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FIGURES

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TABLE

ELECTROMAGNETIC INTERFERENCE

CHARACTERISTICS, MEASUREMENT OF

1. SCOPE

1.1 Scope.-This standard establishes techniques to be used for the measurement and determination of the electromagnetic interference characteristics (emission and susceptibility) of electrical, electronic, and electromechanical equipment, as required by MIL-STD-461.

1.2 Format.-

1.2.1 Numbering System.-The test methods contained in this standard are designated by a series of numbers in accordance with the numbering system described below, where:

R = Radiated
C = Conducted
E = Emission
S = Susceptibility

and "- -" = numerical order of test from 01 to 99.

(a) Conducted Emission tests are designed by "CE- -."
(b) Radiated Emission tests are designed by "RE- -."
(c) Conducted Susceptibility tests are designated by "CS- -."
(d) Radiated Susceptibility tests are designated by "RS- -."

1.2.2 Revision of test methods.-Revisions of test methods are indicated by a letter following the method number. For example, the original number assigned to the conducted emission 30 Hz to 20 KHz Power Leads method is CE01; the first revision of that method is CE01A, the second revision, CE01B, etc.

1.2.3 Method of reference.-When applicable, test methods contained herein shall be referenced in the individual specification by specifying this standard and the method number. To avoid the necessity for changing specifications which refer to this standard, the letter following the method number shall not be used when referencing test methods. For example, use CE01, not CE01A.

1.3 Units.-The International Systems of Units, as adopted by the United States Bureau of Standards is used. This system of units (designated "SI" for Systeme Internationale d'Unites) was defined and given official status at the 11th General Conference on Weights and Measures in Paris at a 1960 meeting. MIL-STD-463 gives a description of the system of units used in this standard.

2. REFERENCED DOCUMENTS

2.1 The issues of the following documents in effect on date of invitation for bids, form a part of this standard to the extent specified herein:

GOVERNMENTAL

STANDARDS

MIL-STD-461 - Electromagnetic Interference Characteristics Requirements for Equipment

MIL-STD-463 - Electromagnetic Interference Characteristics, Definitions and System of Units

DRAWING

ES-DL-201090 - Antenna, Microwave, 12 to 40 GHz, Detail Assembly.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with procurement functions should be obtained from the contracting officer.)

3. DEFINITIONS

3.1 The meanings of terms contained in this standard are in accordance with MIL-STD-463.

4. REQUIREMENTS

4.1 General requirements.–General requirements pertaining to the application of this standard, the applicable test limits, and the measuring equipment to be used for the performance of the tests included in this standard are specified in MIL-STD-461. The test procedures contained in this standard shall be used in the interference test plan required by MIL-STD-461.

4.2 Specific requirements.–Details pertaining to the performance of the tests contained in this standard are contained in this section.

4.2.1 Test Conditions.–

4.2.1.1 Ambient Electromagnetic Level.–The ambient electromagnetic level during testing measured with the test sample deenergized shall be at least 6 dB below the allowable specified limit. If a test site does not meet the requirement specified herein, measurements may be performed using the procedure specified in 4.2.8. These requirements shall apply to both radiated and conducted ambient levels.

4.2.1.2 Ground Plane.–A copper or brass ground plane (solid plate) shall be used that has a minimum thickness of 0.25 mm for copper or 0.63 mm, for brass and is 2.25 square meters or larger in area with the smaller side no less than 76 cm. The ground plane shall be bonded to the shielded room such that the dc bonding resistance shall not exceed 2.5 milliohms. In addition, the bonds shall be placed at distances no greater than 90 cm apart. For large equipment mounted on a metal test stand, the test stand shall be considered a part of the ground plane for testing purposes and shall be bonded accordingly.

4.2.1.3 Accessory Equipment Precaution.–Care shall be taken to insure that accessory equipments (spectrum monitors, oscilloscopes, earphones and other equipments) used in conjunction with interference meters do not affect measurement integrity.

4.2.1.4 Excess Personnel and Equipment.–The shielded enclosure shall be kept free of unnecessary equipment, cable racks, and desks. Only the equipment essential to the test being performed shall be in the enclosure. Personnel not actively involved in the test shall not be permitted in the enclosure.

4.2.1.5 Power Supply Characteristics.–Power supplies for test samples requiring a power source for its operation and not supplied as part of the equipment shall have characteristics and tolerances as specified in the test sample's detailed specification.

4.2.1.6 R.f. Absorber Material.–R.F. absorber material may be used in shielded enclosures during EMI tests to reduce reflections from the surfaces of the enclosure to the measurement antennas.

4.2.2 Operation of Test Sample.–

4.2.2.1 Control Adjustment.–For all modes of operation, controls on the test sample shall be operated and adjusted as prescribed in the instruction manual or as required by the equipment specification to obtain optimum design performance.

4.2.2.2 Signal Inputs.–Actual or simulated signal inputs required to activate, utilize, or operate all circuits shall be used.

4.2.2.3 Arrangement and Operating Conditions.–Interconnecting cable assemblies and supporting structures shall simulate actual installation and usage. Shielded leads shall not be used in the test setup unless they have been specified for use in the intended installation. Cables shall be checked against the installation requirements to verify that no extra shielded wires have been used. Cables and equipments shall be so arranged that there is no shielding interposed between the test sample cables and the measurement antennas.

When testing in shielded enclosures, the faces of the test sample shall be located 10 ± 2 centimeters (cm) from the edge of the ground plane. All leads and cables shall be within 10 ± 2 cm from the edge of the ground plane, and shall be approximately 5 cm above the ground plane.

4.2.2.4 Bonding of Test Sample.–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. When bonding straps are required to complete the test setup, they shall be identical to those specified for the installation. Portable equipments that are intended to be grounded through the third wire of the power cable shall be grounded as indicated in the applicable test procedure, and shall not be grounded by any other means.

4.2.2.4.1 Shock and Vibration Isolators.–Test samples shall be secured to mounting bases having 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. When mounting bases do not have bonding straps, bonding straps shall not be used in the test setup.

4.2.2.4.2 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.

4.2.2.5 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 that function intermittently is required during testing. The loads used shall simulate the resistance, inductance, and capacitance of the actual load. Mechanical devices shall also be operated under load. The device under test shall be actuated by the same means as in the installation. Example: If a solenoid is actuated by a silicon-controlled rectifier, do not use a toggle switch to operate the solenoid for the test.

4.2.2.5.1 Loads for C-E Equipment.–All C-E equipment shall be terminated with shielded dummy loads as appropriate for the equipment under test and the test being run to produce maximum normal emissions and susceptibility. At the frequencies of concern in any given test, the VSWR of resistive dummy loads, attenuators, directional couplers, samplers, power dividers, and the internal output impedance of standard signal generators shall be no greater than:

Transmitter Loads 1.5:1
All other dummy loads and pads 1.3:1
Standard Signal Generators 1.3:1

4.2.2.6 Operating Frequencies.–Measurements shall be performed with the test sample tuned to not less than three frequencies per octave within each tuning band, tuning unit, or range of fixed channels, including a frequency within ±5 percent from each end of each band or range of channels. For narrowband tests, the test sample shall also be tuned to such additional frequencies or channels as may be indicated in the control and test plans to be potentially subject to extraneous emissions or responses. For each chosen frequency setting of the test sample, the interference measuring instrument or signal source shall be scanned continuously in frequency over the range required by this standard.

4.2.3 Use of Measuring Equipment.–The measuring equipment used to perform the tests described in this standard shall meet the requirements of MIL-STD-461. All laboratory equipment shall be operated as prescribed by the respective instruction manuals unless otherwise specified by this standard. This standard takes precedence in the event of conflict with instruction manuals or other such documents issued by industry.

4.2.3.1 Detector Function.–A peak detector shall be used for all measurements required by MIL-STD-461: however, for narrowband measurements, the average detector function may be used.

4.2.3.2 Grounding of Measuring Equipment.–It is important that grounding of EMI instrumentation be accomplished in accordance with the following rules to avoid false data that may be introduced by ground loops. Shock hazards will be minimized by adherence to these rules if care is taken to have the instrument bonded to the ground plane at all times.

(a) The antenna shall be remote from the measuring instrument.
(b) The EMI measuring instrument shall be physically grounded with only one connection.
(c) The EMI measuring instrument shall be connected to the alternating current (a.c.) power source through an isolation transformer. It is imperative that the chassis power ground be broken at this point to prevent the circulation of r.f. ground currents in the test equipment.

4.2.3.3 Monitoring of Measuring Equipment.-

4.2.3.3.1 The IF output of the EMI measuring instrument shall be monitored with a device that gives an amplitude versus frequency presentation on a cathode ray tube. This monitor shall be used to obtain information on the characteristics of the signals being measured.

4.2.3.3.2 The measuring equipment shall also be monitored with headphones or a speaker.

4.2.3.4 Identification of Spurious Responses in Measuring Equipment.-The measurement equipment shall be checked for spurious responses. False data caused by such spurious responses shall be so identified on the X-Y recordings or data sheets.

4.2.3.5 Calibration of Measuring Equipment.-All measuring equipment shall be calibrated in accordance with MIL-STD-461.

4.2.3.6 Impulse Generators.-Impulse generators shall be calibrated as follows:

(a) Apply the output of an impulse generator to the input of an amplitude-linear receiver having synchronously tuned, less than critically coupled circuits. EMI receivers are satisfactory for this purpose if their impulse bandwidth is at least five times the repetition rate of the impulse generator. Any AGC system, shall be disabled and the AGC line firmly referred to ground with a low impedance voltage source of appropriate value.

(b) Obtain an oscilloscope pattern of the overall receiver response at the IF output. The oscilloscope controls shall be so adjusted that the pattern is as large as possible within the calibrated area on the face plate. Either photograph or trace the pattern. Record the oscilloscope sweep speed setting. (The sweep speed shall be calibrated accurately.)

(c) Use a planimeter or other integrating device to determine the area of the pattern. This operation shall be carried out at least 10 times and the average of the readings taken as the area.

(d) Calculate the impulse bandwidth of the receiver in accordance with the following formula:

$$\text{IBW in Hz} = \frac{\text{(Pattern height in cm)}}{\text{(Pattern area in cm}^2\text{) (Sweep speed in sec/cm)}}$$

(e) Connect a sinewave generator to the receiver and at f_0 and adjust the output until the peak pattern height is the same as that obtained with the impulse generator.

