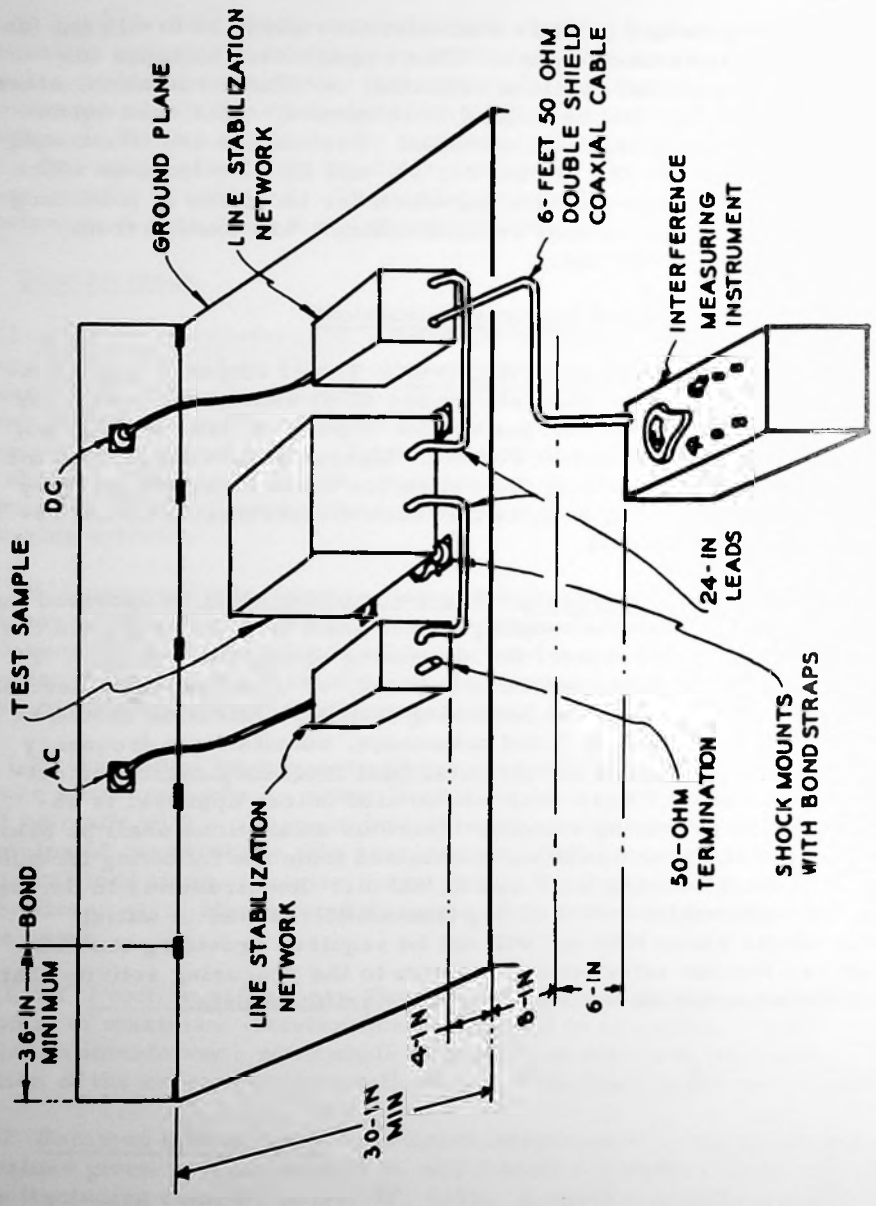


FIGURE 13. TYPICAL TEST SETUP FOR CONDUCTED INTERFERENCE MEASUREMENTS

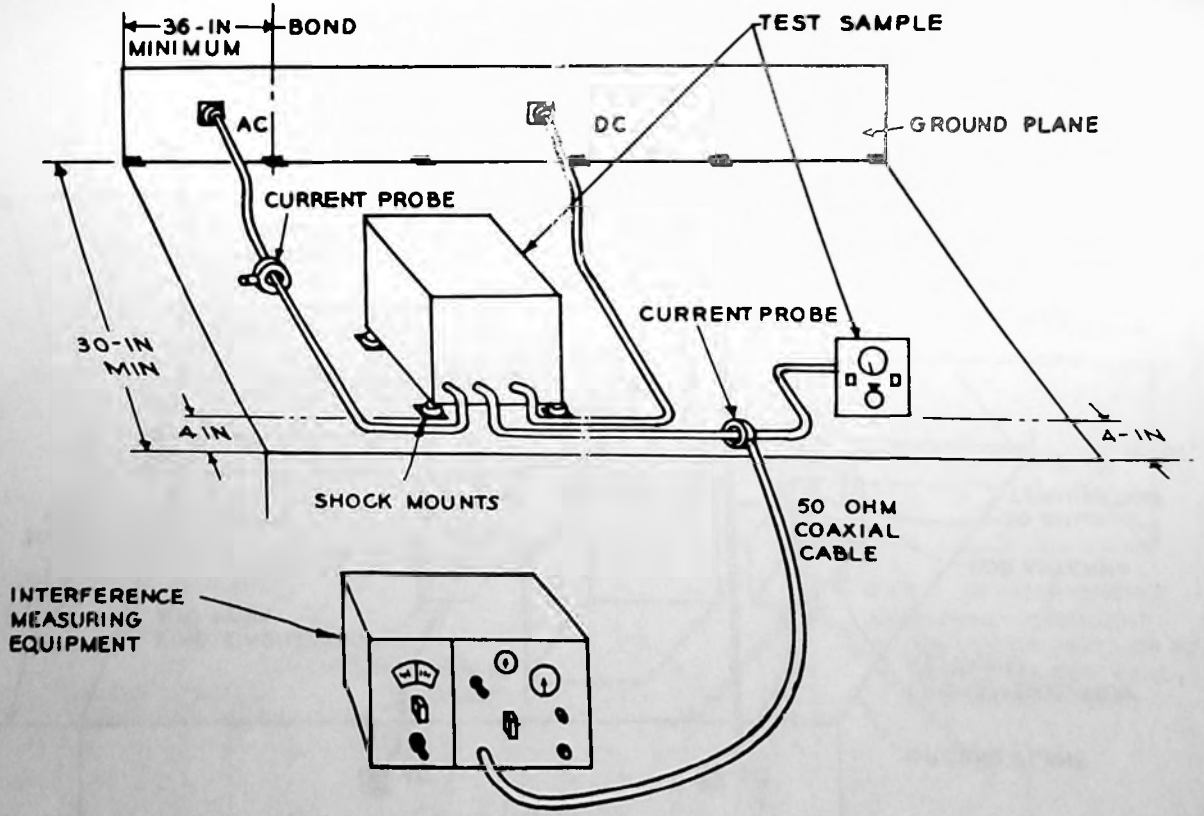


FIGURE 14 TYPICAL TEST SETUP FOR CONDUCTED INTERFERENCE MEASUREMENTS USING CURRENT PROBE

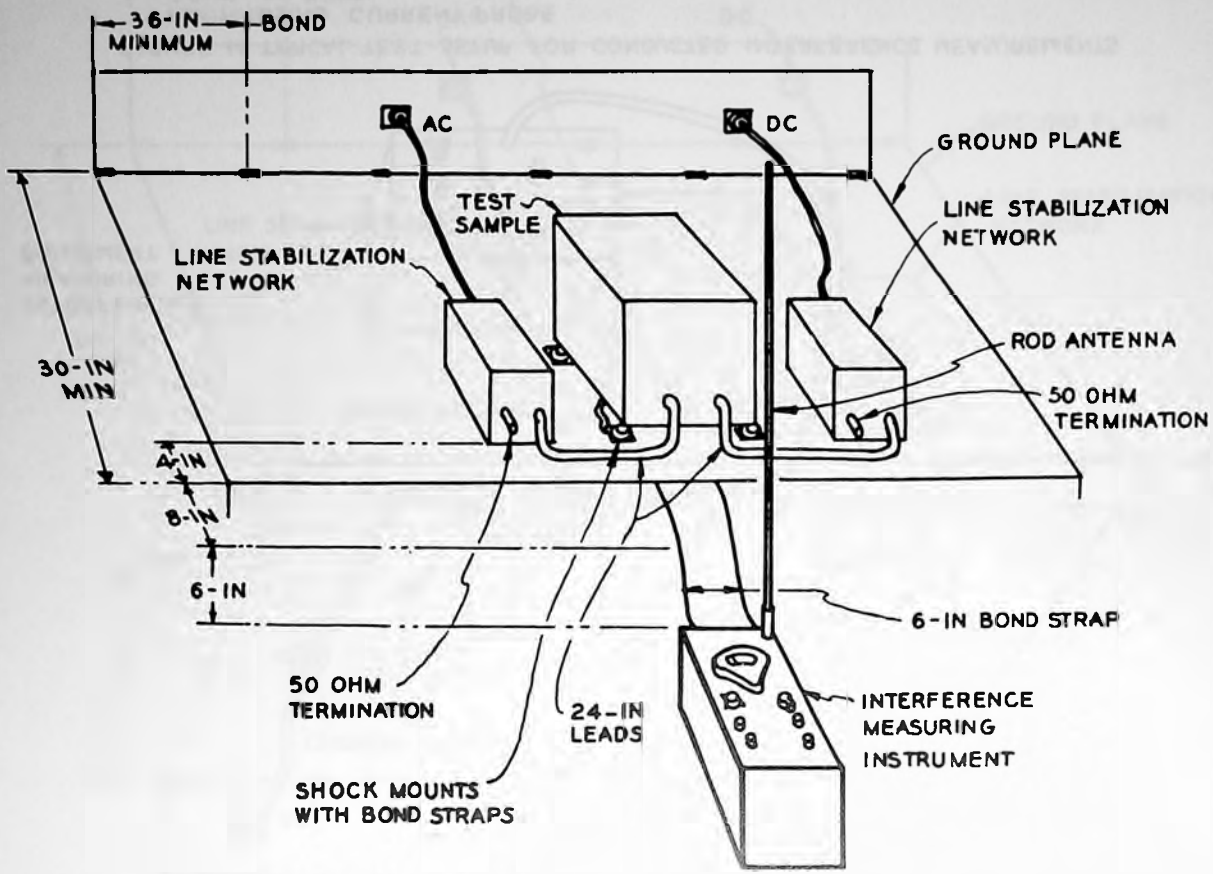


FIGURE 15 TYPICAL TEST SET-UP FOR RADIATED MEASUREMENTS (ROD ANTENNA) CLASS I EQUIPMENT

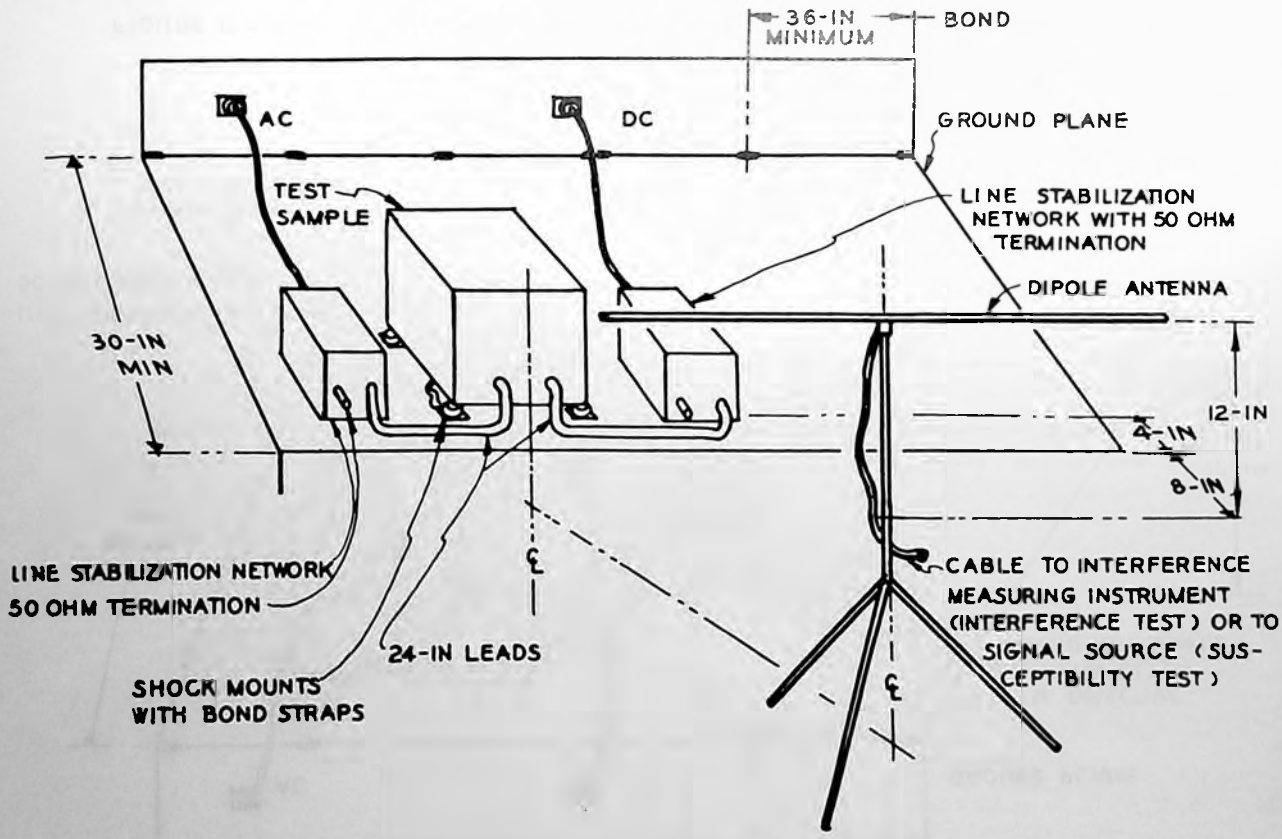


FIGURE 16 TYPICAL TEST SETUP FOR RADIATED MEASUREMENTS (DIPOLE ANTENNA)
CLASS I EQUIPMENT

MIL-I-26600 (USAF)