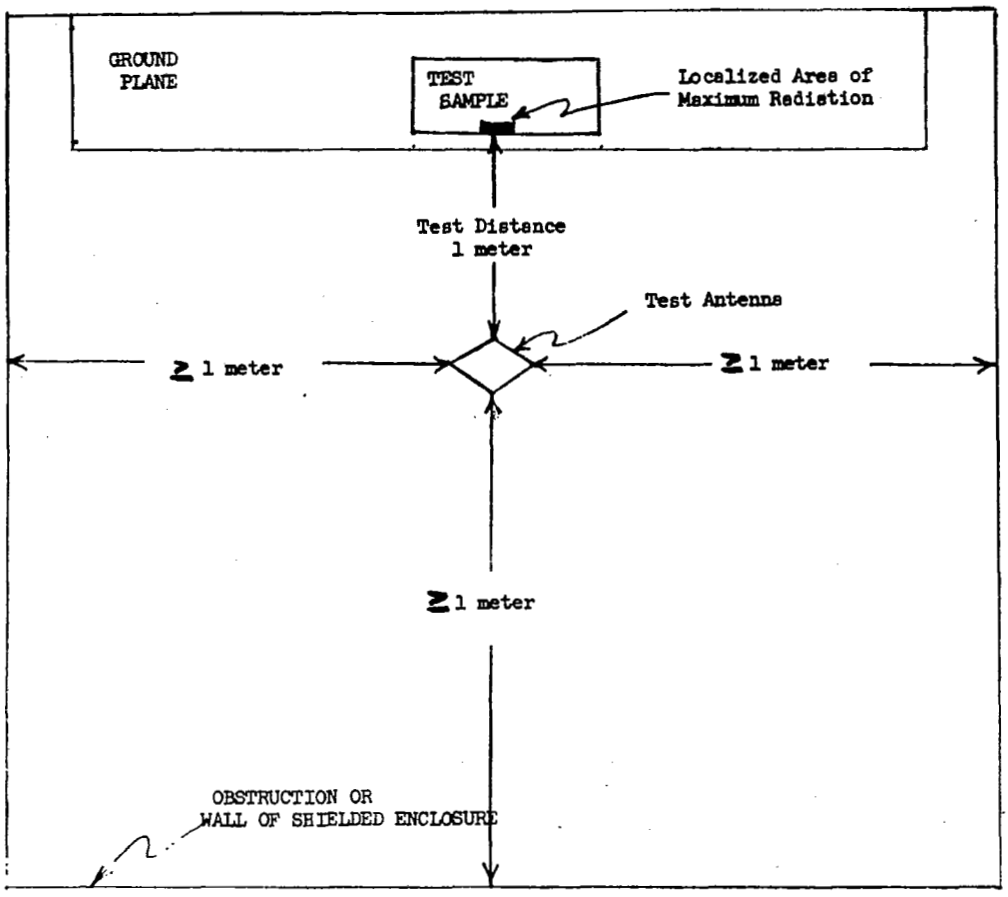
(f) Connect an r.f. power meter to the signal generator and measure the power output. Calculate the r.m.s. voltage on the sinewave signal.

(g) The output of the impulse generator is now calculated by taking the r.m.s. voltage calculated in step (f) divided by the impulse bandwidth determined in step (d).

4.2.4 Placement and Selection of Measuring Antennas.-

4.2.4.1 Each face of the test sample shall be probed with a loop to determine the localized area(s) producing maximum emission or susceptibility. Those areas shall be located 1 meter from the applicable test antenna specified in MIL-STD-461. Probing and frequency scanning shall be performed over the frequency range of each of the specified antennas to determine the worst case condition. The probe shall be oriented for maximum pickup approximately 5 cm from the surface of the test sample.

4.2.4.2 When performing radiated emission measurements, no point of the measuring antenna shall be less than 1 meter to the walls of the shielded enclosure or obstruction. Figure 1 shows a general antenna placement setup for emission measurements.



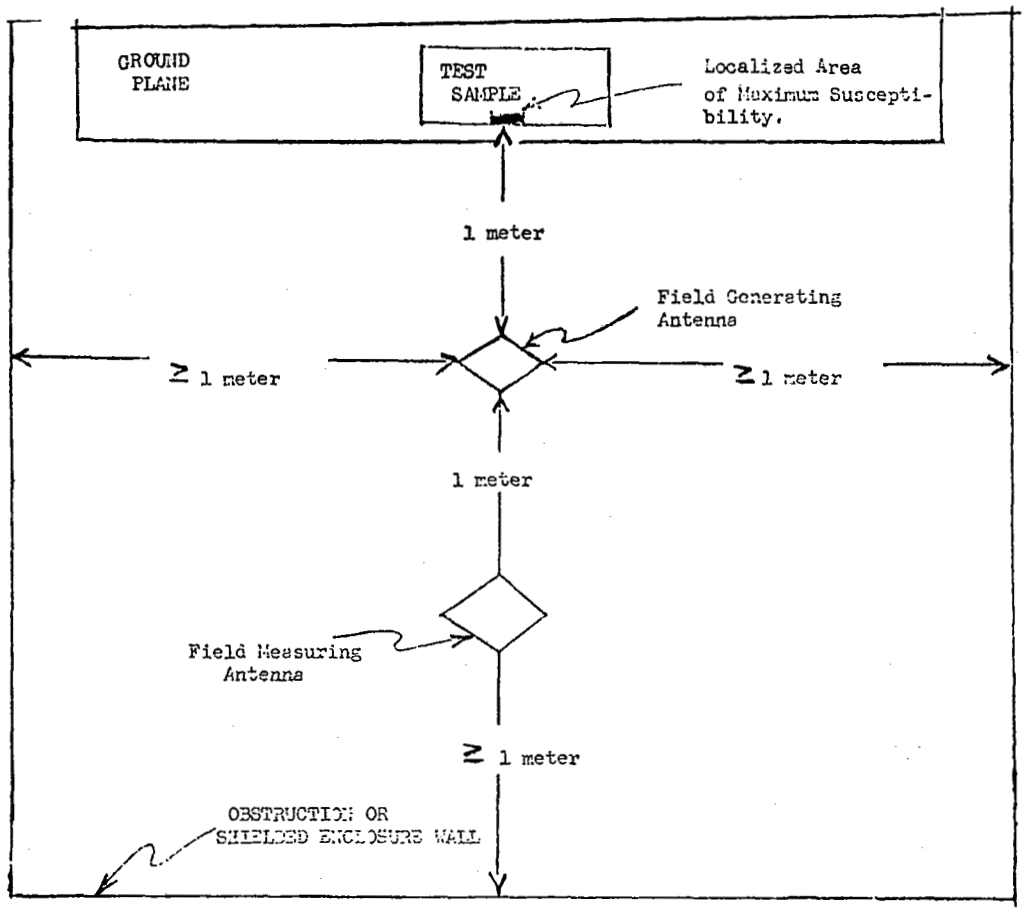
NOTES:
(1) Height of shielded enclosure (if used) ≥ 2.5 meter
(2) End of rod antenna shall not be closer than 30 cm to ceiling of shielded enclosure.
(3) Ends of biconical antenna shall not be closer than 30 cm to ceiling and floor of shielded enclosure when measuring vertical polarizations.

Figure 1 – Placement of antennas for radiated emission measurements.

4.2.4.3 For susceptibility measurements no point of the field-generating and the field-measuring antennas shall be less than 1 meter to the walls of the enclosure or obstruction. Figure 2 shows a general antenna placement setup for susceptibility measurements.

4.2.4.4 For radiated emission measurements between 25 and 200 MHz, the biconical antenna shall be positioned alternately to measure the vertical and horizontal components of the emission. For radiated susceptibility measurements, between 20 and 200 MHz, the biconical antenna shall be positioned so as to generate alternately vertical and horizontal fields.

4.2.5 Measuring Frequencies.–The entire specified frequency range for each applicable test shall be scanned. Measurements shall be taken at not less than three frequencies per octave representing the maximum indications within the octave. In addition, measurements shall also be made at the test sample's critical frequencies (power frequency and harmonics, local oscillator, r.f. frequency, and other frequencies) as specified in the test plan.



NOTES:
(1) Thru (3) of figure 1 apply.
(4) The antennas shall be positioned so that the field measuring antenna does not pick up reflections from the test sample.

Figure 2 – Placement of antennas for radiated susceptibility measurements.

4.2.6 Identification of Broadband and Narrowband Emissions.–To determine the presence of broadband and narrowband emissions, both of the following tests shall be performed if an emission is determined to be broadband in one test and narrow in another, the requirements of MIL-STD-462 shall apply for both types of emissions.

(a) Test 1: The EMI meter shall be tuned over a range of plus and minus 2 impulse bandwidths around its center frequency. A change in peak response of 3 dB or less indicates a broadband emission. Any change of greater than 3 dB indicates a narrowband emission.

(b) Test 2: Measure the pulse repetition rate of the emission. If the pulse repetition rate is less than or equal to the impulse bandwidth (IBW) of the measuring equipment, it is a broadband emission. If it is greater than IBW, it is a narrowband emission.

4.2.6.1 Pulsed C-W Requirements.–The following guidelines govern the requirements for pulsed cw interference:

(a) Narrowband limits shall be used.
(b) Bandwidth correction factors shall not be used.

4.2.7 Transient measurements.–The slideback procedure shall govern the measurement of transient interference with impulses less than 10 pulses per second (p.p.s.) as specified hereinafter:

(a) Measure radiated transients at one frequency every four octaves over the frequency range required for the equipment under test. Measure conducted transients at one frequency every four octaves from 0.014 to 100 MHz.
(b) Use the substitution method with the slideback detector function. Monitor the detector output with an oscilloscope. Preset the slideback cutoff point at the equivalent meter reading using an impulse generator.
(c) Operate the test sample so that the transient occurs. If the transient is not detected above the slideback cutoff, record the level on the preprinted graph as being below the required limit.
(d) If the transient is above the slideback cutoff, use the impulse generator to increase the slideback cutoff setting by 10 dB.
(e) Repeat this procedure until the transient is no longer detected above the slideback cutoff.
(f) The amplitude of the transient is now known within two levels that are 10 dB apart. At each measurement frequency, draw and identify a short horizontal dash on the preprinted graph at these two levels to indicate that the transient amplitude is between the levels.