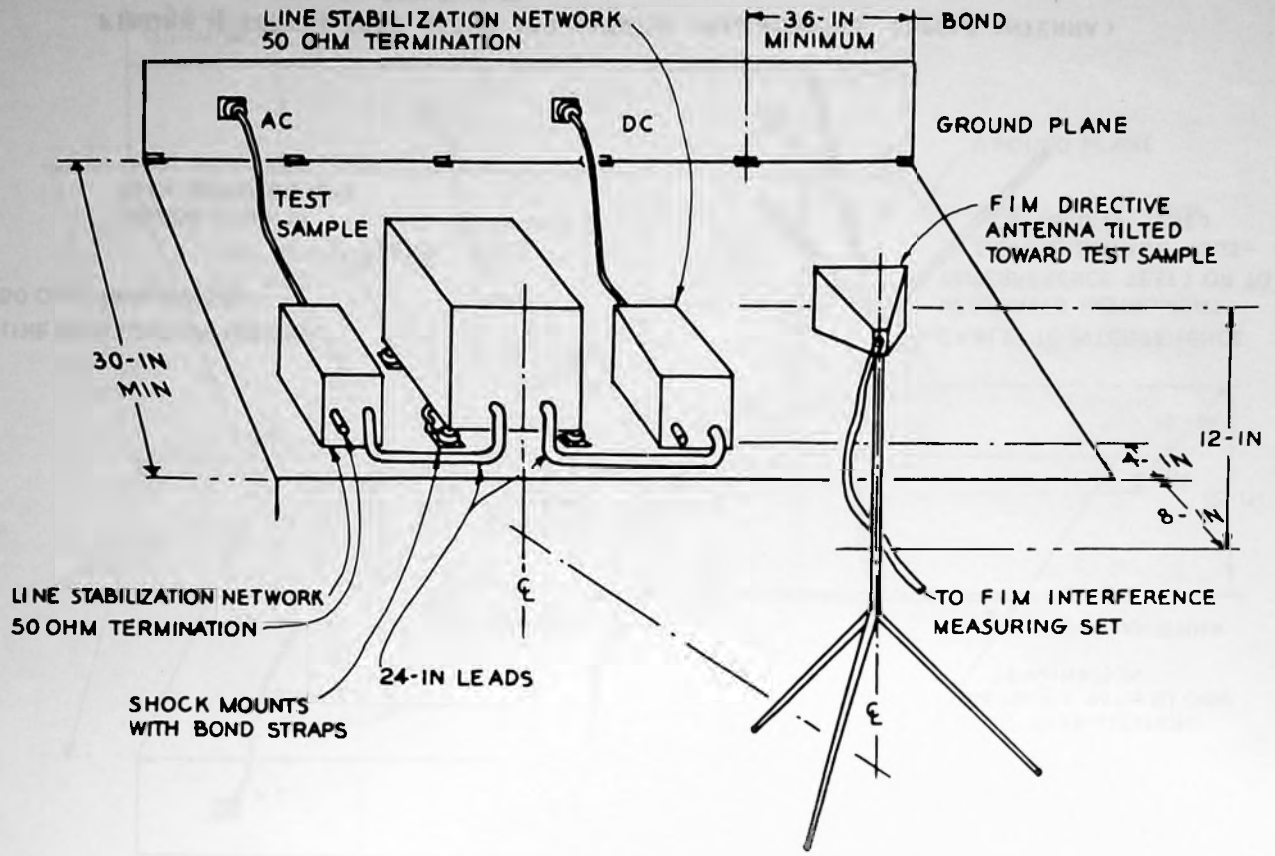


FIGURE 17 TYPICAL TEST SETUP FOR RADIATED MEASUREMENTS (MICROWAVE-DIRECTIVE ANTENNA) CLASS I EQUIPMENT

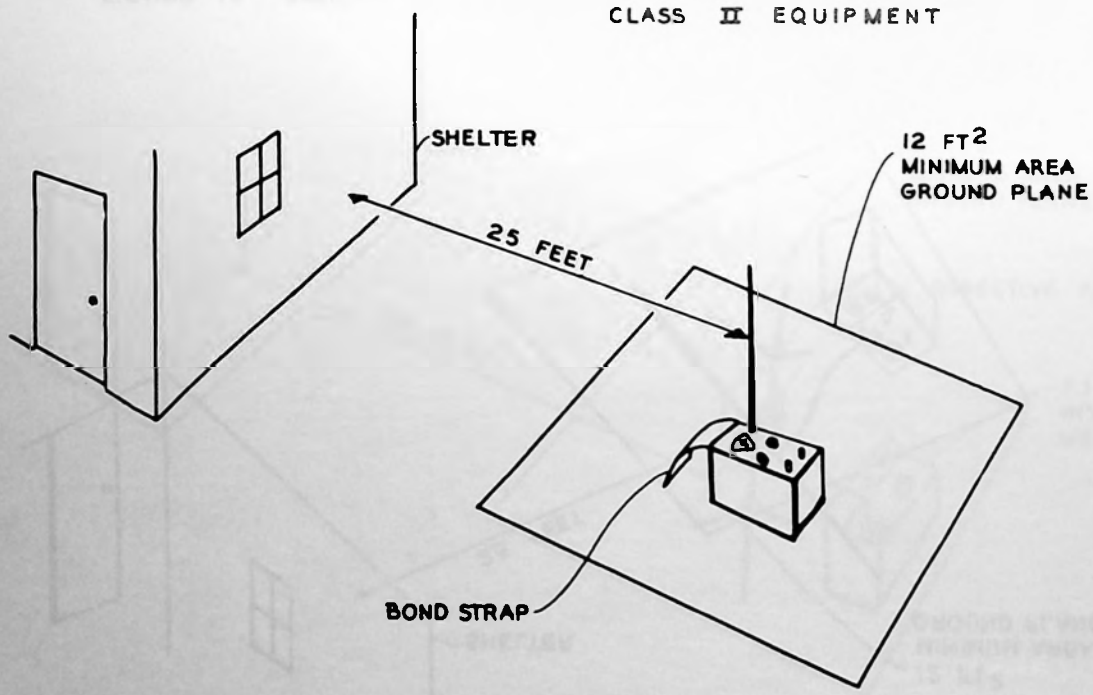


FIGURE 18 TYPICAL TEST SETUP FOR RADIATED MEASUREMENTS
(ROD ANTENNA)

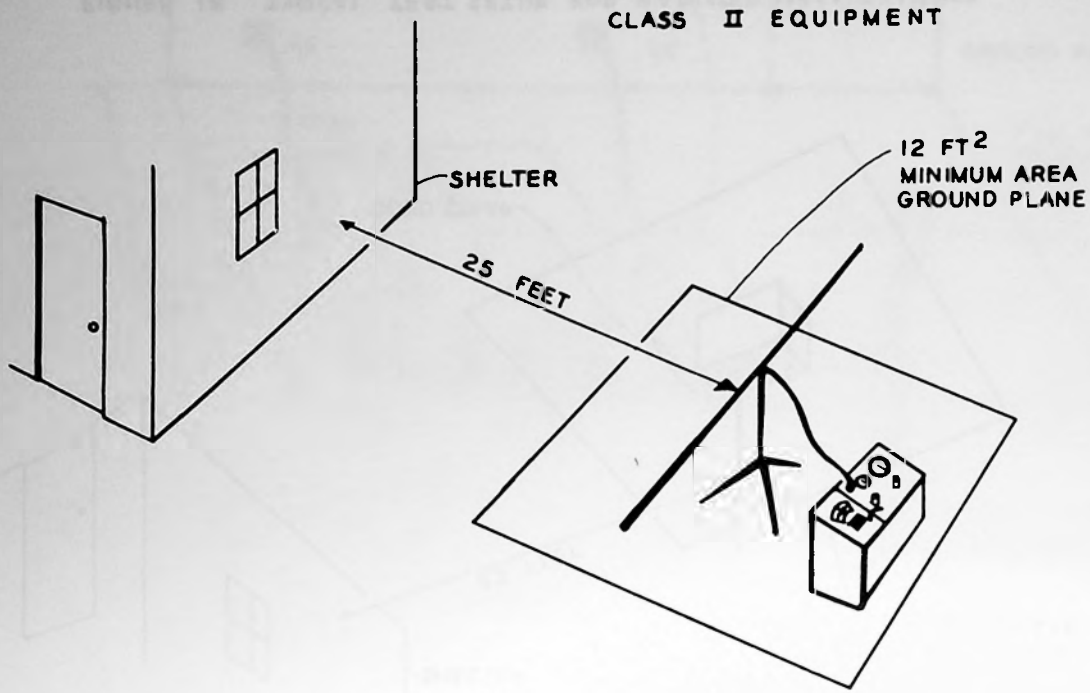


FIGURE 19 TYPICAL TEST SETUP FOR RADIATED MEASUREMENTS (DIPOLE ANTENNA)

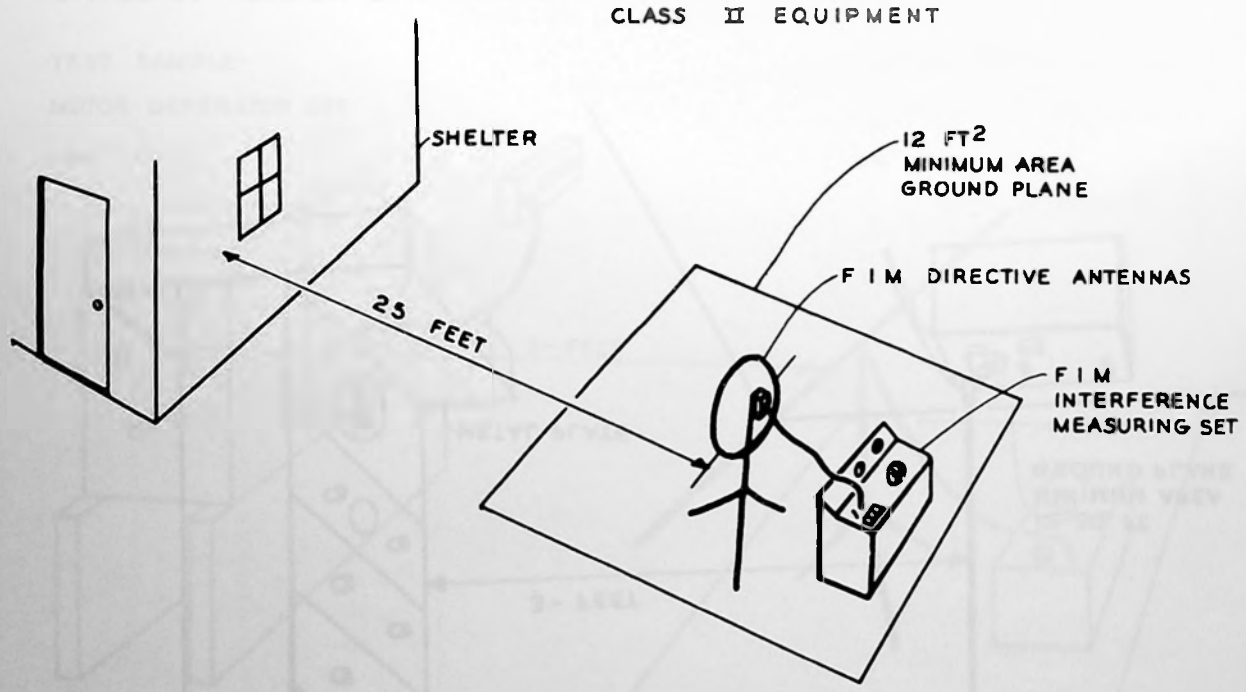


FIGURE 20 TYPICAL TEST SETUP FOR RADIATED MEASUREMENTS
(MICROWAVE DIRECTIVE ANTENNAS)

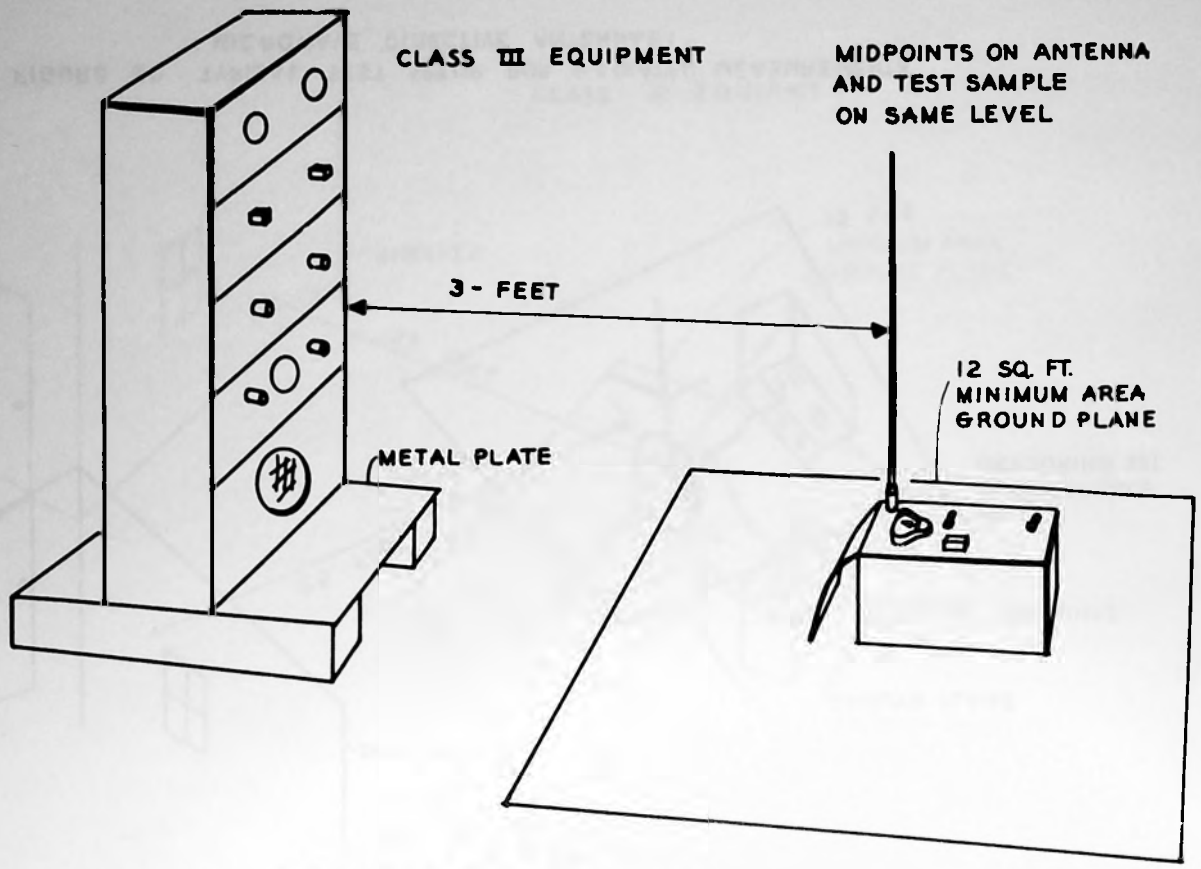


FIGURE 21 TYPICAL TEST SETUP FOR RADIATED MEASUREMENTS (ROD ANTENNA)

CLASS III EQUIPMENT

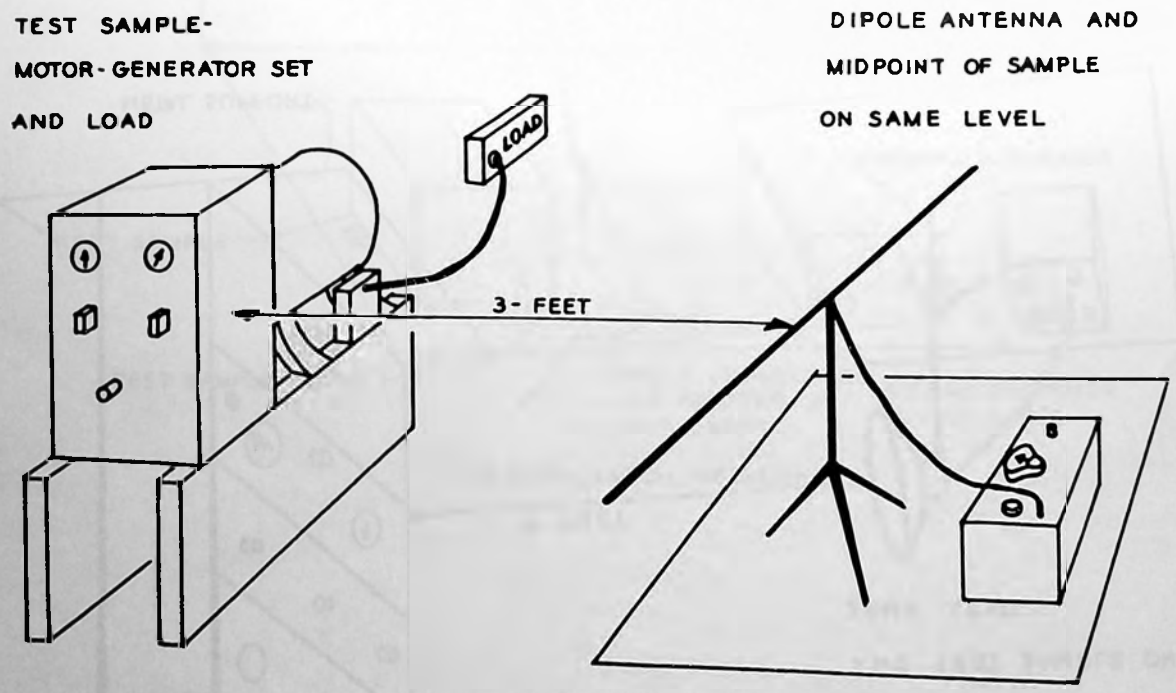


FIGURE 22 TYPICAL TEST SETUP FOR RADIATED MEASUREMENTS (DIPOLE ANTENNA)