4.2.8 Emission Measurements in the Presence of High Ambient Fields.–The technique specified hereinafter can be used for measuring electromagnetic emissions when high ambient signals prevent the performance of the measurements by the normal methods given in this standard.

4.2.8.1 Apparatus.–Listings of specifically approved or acceptable general EMI test equipment have not been included herein or in MIL-STD-461. Because of the special techniques specified however, the use of the following specific apparatus is required:

(a) Raster Generator – Honeywell RG-3 or equivalent.
(b) Dual Beam Oscilloscope with P7 phosphorscreen – Tektronix Type 555 or equal.
(c) Primary Pickup Device.
  (1) Antenna Unit – Honeywell ARP 300S or equal.
  (2) Current Probe – As applicable.
(d) EMI Meter.
(e) Synch Pickup Probe – LO-205 (part of NF105) or equal.
(f) Amplifier (1 kHz to 150 MHz) – Hewlett-Packard 461A or equal.
(g) Signal Generators.
  (1) Hewlett-Packard Model 606B or equal.
  (2) General Radio GR-805D or equal.
  (3) Hewlett-Packard Model 615B or equal.

4.2.8.2 Test Setup and Procedure.–The basic test setup is shown on Figure 3. The choice of pickup devices shall depend on the ambient noise level and the type and level of the emission being detected and measured. The final test configuration shall conform to the measuring requirements of this standard.

4.2.8.2.1 Setting of operating controls.–

(a) EMI Meter.–The input attenuator, r.f. gain control, and audio level control shall be set so that there will not be any overloading or signal clipping.
(b) Raster Generator.–The raster generator accepts detected video from the EMI meter. After amplification in a video amplifier stage, the video is processed by a paraphase amplifier where either normal or inverted signal amplification may be selected. A final video amplifier restores the signal to the proper level for cathode follower output to the Z output jack and the audio stage. Along with the video signal processing, a variable sweep is generated in the raster generator. A phantastron sweep generator produces a sawtooth waveform which can be made to recur at a predetermined rate obtained either externally or internally as chosen by the operator.

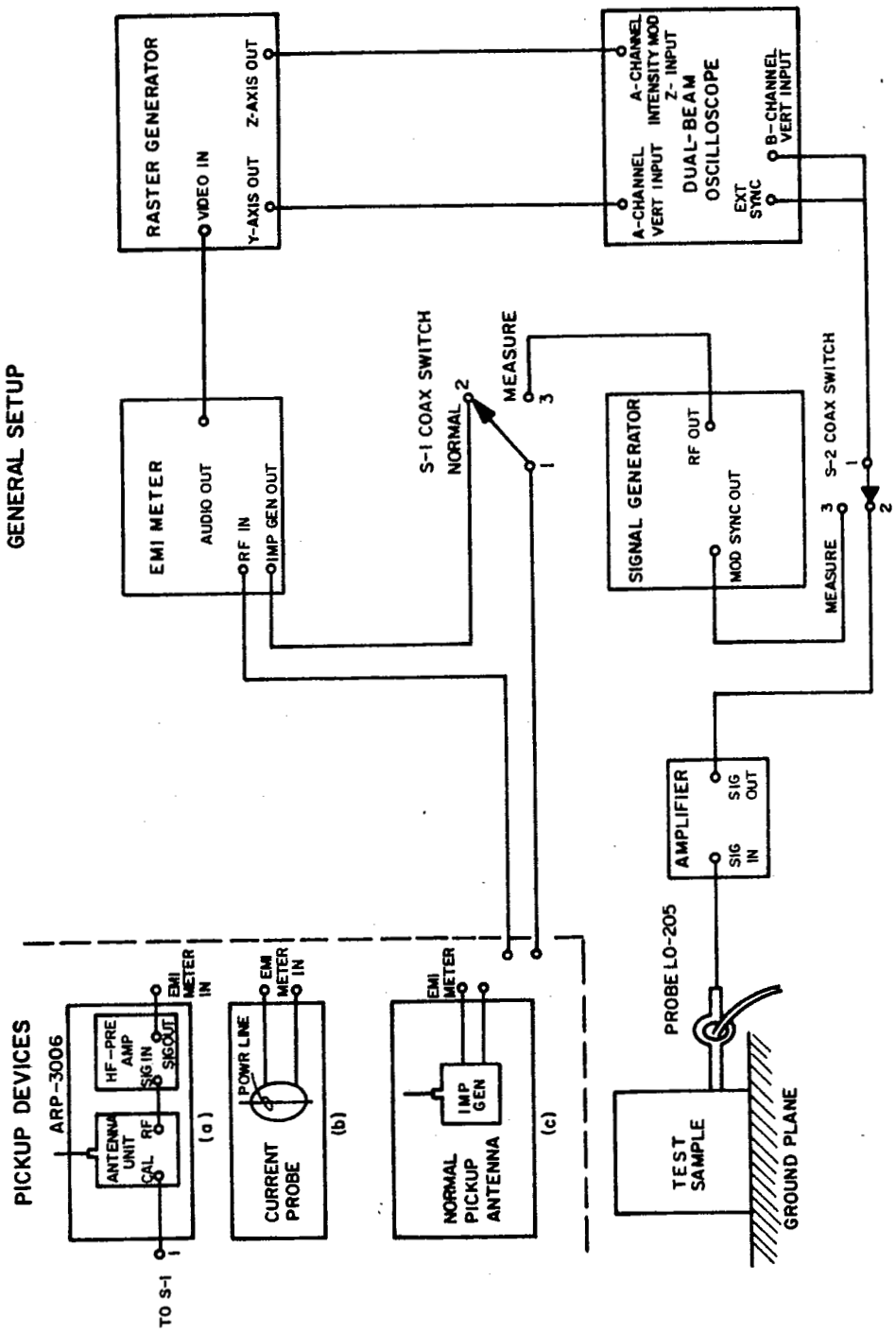


Figure 3 - Test setup for emission measurements in the presence of high ambient fields.

(1) Input attenuator, input gain, pulse stretcher, and high and low cutoff frequency controls shall be set to compensate for signal amplitude, shape, and frequency.
(2) Amplifier Mode – Set on normal linear signal.
(3) Slideback – Set to off (full counter clockwise).
(4) Sweep Video – Set to Sweep.
(5) Sweep rate trigger – set to recur.
(6) Trigger – set for desired sweep speed.
(7) Volume – Set for desired speaker volume.

(c) Sampling Pickup System.–The controls shall be set as follows:

(1) Probe.–Place the probe at desired point on the test sample to pick up sufficient synch signal.
(2) Amplifier H. P. Model 461A.–Set the gain control for a normal presentation on the oscilloscope. There shall be no clipping or distortion of the synch signal.

(d) Dual Beam Oscilloscope.–The controls shall be set as follows:

(1) Trigger – Set for external synch.
(2) Vertical Sensitivity controls – Set for normal presentation on A and B channels. There shall be no clipping or distortion of signals.
(3) Other controls – Set to compensate for signal amplitude, shape, and frequency.

4.2.8.2.2 Measurement Procedures.–Measurement procedures shall be as follows:

(a) Scan the full frequency range of the lowest tuning band of the EMI Meter for the frequency of maximum emission.
(b) Adjust the operating controls of EMI Meter, raster generator, dual beam oscilloscope, and signal sampling amplifier to produce the desired display on the dual beam oscilloscope.
(c) Adjust the trace on the dual beam oscilloscope so that the vertical sweeps are positioned symmetrically about the zero voltage reference axis.
(d) Reduce the Channel A intensity on the oscilloscope to the fade-out point.
(e) Set the channel B intensity on the oscilloscope to a point where the brightness of the presentation does not obscure the raster presentation on channel A.
(f) Readjust the gain and attenuation controls of the EMI Meter, raster generator, sampling amplifier, and oscilloscope controls to obtain channel A and B waveforms which do not overload the video amplifiers.
(g) Adjust the sweep rate controls on the raster generator and oscilloscope for the desired frame rate.
(h) Correlated, repetitive interference pulses should appear as vertical columns of dots or solid vertical lines depending upon the sensitivity setting of the oscilloscope vertical amplifier. This is a means of separating the source interference signal from any high ambient random noise. The interference source signal is thus identified when this correlation is found between the monitor signal and the raster presentation.
(i) Adjust the channel A intensity control so that the correlated source interference signal is just visible.
(j) Turn off test sample.
(k) Place S1 and S2 in the measure position.
(l) Tune the signal generator to same frequency as the EMI meter.
(m) Place signal generator modulation control at 400 Hz 30 percent modulation.
(n) Without resetting operating controls of EMI meter, raster generator and oscilloscope, set the r.f. output of the signal generator so that the writing on the oscilloscope equals the intensity as in step (d).
(o) The induced voltage of the emission at the antenna shall equal the output voltage of the signal generator minus antenna injection network loss.

5. MEASUREMENT PROCEDURES

5.1 This section contains the measurement procedures to be used in determining compliance with the emission and susceptibility requirements of MIL-STD-461. The test procedures are applicable for the entire

specified frequency range; however, certain equipments or classes of equipments may not require testing throughout the complete measurement frequency range. These modifications are specified in MIL-STD-461.

5.2 Table I is an index of measurement procedures by method number, date, and title.

Table I – Index of Measurement Procedures

Method	Date	Title
CE01	31 July 1967	Conducted Emission, 30 Hz to 20 kHz, Power Leads
CE02	31 July 1967	Conducted Emission, 30 Hz to 20 kHz, Control and Signal Leads
CE03	31 July 1967	Conducted Emission, 20 kHz to 50 MHz, Power Leads
CE04	31 July 1967	Conducted Emission, 20 kHz to 50 MHz, Control and Signal Leads
CE05	31 July 1967	Conducted Emission, 30 Hz to 50 MHz, Inverse Filter Method
CE06	31 July 1967	Conducted Emission 10 kHz to 12.4 GHz, Antenna Terminal
CS01	31 July 1967	Conducted Susceptibility, 30 Hz to 50 kHz, Power Lead
CS02	31 July 1967	Conducted Susceptibility, 50 kHz to 400 MHz, Power Lead
CS03	31 July 1967	Conducted Susceptibility, 30 Hz to 10 GHz, Intermodulation, Two Signal
CS04	31 July 1967	Conducted Susceptibility, 30 Hz to 10 GHz, Rejection of Undesired Signals At Input Terminals (2-Signal Generator Method)
CS05	31 July 1967	Conducted Susceptibility, 30 Hz to 10 GHz, Cross-Modulation
CS06	31 July 1967	Conducted Susceptibility, Spike, Power Leads
(T) CS07	31 July 1967	Conducted Susceptibility, Squelch Circuits
CS08	31 July 1967	Conducted Susceptibility, 30 Hz to 10 GHz, Rejection of Undesired Signals at Input Terminals (1-Signal Generator Method)
RE01	31 July 1967	Radiated Emission, 30 Hz to 30 kHz, Magnetic Field
RE02	31 July 1967	Radiated Emission, 14 kHz to 10 GHz, Electric Field
RE03	31 July 1967	Radiated Emission, Spurious and Harmonic Emissions 10 kHz to 40 GHz
(T) RE04	31 July 1967	Radiated Emission, 20 Hz to 50 kHz, Magnetic Field
RE05	31 July 1967	Radiated Emission, 150 KHz to 1 GHz, Vehicles and Engine-Driven Equipment
RE06	31 July 1967	Radiated Emission, 14 KHz to 16 Hz, Overhead Power Lines
RS01	31 July 1967	Radiated Susceptibility, 30 Hz to 30 kHz, Magnetic Field
RS02	31 July 1967	Radiated Susceptibility, Magnetic Induction Fields
RS03	31 July 1967	Radiated Susceptibility, 14 kHz to 10 GHz, Electric Field
RS04	31 July 1967	Radiated Susceptibility, 14 kHz to 30 MHz.

Custodians:
Army - EL
Navy - SH
Air Force - 11

Review activities:
Army - EL, MI, AV
Navy - SH, AS, OS
Air Force - 11, 13, 14, 15, 17, 19, 68, 69, 70, 71, 80, 82, 84

User activities:
Army - AV, AT, ME, WC, GL, MD

Preparing activity:
Air Force - 11
(Project MISC-0351)

METHOD CE01

CONDUCTED EMISSION, 30 HZ TO 20 KHZ, POWER LEADS

1. Purpose.- This test method is used for measuring conducted emissions on all power leads.

2. Applicability.- This test method is applicable for measuring conducted emissions in the frequency range of 30 Hz to 20 Khz on a.c. and d.c. power input and output leads, including neutrals which are grounded externally to the equipment. Bonding straps do not have to be measured.

3. Apparatus.- The test apparatus shall include the following:

(a) Current Probes.
(b) Matching Transformer.- An impedance matching transformer may be needed between certain current probes and the interference meter so that the measuring system will meet the sensitivity requirements needed to perform the test.
(c) Electromagnetic Interference Meter.
(d) Band-Reject Filter.- A band-reject filter shall be used in the measuring circuit to remove the power frequency and its 2nd, 3rd, and 4th harmonics when testing ac power lines for broadband interference.
(e) Ten Microfarad Feed-Through Capacitor.

4. Test Procedure.- The test setup shall be as shown on Figure CE01-1.

4.1 Narrowband Measurements.- The following equipment shall be used:

(a) Current probe.
(b) Matching transformer.
(c) Instrument with selectivity (that is interference meter).

4.2 Broadband Measurements.- The following equipment shall be used for broadband surements:

(a) Interference meter (used in 20 Khz bandwidth position)
(b) Current probe
(c) Matching transformer
(d) Band-reject filter

5. Notes

(a) When matching transformers or band-reject filters are used, their characteristics must be described in the control plan and test plan.
(b) Conducted emissions shall be measured separately on each power lead.

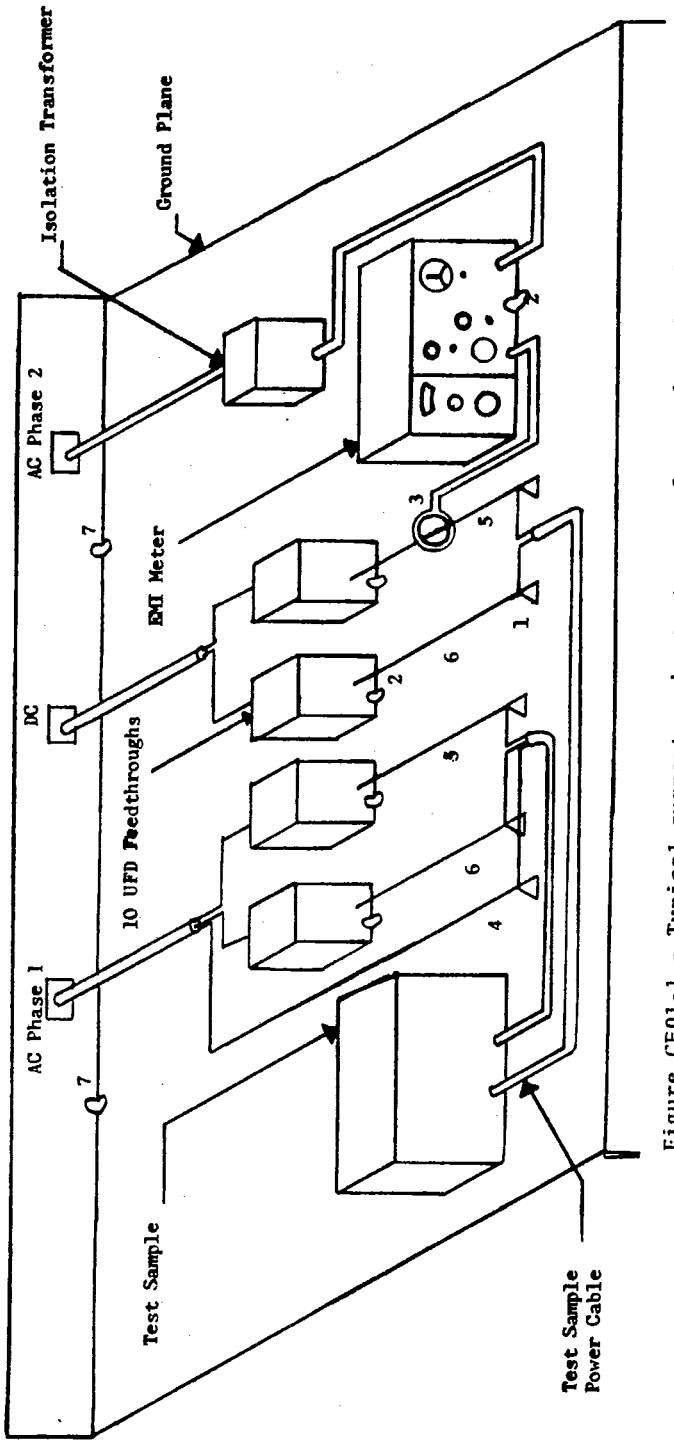


Figure CE01-1 - Typical current probe test setup for conducted emission measurements on power leads (cont'd).

1. 5 cm Standoffs
2. Low Impedance Bond to Ground Plane
3. Current Probe
4. Test Sample Chassis Ground
5. High Side
6. Return
7. DC bond impedance between the ground plane and enclosure shall not exceed 2.5 milliohms.

S:

1. The minimum separation between cables, leads, and ground plan shall be 5 cm.
2. The length of power lead from the test sample to the feedthrough capacitor shall not exceed 1 meter.
3. The length of each power lead between the point of separation and connection to the feedthrough capacitor shall be 30 ± 2 cm. The current probe shall be positioned along this length to produce a maximum reading on the EMI meter.
4. The test sample and EMI instrumentation shall derive their power requirements from two separate phases of the AC power source. The purpose of this requirement is to provide isolation between the test sample and measurement instrumentation through the shielded enclosure's power line filters.
5. The EMI measuring instrumentation shall be connected to the a.c. power source through an isolation transformer. It is imperative that the chassis power ground be broken at this point to prevent the circulation of r.f. ground currents in the test equipment.

CAUTION: Be sure all test instrumentation is properly bonded to the ground plane before applying power to prevent a potential shock hazard to personnel.

Figure CE01-1 - Typical current probe test setup for conducted emission measurements on power leads.

METHOD CE02

CONDUCTED EMISSION, 30 HZ TO 20 KHZ, CONTROL AND SIGNAL LEADS

1. Purpose.- This method is used for measuring conducted emissions on control and signal leads.

2. Applicability.- This test method is applicable for measuring conducted emissions in the frequency range of 30 Hz to 20 kHz on all interconnecting signal and control wires.

3. Apparatus.- The test apparatus shall include the following:

(a) Current Probes.
(b) Matching Transformer - An impedance matching transformer may be needed between certain current probes and the interference meter so that the measuring system will meet the sensitivity requirements needed to perform the test.
(c) Electromagnetic Interference Meter.
(d) Ten-Microfarad Feed-Through Capacitor.
(e) Band-Reject Filter - A band-reject filter shall be used in the measuring circuit to reject, from the EMI meter, the emissions contained in the necessary information bandwidth.

4. Test Setup and Test Procedure.- The test setup shall be as shown in Figure CE02-1.

4.1 Narrowband Measurements.- The following equipment shall be used for narrowband measurements:

(a) Current probe.
(b) Matching transformer.
(c) Instrument with selectivity (interference meter).

4.2 Broadband measurements.- The following equipment shall be used for broadband measurements:

(a) Interference meter (used in 20 kHz bandwidth position).
(b) Current probe.
(c) Matching transformer.
(d) Band-reject filter.

5. Notes.-

(a) The equipment shall be loaded as specified under the test sample requirements in this standard.
(b) Any control lead carrying ac power shall be tested in accordance with CE01.
(c) Signal and control leads within the same cable may be group tested under the following conditions:

(1) When testing cables whose dimensions exceed the current probe's diameter, the cable should be divided into groups so that the probe can enclose the conductors being tested. Each group which results from the division should contain approximately the same number of conductors.
(2) In no case shall a group of leads be probed with both the high and return leads in the test group, except for twisted pairs.
(3) If a group of leads exceeds the limits of this standard the offending leads shall be identified and measured separately.