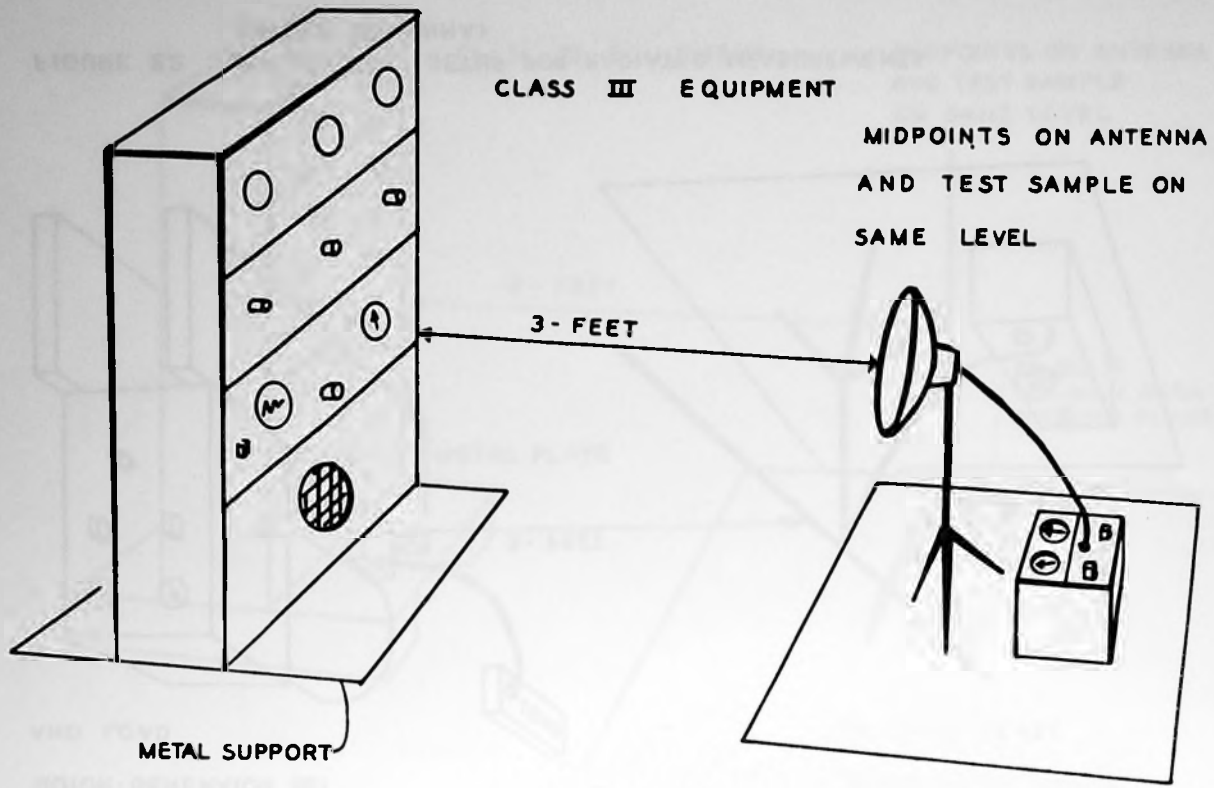


FIGURE 23 TYPICAL TEST SETUP FOR RADIATED MEASUREMENTS
(MICROWAVE DIRECTIVE ANTENNA)

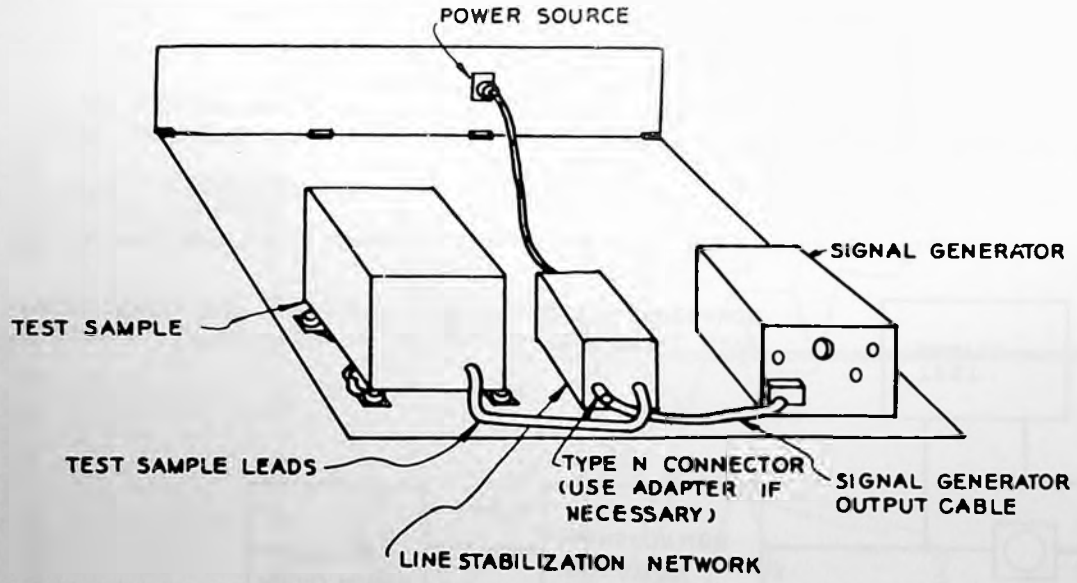
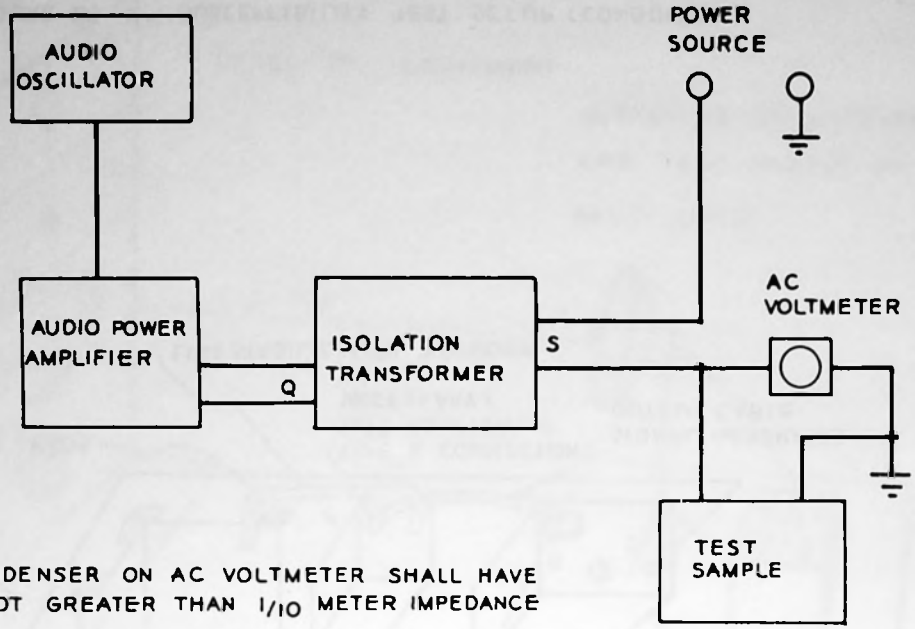


FIGURE 24 RF SUSCEPTIBILITY TEST SETUP (CONDUCTED)



3. SERVES CONDENSER ON AC VOLTMETER SHALL HAVE REACTANCE NOT GREATER THAN 1/10 METER IMPEDANCE

2. TRANSFORMER SHALL CARRY ALL CURRENTS WITHOUT SATURATION. TURNS RATIO $\frac{\text{PRIMARY}}{\text{SECONDARY}} = \frac{2}{1}$