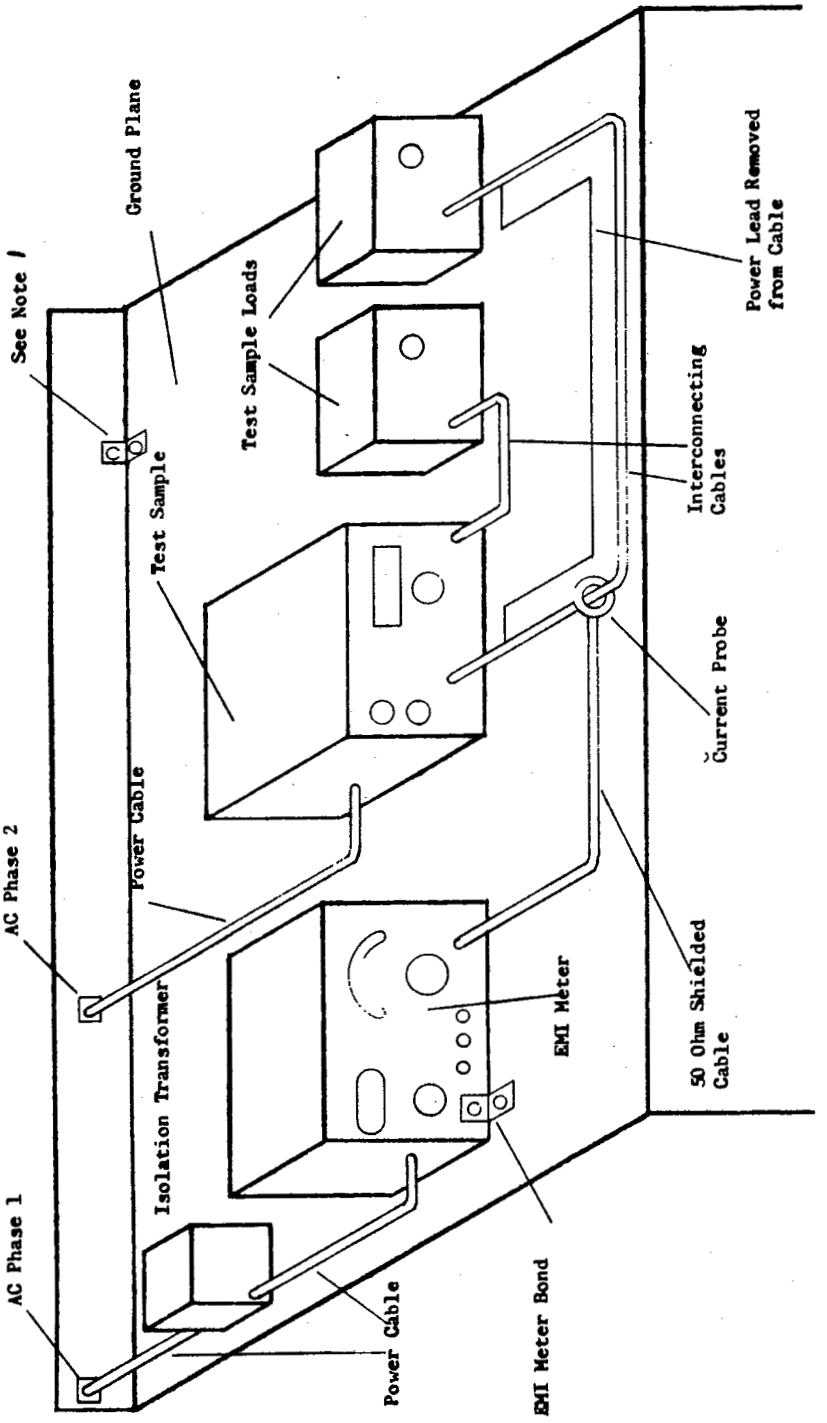


Figure CE02-1 Typical probe test setup for conducted measurement of interconnecting cables

NOTES:

1. The d.c. bond impedance between the ground plane and enclosure shall not exceed 2.5 milliohms.
2. The minimum separation between cables, leads, and ground plane shall be 5.cm.
3. The test sample and EMI measuring instrumentation shall derive their power from two separate phases of the a.c. power source. The purpose of this requirement is to provide additional isolation between the test sample and measuring instrumentation through the enclosure's power line filters.
4. The current probe shall be positioned along the length of interconnecting cable to produce a maximum reading on the EMI meter.
5. The EMI measuring instrumentation shall be connected to the a.c. power source through an isolation transformer. It is imperative that the chassis power ground be broken at this point to prevent the circulation of RF ground currents in the test equipment.

CAUTION: Be sure the instrumentation is properly bonded to the ground plane before applying ac power to prevent potential shock hazard to personnel.

Figure CE02-1 Typical probe test setup for conducted measurement of interconnecting cables (continued).

METHOD CE03

CONDUCTED EMISSION, 20 KHZ TO 50 MHZ, POWER LEADS

1. Purpose.- This method is used for measuring conducted emisssions on all power leads.

2. Applicability.- This test method is applicable for measuring conducted emissions in the frequency range of 29 kHz to 50 MHz on a.c. and d.c. power input and output leads, including neutrals which are grounded externally to the equipment. Bonding straps need not be measured.

3. Apparatus.- The test apparatus shall include the following:

(a) Current Probes.
(b) Electromagnetic Interference Meter.
(c) Ten Microfarad Feed-Through Capacitor.

4. Test Procedure.- The test setup shall be as shown in Figure CE01-1. Conducted emissions shall be measured separately on each power lead.

METHOD CE04

CONDUCTED EMISSION, 20 KHZ TO 50 MHZ, CONTROL AND SIGNAL LEADS

1. Purpose.- This method is for measuring conducted emissions on control and signal leads.

2. Applicability.- This test method is applicable for measuring conducted emissions in the frequency range of 20 kHz to 50 kHz on all interconnecting signal and control wires.

3. Apparatus.- The test apparatus shall include the following:

(a) Current Probes
(b) Electromagnetic Interference Meter
(c) Ten Microfarad Feed-Through Capacitor

4. Test Procedure.- The test setup shall be as shown in Figure CE02-1.

5. Notes.-

(a) The equipment shall be loaded as specified under the test sample requirements in this standard.
(b) Any control lead carrying ac power shall be tested in accordance with CE03.
(c) Signal and control leads within the same cable may be group tested under the following conditions:

(1) When testing cables whose dimensions exceed the current probe's diameter, the cable should be divided into groups so that the probe can enclose the conductors being tested. Each group which results from the division should contain approximately the same number of conductors.
(2) In no case shall a group of leads be proved with both the high and return leads in the test group, except for twisted pairs.
(3) If a group of leads exceeds the limits of this standard, the offending leads shall be identified and measured separately.

METHOD CE05

CONDUCTED EMISSION, 30 HZ TO 50 MHZ, INVERSE FILTER METHOD

1. Purpose.- This method is used for measuring conducted emissions in the frequency range of 30 Hz to 50 MHz by use of inverse filter techniques.

2. Applicability.- This method may be used in lieu of methods CE01, 02, 03, and 04 when the interference signal to be measured is generated by a single shot event or at repetition rates of less than 5 p.p.s.

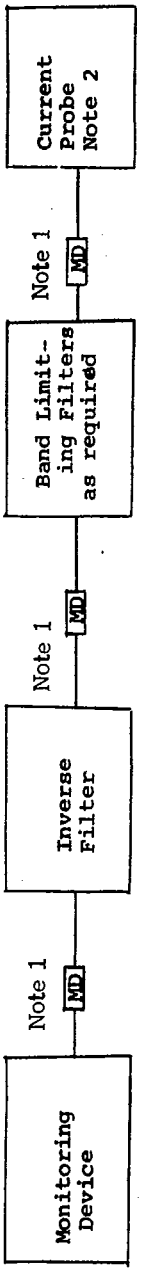
3. Apparatus: Apparatus shall include:

(a) Current Probes.- Probes with a 50-ohm loaded transfer impedance of 1 ohm over the frequency range being tested are recommended.
(b) Monitoring Device.- Oscilloscope, or VTVM with memory circuits.
(c) Inverse Filter.- A filter with response that is inverse of the appropriate limit curve.
(d) Band Limiting Filters.- To limit overall monitoring device response to frequency range of interest.

4. Test Setup.- The test setup shall be as shown on figure CE05-1.

5. Notes.-

(a) The response of all apparatus used, as referenced to the applicable limit shall be flat within ± 3 dB.
(b) The equipment used and calibration procedures shall be described in the test plan and test report.



NOTE (1) Use matching devices as required for adequate impedance match for equipment used.

(2) May also include network to compensate for current probe transfer impedance

Figure CE05-1 - Test setup for conducted emission, inverse filter method.

METHOD CE06

CONDUCTED EMISSION, 10 KHZ TO 12.4 GHZ, ANTENNA TERMINAL

1. Purpose.- This method is for measuring conducted emissions appearing at the antenna terminals on receivers and transmitters in key-up and key-down conditions, r.f. amplifiers, and other devices designed to be connected to antennas.

2. Applicability.- This test procedure shall be used to measure the available power of emissions appearing at an equipment's antenna terminals. The procedures outlined therein for the range from 10 kHz to 12.4 GHz are applicable for receivers, transmitters, (key-up and key-down) and r.f. amplifiers. These procedures do not apply to equipments designed to operate into a fixed non-removable antenna or for transmitters whose average output power is greater than five kilowatts.

2.1 Frequency Range of Test.- Frequency range of this test is as follows:

Equipment (Test Sample) Operating Range	Range of Test
VLF (10 to 30 kHz)	0.01 to 10 MHz
LF (30 to 300 KHz)	0.01 to 100 MHz
MF (0.3 to 3 MHz)	0.01 to 600 MHz
HF (3 to 30 MHz)	0.01 to 1,000 MHz
VHF (30 to 300 MHz)	0.01 to 3,000 MHz
UHF (300 to 1240 MHz)	0.01 to 12,400 MHz

3. Apparatus.- The measuring apparatus shall be as indicated in figures CE06-1, CE06-2, or CE06-3, as applicable.

4. Test Setup .- The test procedure shall be selected according to the output power and operating frequency from the procedures described hereinafter.

4.1 When the signals at the antenna terminals do not exceed 13 dBw (average power) and the highest intentionally generated frequency is below 1.24 GHz, the test setup in figure CE06-1 shall be used. The same test setup may be employed for receivers and transmitters in the key-up condition, except that the attenuator and rejection network shall be removed.

4.1.1 If the equipment is designed to operate with a specified antenna, the test setup in CE06-3, shall be used as indicated in the test plan.

4.2 When the signal at the antenna terminals is greater than 13 dBw but less than 37 dBw, the test setup shall correspond to either figure CE06-2 or CE06-3 as indicated hereinafter.

4.2.1 The frequency range of the test varies between 0.010 to 3000 MHz when f_o is in the range of 0.010 to 300 MHz (see 2.1). In this case, the setup in figure CE06-2 shall be used. When an equipment in this range is designed to operate with a specified antenna, the test setup in CE06-3 shall be used with approval of the procuring activity.

4.2.2 The frequency range of the test is between 0.010 and 12,400 MHz when f_o is in the frequency range of 300 to 1240 MHz. In this case, the setup in figure CE06-3 shall be used.

4.3 When the power available at the antenna terminals is greater than 37 dBw or the operating frequency of the test sample is greater than 1.24 GHz, these measurements shall be made in the radiated field, using Method RE03.

4.4 Balanced ouptputs.- If the test sample has a balanced output, measurements shall be made between leg and ground. These equipments are a special case and the responsiblity for developing the required instrumentation is left to the contractor.

4.5 Waveguide transmission lines.- When waveguide is used as the transmission medium up to 1.24 GHz, the interference measuring set shall be coupled to the test sample by a coaxial to waveguide transition. The purpose of using the coaxial system is to eliminate all modes except the TEM or dominate mode. It is not necessary to perform this test at frequencies greater than 10 percent below the waveguide cut-off frequency.

5. Notes.

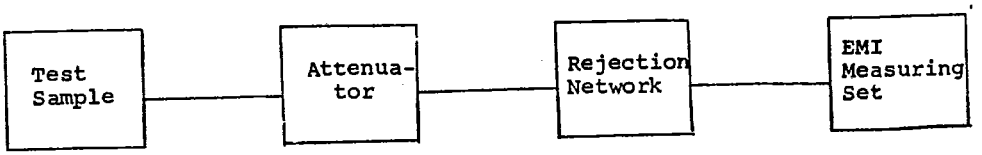
5.1 An impedance match between the test sample and the measuring equipment shall be maintained.

5.2 Look for broadband signals at the antenna terminals caused by relays, blower motors, and other parts.

5.3 It is easy to damage equipment during this test or to generate spurious responses in the interference measuring set. To minimize these problems, it is recommended that the fundamental frequency be attenuated to approximately -30dBw at the input to the rejection network.

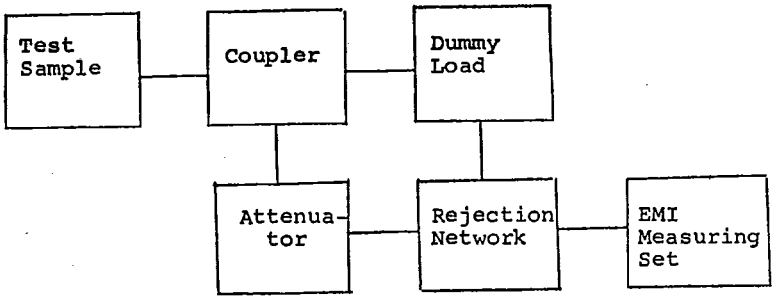
5.4 Identification of spurious responses can be simplified by monitoring the measurement instruments IF with a spectrum analyzer.

5.5 The test sample shall always operate into a matched resistive load for all antenna terminal tests except when the test setup of 4.2.2 is used, where the actual equipment antenna is used as a load.



AVg. Power at input to EMI meter at f_o should not be greater than - 30 dBw

Figure CE06-1 - Test setup for conducted emission, antenna terminal



AVg. Power at input to EMI at f_o should not be greater than - 30 dBw

Figure CE06-2 - Test setup for conducted emission antenna terminal

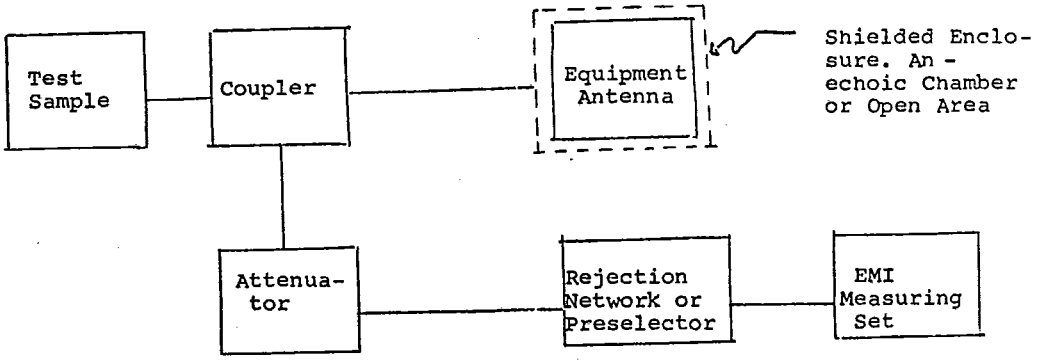


Figure CE06-3 - Test setup for conducted emission antenna terminal

METHOD CS01

CONDUCTED SUSCEPTIBILITY, 30 HZ TO 50 KHZ, POWER LEAD

1. Purpose.- This method is used to determine whether communication electronic equipment is susceptible to electromagnetic energy injected on its power leads.

2. Applicability.- This test method is applicable for all Class I equipment (see MIL-STD-461).

3. Apparatus.- Test apparatus shall be as follows:

(a) The measuring apparatus is shown in Figure CS01-1.
(b) Figure CS01-2 shows the construction data for an acceptable isolation transformer. The transformer shall carry all currents without saturation, shall have low leakage reactance, less than one microhenry, and shall have a secondary current capability of 35 amperes (power line current) a.c. or d.c. with 10-percent drop.
(c) A 100-microfarad capacitor across d.c. power sources might be required if diffficulty is encountered in obtaining the required test voltage.

4. Test Setup and Procedure.- The test setup is shown in Figure CS01-1. The procedure is as specified in 4.1 through 4.5.

4.1 If the output impedance of the signal source looking into the secondary terminals of the isolation transformer is unknown, measurement shall be as follows:

(a) Apply a signal to the primary of the transformer and measure the open circuit secondary voltage (Voc).
(b) Connect a known load, R_L, across the secondary and measure the closed circuit secondary voltage (Vcc).
(c) The impedance shall be calculated as follows:

$$Z = \frac{R_L\ (Voc - Vcc)}{Vcc}$$

(d) Repeat the above at one frequency per decade from 30 Hz to 50 kHz (including 30 Hz and 50 kHz).
(e) The measured impedance shall be less than or equal to 0.5 ohms. If it is not, adjust the turns ratio until the desired impedance is attained.

4.2 The test sample shall be connected as shown in figure CS01-1.

4.3 The oscillator shall be tuned through the required frequency range, the output to the specified level adjusted and verification made that: (a) malfunction is present (b) there is degradation of performance, or (c) deviation from indication occur beyond tolerances indicated in the equipment specification or approved test plan. The frequency range within 10 percent of the rated power frequency can be omitted, unless otherwise specified by the procuring activity.

4.4 If the test sample is susceptible to the specified limit level, the output shall be decreased to determine the susceptibility threshold level. This value shall be recorded.

4.5 The power voltage applied to the test sample shall be measured over the frequency range of the test and recorded. In some cases, the supply voltage will have to be raised to compensate for losses in the isolation transformer.

5. Notes.-

5.1 On a.c. lines, a network to eliminate the power frequency at the oscilloscope, VTVM, or EMI meter will simplify measurement.

5.2 The unused primary windings on the transformer shown on figure CS01-3 can be used either to buck flux out from the power current or all can be used in parallel with each other to increase current capacity.

5.3 A 50-ampere transformer can be constructed by using a double stack of 19E1 laminations and 0.707 as many turns as that shown on figure CS01-3. The iron weight would then be 20 pounds and the copper weight 7 pounds. Copper loss will be about 50 percent higher but leakage inductance should not increase. Flux density shall be less than 0.68 tests.

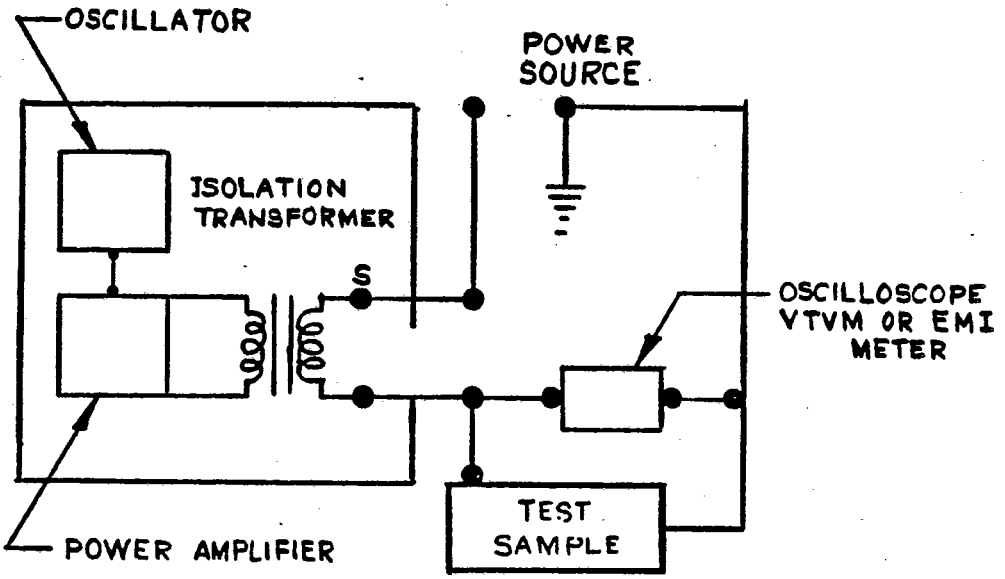
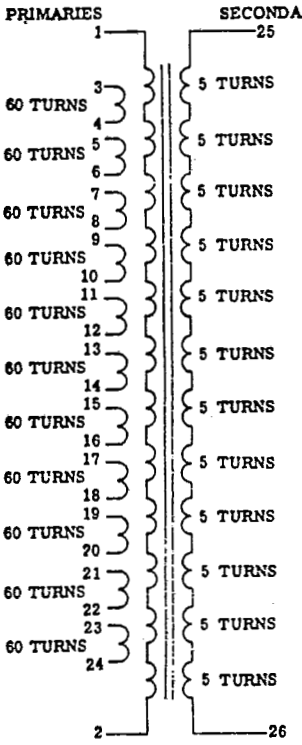


FIGURE CS01-1. Conducted susceptibility, 30 Hz to 50 kHz typical test setup



Lamination: 19 EI 14 Microsil, Magnetic Metals Co.
Build : Butt
Stack : Square
Bobbin : Fabricate from 1/8 inch epoxy glass laminate
Treatment : May be potted
Gap : 0.2 inch
Weights : Laminations 10 lbs/copper 5 lbs

Winding Data

1) 1-2, 25-26 wind 5 turns bifilar. 1-2 of 0.005 by 2.7 inch copper shim, 25-26 of 0.001 by 2.00 inch copper shim insulation to be 0.006 inch paper
2) 3-4 wind 60 turns 4AWG30 heavy isonel or equal
3) 1-2, 25-26 wind second set of 5 turns bifilar as in step 1. Connect the 1-2 windings with 0.010 by 0.50 inch copper strip.
4) 5-6 wind 60 turns 4AWG30 with heavy isonel or equal
5) Continue as above, alternating the bifilar windings with the 60-turn windings 7-8, 9-10, 11-12..... 23-24. The last winding will be 5 turns bifilar of 1-2, 25-26.