1. AUDIO AMPLIFIER SHALL BE 30-50 WATTS AND SHALL HAVE A LOW IMPEDANCE OUTPUT OF 5 OHMS OR LESS

FIGURE 25 AF SUSCEPTIBILITY TEST SET UP

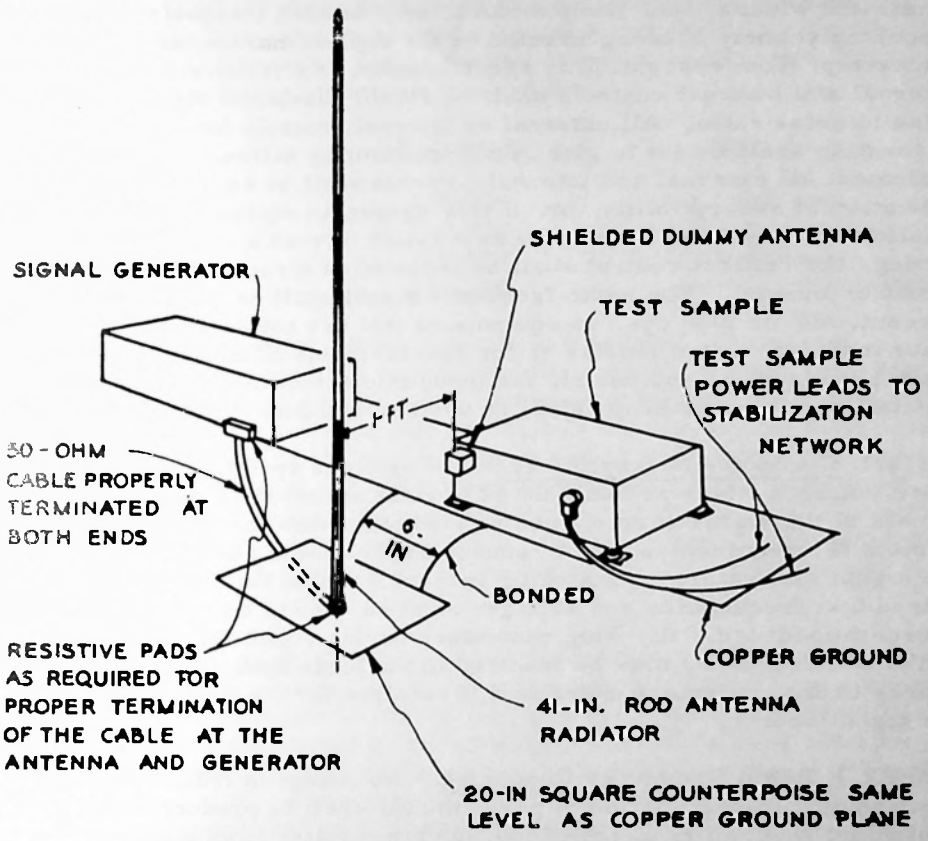


FIGURE 16 SHOWS TYPICAL TEST SET UP USING DIPOLE ANTENNA

FIGURE 26 SUSCEPTIBILITY RADIATED TEST SETUP
(ROD ANTENNA)

4.3.4 Susceptibility. - Equipment, such as navigation light flashers, windshield wipers, fuel pump motors, etc, deemed incapable by the procuring activity of being affected by the applied extraneous signals are exempt from susceptibility requirements. On receivers, all external and internal controls shall be set for maximum signal plus noise to noise ratio. All external or internal controls for squelch or limiting shall be set to give minimum limiting action. On other equipment all external and internal controls shall be set for maximum indication of susceptibility, or, if this causes an equipment to malfunction or to become inoperable as a result of such a control setting, the critical control shall be adjusted as directed in the instruction manual. The radio frequency signal shall be modulated 30 percent, 400 or 1000 cps, on equipments that are not designed for other modulation frequencies or for special forms of modulation. When testing other equipment, the modulation frequency or any other special form of modulation shall be used to modulate the radio frequency.

4.3.4.1 Conducted Susceptibility. - The voltages specified shall be those voltages which are calculated to exist across the output terminals of the signal source when no load other than that necessary to meet the requirements as to source impedance is connected to the signal generator. A matching network suitable for use at required test frequencies and voltages shall be used to obtain the proper source impedance. Blocking capacitors having neglibible impedance at the test frequency may be inserted in the leads from the signal source to the equipment under test if required for the protection of the signal source.

4.3.4.1.1 Radio Frequency Conducted. - No change in indication, malfunctioning, or degradation of performance shall be produced in any equipment when an rf signal of 100,000 microvolts, from a source having an impedance of 50 ohms is applied to the test sample as shown in figure 24. Tests shall be made over the frequency range of 0.150 mc to 10,000 mc.

4.3.4.1.2 Audio Frequency Conducted. - No change in indication, malfunction, or degradation of performance shall be produced in any equipment when a sine wave audio frequency signal of 3 volts rms is applied between each ungrounded power lead and ground as shown in figure 25. Measurements shall be made over a frequency range of 50 to 15,000 cps.

4.3.4.2 Radio Frequency Radiated. - No change in indications, malfunction, or degradation of performance shall be produced when the equipment is subjected to a radio frequency field. This field shall be established with a signal generator driving the antenna listed below.

Care shall be taken to use matching networks, when required. The voltages specified are those calculated to exist across the antenna terminals. The test setup is shown in figure 26 for the rod antenna and is similar to figures 16 and 17 for the other antennas, with the signal source replacing the interference meter.

Frequency	Microvolts	Antenna
0.10 to 25 mc	100,000	41 inch rod
25 to 35 mc	100,000	35 mc dipole
35 to 1000 mc	100,000	tuned dipole
1000 to 10,000 mc	100,000	nondirective antennas

4.3.4.3 Intermodulation. - Receivers, preamplifiers, or antenna couplers shall not produce an output indication when two sine wave signals, representing undesired signals, are connected to the input terminals of the test sample. The two frequencies shall be chosen so that their sum or difference is equal to the test frequency and so that neither will give an output when applied alone. The magnitude of each shall be at least 100 db above 1 microvolt at the test sample terminal; one shall be modulated 30 percent with a 1000 cycle signal, and the other 30 percent with a 400 cycle signal. Impedance matching networks shall be used as required.

4.3.4.4 Receiver Front End Rejection. - Front end rejection of receivers shall be equal to or greater than the limit shown in figure 10 except that image frequencies outside the tuning range of the receiver shall be 60 db. This requirement shall apply to each tuning unit on receivers with plug-in or separate tuning units. Dimension a in figure 10 shall not be greater than 20 percent of fc. This test shall be performed with any signal generators equipped with an accurate attenuator and capable of a signal output at least 80 db greater than the minimum signal perceptible at the tuned frequency of the particular receiver being tested. If necessary, matching networks shall be used to obtain a 50-ohm (± 20 percent) output. All measurements shall be corrected to account for any changes in output voltages due to addition of matching networks and shall be equal to the open circuit voltage at the output terminals. With the signal generator and receiver connected with a 50-ohm coaxial cable and tuned to the same frequency, the generator setting which gives the minimum perceptible reading above the receiver background noise shall be noted. Modulation may be used in conjunction with an output meter if the receiver is not equipped to give meter indications of cw signals. The frequency range between 150 kc and 10,000 mc shall then be scanned with the generator output preferably set at least 80 db above the output originally noted. Those frequencies at which output signals are obtained

shall be investigated to obtain the generator reading which corresponds to the original receiver output signal. Since all signal generators emit a substantial amount of harmonics, care should be taken that the receiver is not erroneously rejected because of such spurious signal content. Front end rejection is calculated with the following formula:

$$\text{Front end rejection} = 20 \log V_2/V_1$$

V_1= Signal generator voltage required for minimum perceptible receiver output on channel or frequency under test.

V_2= Signal generator voltage required for minimum perceptible receiver output at all other frequencies.

When this test cannot be accomplished due to the possibility of crystal burnout or for other reasons, the test signals shall be injected into the test sample by using a suitable antenna fed from a signal generator. The test procedure to be used shall be included in the test plan.

5. PREPARATION FOR DELIVERY

5.1 This section is not applicable to this specification.

6. NOTES

6.1 Intended Use. - The test procedures and limits specified herein are intended to insure that aeronautical, electrical, and electronic equipments will operate properly in service use when subjected to certain radio and audio interference voltages, and will not cause the malfunction of other equipments by generation of interference voltages. This specification applies to components or systems as specified by the procuring activity or by the detail specification.

6.2 Instrumentation. - The applicable interference measuring instruments which are currently commercially available are listed in table I according to their compliance with this specification. Instruments that have been modified to meet category A requirements should not be used unless a distinctive non-removable label has been attached by the instrument manufacturer; any restrictions on the usage of the modified instrument, or associated accessories, should be indicated on the label.

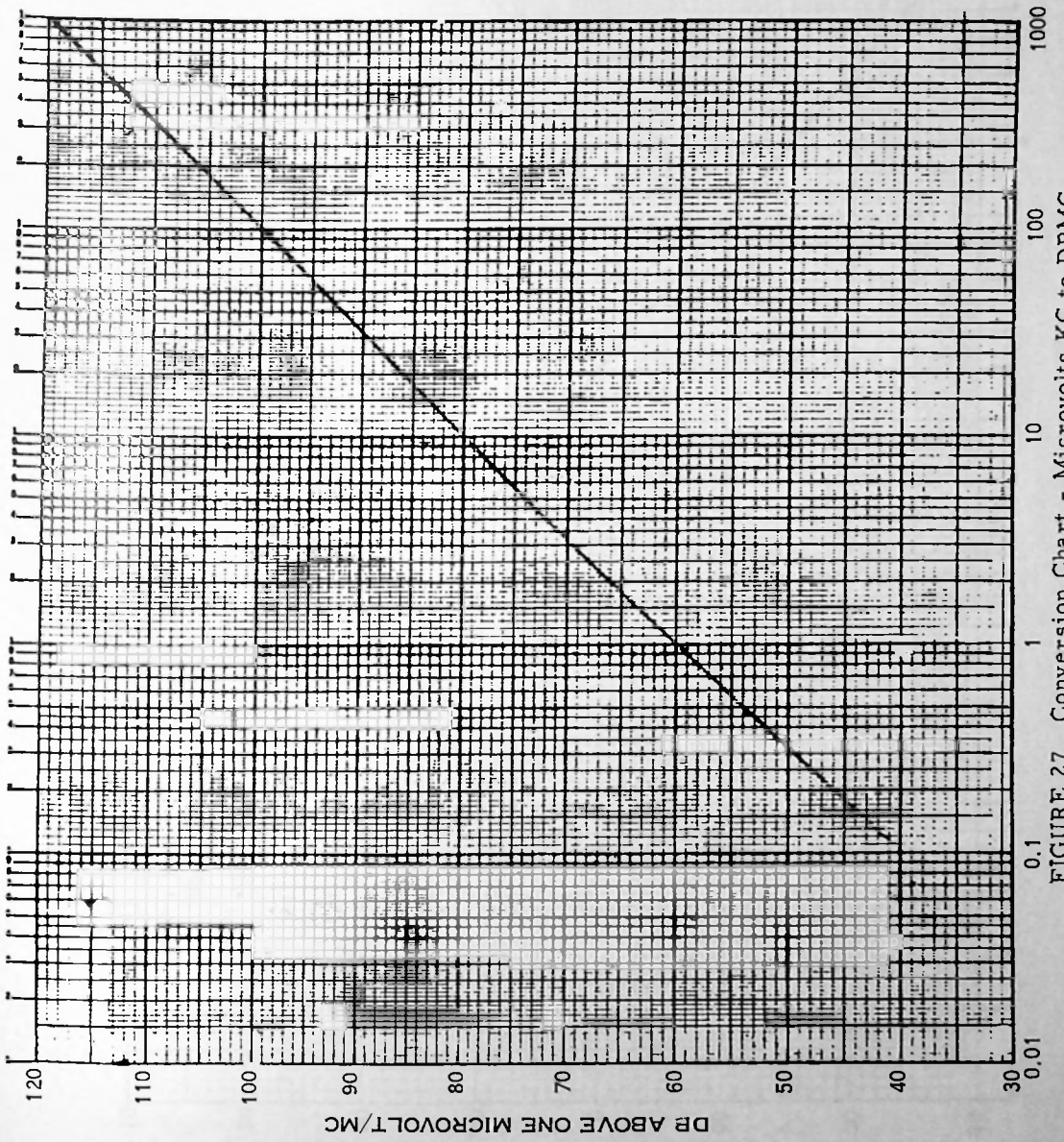


FIGURE 27 Conversion Chart - Microvolts KC to DBMC

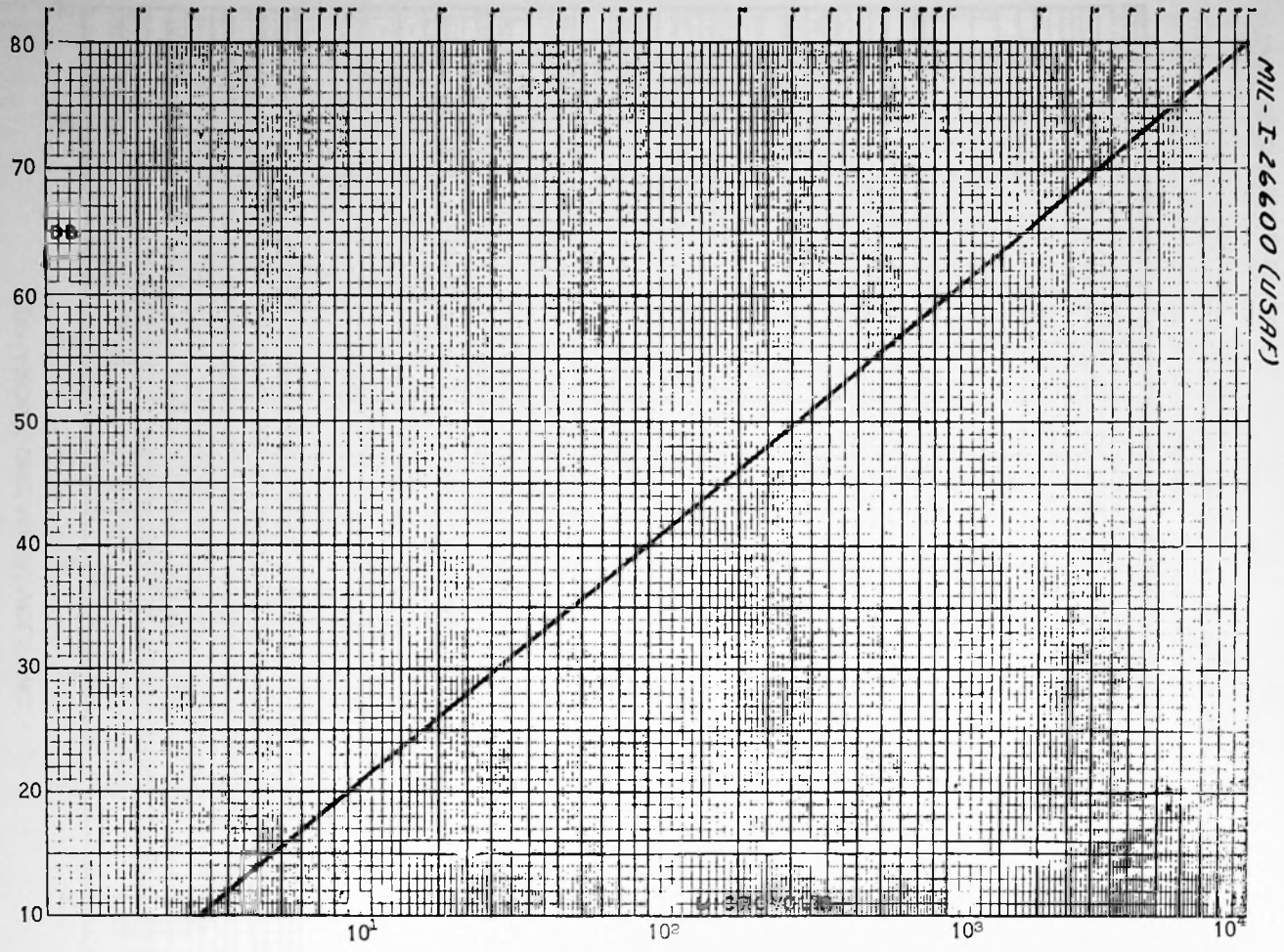


FIGURE 28 Conversion Chart - Microvolts to DB

6.2.1 Category A. - Category A instruments are those interference measuring instruments which adequately measure the parameters of interference signals as required by this specification and which are approved by the Air Force. Any combination of category A instruments may be used for the required measurements.