Weights: Lamination 10 lbs, copper 5 lbs

Electrical characteristics

Open circuit inductance:		L 1-2 = 1.55 5 MH ± 15 percent At 1 kHz10V RMS
Leakage inductance	:	L_1-2 0.8 UH, 25-26 shorted. L_1-2 1.8 UH, all primary in Series and shorted.
Self Resonant Freq	:	Greater than 80 kHz, 1VRMS
High potential test	:	100 VRMS - all windings
DC resistance (ohms) ± 20 percent (Make inductance Measurements with Tektronix L-c Meter or equivalent)	:	1-2 0.265 11-12 1.33 21-22 1.70 3-4 1.05 13-14 1.40 23-24 1.77 5-6 1.12 15-16 1.47 25-26 0.36 7-8 1.20 17-18 1.55 9-10 1.27 19-20 1.62

Figure CS01-2 Construction data for isolation transformer

METHOD CS02

CONDUCTED SUSCEPTIBILITY, 50 KHZ TO 400 MHZ, POWER LEAD

1. Purpose.- This method is used to determine whether communication electronic equipment is susceptible to electromagnetic energy injected on its power leads.

2. Applicability.- This test method is applicable for all Class I equipment (see MIL-STD-461).

3. Apparatus. The apparatus shall consist of the following:

(a) Signal Source.- A 50-ohm internal impedance and an output voltage of 7 volts to a matched load.
(b) Coupling Capacitor. The capacitor shall be used to isolate the power line frequencies from the signal source and shall have an RF impedance of 5 ohms, or less, over the frequency range of the test. The capacitor may be changed during the test so as to maintain the impedance.
(c) VTVM, Oscilloscope, or EMI meter.

4. Test Setup and Procedure.- Test setup and procedures shall be as follows:

(a) Use the general test setup as shown in Figure CS02-1.
(b) Connect the coupling capacitor and VTVM, oscilloscope, or EMI meter within 5 cm of the termination to the test sample.
(c) Appy the test signal to each power lead.
(d) When testing equipment using single point grounds, apply the test signal between each power lead and the ground return, and also each power or ground return lead and the ground plane.
(e) Measure and record the voltage across the terminal of the test sample.
(f) If the test sample is susceptible to the applicable limit level, decrease the signal source output to determine and record the threshold of susceptibility.

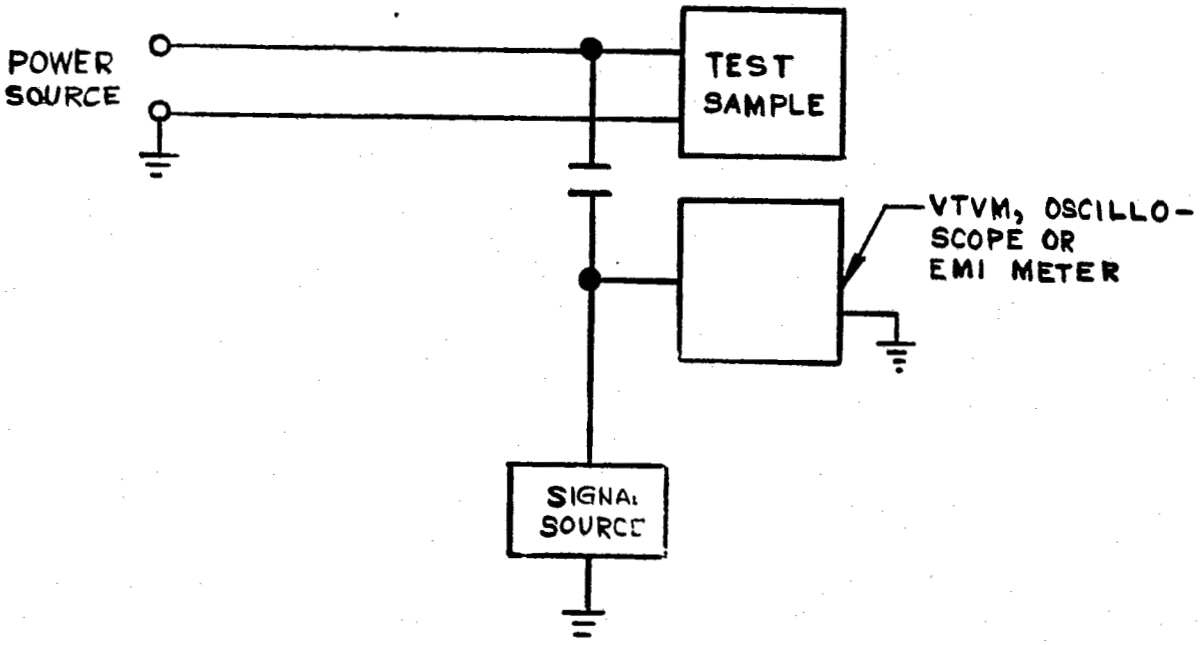


FIGURE CS02-1. Conducted susceptibility 50 kHz to 400 MHz

METHOD CS03

CONDUCTED SUSCEPTIBILITY, 30 Hz to 10 GHz, INTERMODULATION,

TWO SIGNAL

1. Purpose.- This method is used to determine the presence of intermodulation products from two signals.

2. Applicability.- This method shall be applied to receivers and tuned amplifiers operating in the frequency range of 30 Hz to 10 GHz.

3. Apparatus.- Test apparatus shall consist of the following:

(a) Signal generators capable of delivering the required outputs and covering the range necessary for this test.
(b) A three-port network providing at least 20-dB isolation between signal generators. The network shall maintain the proper impedance match at all its signal ports. The network shall be tested to ensure that is does not generate intermodulation products.
(c) Low-pass filters which will remove all signal generator harmonics shall be used.
(d) Frequency measurement equipment capable of measuring frequency to an accuracy of ± 0.5 percent.
(e) Output Monitor (to monitor performance of test sample).

4. Symbols.- Symbols shall be as follows:

(a) f_o = test sample tuned frequency.
(b) f_1 = frequency of signal generator 1.
(c) f_m = frequency at which intermodulation occurs as determined by the setting of signal generator 2.
(d). $\Delta f = f_o \pm f_1$

5. Test setup and Procedures.- Test setup and procedures shall be as follows:

(a) Set up the instrumentation as shown in Figure CS03-1.
(b) Remove the test sample and test for intermodulation products which may be generated in the instrumentation.
(c) With signal generator 2 turned off, and signal generator 1 tuned to f_o, adjust the level of signal generator 1 to produce the standard reference output. The signal generator shall be modulated as required by the detail equipment specification to produce the standard reference output. Record the level and frequency of the generator. See note 6.1.
(d) Repeat step (c), with signal generator 1 turned off and signal generator 2 tuned to f_o with the required modulation. Record the level and frequency of the generator.
(e) For the remainder of the test, turn both signal generators on with signal generator 1 modulated, as required by 6.1 and signal generator 2 unmodulated.
(f) Set the output of generator 1 equal to the applicable limit level (specified in MIL-STD-461) above the level obtained in step (c). Slowly tune generator 1 above f_o until there is no longer a response. This is f_1; measure the frequency. The difference between f_o and f_1 is Δf. Leave generator 1 at f_1.
(g) Generator 2 shall be initially set at a frequency that is Δf above f_1 with an output equal to the applicable limit level (specified in MIL-STD-461) above the level obtained in step (d). Slowly increase the frequency of generator 2, maintaining a constant ouptput level, until a frequency equal to 10 f_o or 10 GHz, whichever is less, is obtained.
(h) Test each response observed in step (g) by reducing the output of signal generator 1 to zero. If the response is still present, it is not an intermodulation product and can be neglected for this test.

(i) When a true intermodulation response is found, reduce the levels of both generators equally until the standard reference output is obtained. Record the levels and frequencies of each true intermodulation response. The difference between the signal generator levels and the level obtained in step (c) is the intermodulation rejection.

(j) Repeat steps (h) and (i) with signal generator #1 set at a frequency Δf below f_o. Decrease the frequency of generator 2, maintaining a constant output level. The lower limit shall be 0.1 f_o or 30 Hz, whichever is highest.

(k) Repeat all the above with f_1 in the frequency range from 200 to 400 MHz at an output level 80 db above the reference level. Select f_1 so that no response occurs with signal generator 2 at zero output. This step does not apply to receivers operating in the frequency range of 200 to 400 MHz.

(l) Repeat (a) thru (j) with f_1 selected in the frequency range of 2 to 25 MHz. The output of signal generator 1 shall be 80 dB above the reference level. This step does not apply to receivers operating in the frequency range of 2 to 25 MHz.

6. Notes.-

6.1 The signal generator used for this test shall always be modulated in the same manner as specified in the section of the test sample's detailed equipment specification pertaining to receiver sensitivity measurements. When the equipment specification does not define this area, the following modulations shall be used.

(a) AM Receivers.- The signal generator shall be 30 percent modulated by a 400 Hz sine wave.

(b) SSB and FM Receivers.- The signal generator shall be unmodulated (A_o emission).

(c) Pulsed Receivers.- The modulation pulse shall be adjusted so that 80 percent of its spectral energy lies within the 3 dB bandwidth of the receiver.