6.2.2 Category B. - Category B instruments are those existing instruments which are in use but which do not adequately measure the parameters of interference signals as required by this specification. Use of these instruments is permissible until conditions permit their replacement by category A instruments, if: (a) the category B instrument was procured prior to 29 May 1953, and the instrument is listed in the table; or (b) if a category A instrument is not commercially available in the same frequency range.

6.2.3 Category C. - Category C instruments should not be used unless specifically authorized by the procuring activity.

6.2.3.1 Category C-1. - Category C-1 instruments are those which have recently been developed to meet category A requirements that have not been evaluated by the Air Force.

6.2.3.2 Category C-2. - Category C-2 instruments are those which have been recently developed but do not meet category A requirements, and which can presumably be modified by the manufacturer to attain a category A rating.

TABLE I[1]

Category	Frequency Range	Commercial Nomenclature	Manufacturer
A	0.15 to 25 mc	NM-20A, B	Stoddart
	0.15 to 30 mc	T-A/NF-105[2]	Empire
	20 to 400 mc	NM-30A[3](Ser No. 191-1 or higher)	Stoddart
	20 to 200 mc	T-1/NF-105	Empire
	200 to 400 mc	T-2/NF-105	Empire
	400 to 1000 mc	T-3/NF-105[4]	Empire
	375 to 1000 mc	NM-50A[5](Ser No. 222-1 and higher)	Stoddart
	1000 to 10,000 mc	FIM	Polarad
B	375 to 1000 mc	NM-50A[5](Ser No. 190-50 and below)	Stoddart
C-1	375 to 1000 mc	NM-50B	Stoddart
C-2	0.15 to 30 mc	T-A/NF-105[6]	Empire
	20 to 400 mc	NM-30A[5](lower than Ser. No. 191-1)	Stoddart
	400 to 1000 mc	T-3/NF-105 [7]	Empire

(1) This table is subject to change upon reasonable notice to include new instruments having superior performance characteristics and to change the category of older instruments which have become obsolete.

(2) This category applies only to tuning units purchased after 11 March 1957

(3) This category applies only when power supply 91226-1 is used.

(4) This category applies to instruments purchased after 9 May 1956.

(5) These instruments can be modified to category A requirements by the manufacturer.

(6) This category applies to instruments purchased prior to 11 March 1957. The manufacturer can supply information on the changes necessary to modify the tuning units to category A requirements.

(7) This category applies to instruments purchased prior to 9 May 1956. These instruments can be modified to category A requirements by the instrument manufacturer.

6.2.4 Antenna System Correction. - The following factors when added to the reading that is obtained on the interference measuring instrument, convert to antenna induced microvolts and compensate for mismatch, input impedance, et cetera. The instrument reading, before the addition of this factor, is that voltage which is calculated to be at the input of the coaxial cable or input connector.

Instrument	Antenna System Correction (DB)
NM-20A, B	0
NM-30A (90833-2 antenna)	8
NM-30A (90832-2 antenna)	14
NM-50A	8
NF-105 (DA antennas)	11
NF-105 (DM antennas)	8

6.3 Bonding. - The requirements of MIL-B-5087 are recommended for study as a guide toward design for compliance with the bonding requirements of this specification.

6.4 Additional Information. - The information contained in the handbook, "Design Techniques for Interference-Free Operation of Airborne Electronic Equipment," is recommended as a guide towards design for compliance with this specification. Organizations with a military contract can obtain the handbook, at no cost, from ASTIA, Publication No. ATI-159699. Organizations without a military contract can order the handbook as Report No. P. B. 111051 from the Department of Commerce, Office of Technical Services, Washington 25, D. C. A check for $11.50, payable to the Treasurer of the United States, must accompany the order.

6.5 Definitions

6.5.1 Interference. - Interference is defined as any electrical or electromagnetic disturbance, phenomenon, signal or emission, manmade or natural, which causes or can cause undesired response, malfunctioning or degradation of performance of electrical and electronic equipment, or premature and undesired location, detection or discovery by enemy forces, except deliberately generated interference (electronic countermeasures).

6.5.2 Susceptibility. - As used herein, susceptibility is defined as that characteristic which causes an equipment to malfunction or exhibit an

undesirable response when its case or any external lead or circuit, excepting antennas, is subjected to the specified radio or audio frequency voltage or field.

6.5.3 Ambient Interference. - Ambient interference, for the purpose of this specification, is the interference level emanating from sources other than the test sample, including the internal background noise of the interference measuring equipment.

6.5.4 Antenna Induced Microvolts. - Antenna induced microvolts is that voltage which exists across the open-circuited antenna terminals.

6.5.5 Impulsive Interference. - For the purposes of this specification, all broadband noise, including random noise, is considered to be impulsive interference.

6.5.6 Octave. - An octave is a frequency ratio of 1 to 2, i.e., from 1 to 2 mc, 2 to 4 mc, 500 to 1000 mc et cetera.

6.5.7 Microvolts per MC. - The nearest approach to a standard unit of measurement of broadband radio interference is in terms of microvolts per megacycle. Interference intensity in microvolts per megacycle is equal to the number of root mean square sine wave microvolts (unmodulated) applied to the input of the measuring circuit at its center frequency that will result in detector peak response in the circuit equal to that resulting from the interference pulse being measured, divided by the impulse bandwidth of the circuit in megacycles. The impulse bandwidth is the area divided by the height of the voltage response versus radio frequency selectivity curve from antenna through the peak detector. Impulse bandwidth is approximately equivalent to the bandwidth between the 0.45 voltage points on the selectivity curve.

6.5.8 Impulse Bandwidth. - The impulse noise bandwidth of the interference measuring instrument should be used in calculations involving broadband noise. Effective (random) bandwidth should not be used.

6.5.9 Radio Receiver Front End Rejection. - Front-end rejection is the measured capability of a receiver, expressed in decibels, in rejecting signals at the antenna terminals that are outside the channel, or frequency, to which the receiver is tuned.

6.5.10 Weapon System. - A weapons system is an instrument of combat, such as an air vehicle, together with all related equipment, both airborne and ground based, the skills necessary to operate the equipment, and the supporting facilities and services required to enable the instrument of combat to be a single unit of striking power in its operating environment.

6.5.11 Supporting Systems. - A supporting system is a system composed of techniques, skills, and equipment, the composite of which is not an instrument of combat but which is in support of an operational role or mission.

6.5.12 Aeronautical Equipment. - Aeronautical equipment, for the purpose of this specification, is equipment, either airborne or ground based, that is used in conjunction with weapons or supporting systems and is under the cognizance of the Air Services.

6.5.13 Open Space. - The term open space, as used in this specification, is intended to designate an ideal site for radiated interference measurements. This ideal site should be open, flat terrain at a considerable distance (100 feet or more) from buildings, electric power lines, fences, trees, underground cables, and pipe lines. This site should have a sufficiently low ambient level of radiated interference to permit testing to the governing radiated interference limit at any test frequency selected.

6.6 Standard Antennas. - Because of the nonuniformity of the electromagnetic field which usually exists close to a test sample, it is imperative that tests for radiated interference be conducted with antennas identical to those specified. Attempts to correlate results obtained with other antennas by reducing the results to microvolts per meter, based upon plane wave calculations and antenna effective height, may be erroneous and will not be accepted as indicating compliance with this specification.

6.7 Operator and Observer Positions. - In those cases where the operator's or observer's location seems to vary a measurement reading, a minimum distance of 3 feet should be maintained between his body and the antenna; the operator should change position slightly until a maximum reading is obtained. In all cases, as few observers as possible should be present in the screen room during the radiated measurements.

6.8 Impulse Generators. - Satisfactory impulse generators can be obtained from Empire Devices Products Corporation, 38-15 Bell Boulevard, Bayside 61, New York, and from Stoddart Aircraft Radio Company, 6644 Santa Monica Boulevard, Hollywood 38, California.

6.9 Current Probes. - Current probes are available from Stoddart Aircraft Radio Company.

6.10. Conversion Charts. - Figure 27 provides a convenient method for converting microvolts per kilocycle bandwidth to decibels above 1 microvolt per megacycle. Figure 28 converts microvolts to decibels above 1 microvolt.

6.11 Coaxial Switches. - Coaxial switches can be used to advantage for measurements where many manipulations of coaxial cables are required during tests.

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