6.2 Because some generators may drift in frequency, it may be necessary to retune each generator to be sure that the maximum response is being measured.

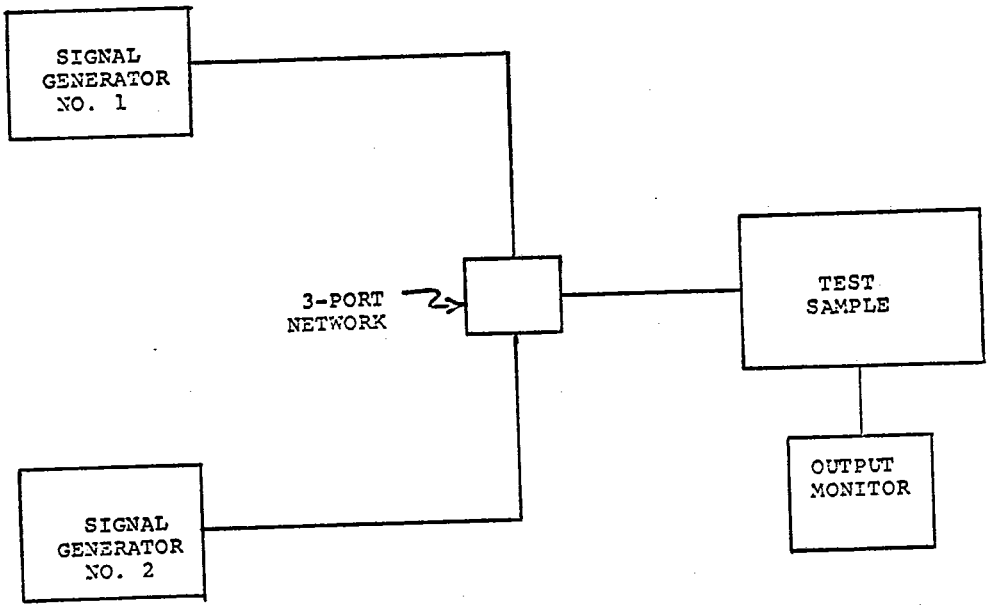


Figure CS03-1 - Conducted Susceptibility, 30 Hz to 10 GHz, Intermodulation, Test Setup

METHOD CS04

CONDUCTED SUSCEPTIBILITY, 30 HZ TO 10 GHZ, REJECTION OF

UNDESIRED SIGNALS AT INPUT TERMINALS (2-SIGNAL GENERATOR METHOD)

1. Purpose.- This method is used for determining the input terminal spurious responses using two signal generators.

2. Applicability.- This test shall apply over the frequency range indicated in 6.2 to any receiver or tuned amplifier operating in the frequency range from 30 Hz to 10 GHz.

3. Apparatus.- Test apparatus shall consist of the following:

(a) Signal generators capable of delivering the required signals over the required frequency range.
(b) Low-pass filters which will remove all signal generator harmonics shall be used.
(c) Frequency measurement equipment capable of measuring frequency to an accuracy of ± 0.5 percent.
(d) Output Monitor - To monitor performance of test sample.
(e) A three-port network providing at least 20 dB isolation between signal generators. The network shall maintain the proper impedance match at all its signal ports. The network shall be tested to ensure that it does not generate intermodulation products.

4. Symbols.- Symbols shall be as follows:

(a) f_o = Test sample tuned frequency.
(b) f_{sp} = frequency at which spurious response occurs.
(c) IF = test sample intermediate frequency.
(d) F_{LO} = test sample local oscillator frequency.

5. Test Setup and Procedures.- Test setup and procedures shall be as follows:

(a) Set up the apparatus as shown in Figure CS04-1.
(b) With signal generator 2 turned off and signal generator 1 tuned to f_o, adjust the level of signal generator 1 to produce the standard reference output. The generator shall be modulated as required by the detail equipment specification to produce the standard output. Record the level and frequency of the generator. (See 6.1)
(c) Repeat step (b) with signal generator 1 turned off and signal generator 2 tuned to f_o with the required modulation. Record the level and frequency of the generator.
(d) For the remainder of the test, turn both signal generators on, with signal generator 1 modulated, as required, and signal generator 2 unmodulated.
(e) Set signal generator 1 at the level obtained in step (b) with its proper modulation, and signal generator 2 at the specified level (specified in MIL-STD-461) above that required to obtain the standard reference output in step (c).
(f) Scan the applicable frequency range (see 6.2) with signal generator 2. Check all responses to assure that a spurious response is being measured, and not an intermodulation product.
(g) When a true spurious response is obtained, reduce the output of signal generator 2 until the standard reference output is obtained. Calculate the difference in dB between this level and that obtained in step (c). This is the spurious response rejection.

6. Notes.-

6.1 The signal generator used for this test shall always be modulated in the same manner as specified in the section pertaining to receiver sensitivity measurements of the detailed equipment specification. When the equipment specification does not define this area, the following shall be used:

(a) AM Receiver.- The signal generator shall be 30 percent modulated by a 400 Hz sine wave.
(b) SSB and FM Receivers.- The signal generator shall be unmodulated (A_o emission).
(c) Pulsed Receivers.- The modulation pulse shall be adjusted so that 80 percent of its spectral energy lies within the 3-dB bandwidth of the receiver.

6.2 The applicable frequency range for this test is given below:

6.2.1 Amplifiers.- Signal generator 2 shall be scanned from 0.05 f_1 to f_1 and from f_2 to 20 f_2 where f_1 is the lower amplifier cutoff frequency and f_2 is the upper cutoff frequency.

6.2.2 Receivers.- Signal generator 2 shall be scanned over the entire frequency range determined from the listing shown herein. The frequency range between the 80-dB down points on the selectivity curve are exempt from this test. The lower frequency limit shall be the lowest value obtained from column A and the upper frequency limit shall be highest value found in column B (this upper limit shall not exceed 10 GHz).

COLUMN A	COLUMN B
$IF/_5$	$5f_{LO}+IF$
$.05f_o$	$20\ f_o$

When testing multiple conversion receivers, the IF of column A shall be the lowest intermediate frequency while the IF and F_{LO} in column B shall be the highest frequencies associated with the receiver.

6.2.3 Receivers with waveguide input.- The required frequency range shall be from 0.8 f_{co} to the higher level obtained from column B (see 6.2.2) but shall not exceed 10 GHz (f_{co} is the waveguide cutoff frequency).

6.3 All signal generators emit a substantial amount of harmonics and other spurious energy. Care shall be taken not to mistake an emission of the generator falling on f_o for a spurious response of the equipment. It is possible to have spurious responses at fo/2, fo/3, fo/4, and so forth which are not due to generator harmonics.

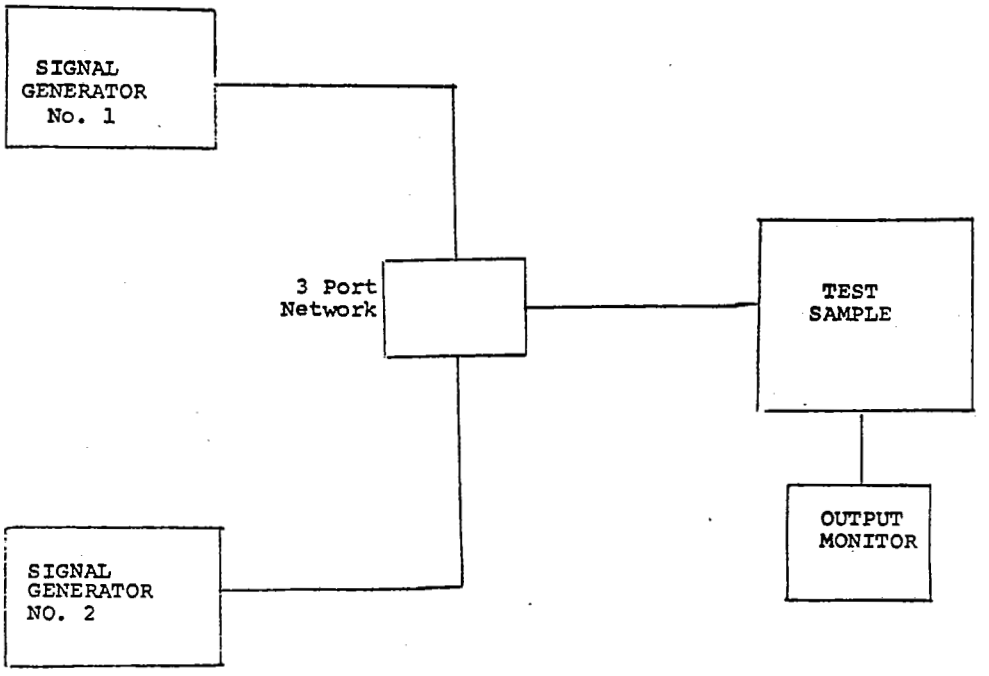


Figure CS04-1 Conducted susceptibility, 30 Hz to 10 GHz, Rejection of undesired signals at input terminals, 2-Signal generator method

METHOD CS05

CONDUCTED SUSCEPTIBILITY, 30 HZ TO 10 GHZ, CROSS MODULATION

1. Purpose.- This method is used for determining cross-modulation products using two signal generators.

2. Applicability.- This test shall be applied to receivers and tuned amplifiers operating in the frequency range from 30 Hz to 10 GHz.

3. Apparatus.- Test apparatus shall consist of the following:

(a) Signal generators capable of delivering the required outputs over the required frequency range.
(b) Low-pass filters which will remove all signal generator harmonics shall be used.
(c) Frequency measurement equipment capable of measuring frequency to an accuracy of ± 0.5 percent.
(d) Output monitor - to monitor the performance of the test sample.
(e) Three port network providing at least 20-dB isolation between signal generators. The network shall maintain the proper impedance match at all its signal ports. The network shall be tested to ensure that it does not generate intermodulation products.

4. Symbols.- Symbols shall be as follows:

(a) f_o = test sample tuned frequency.
(b) f_1 = frequency of signal generator 1
(c) f_{cm} = frequency at which cross-modulation occurs as determined by setting of signal generator 2.
(d) IF = test sample intermediate frequency

5. Test Setup and Procedures.- Test setup and procedures shall be as follows:

(a) Set up the apparatus as shown in Figure CS05-1.
(b) With signal generator 2 turned off and signal generator 1 tuned to f_o, adjust the level of signal generator 1 to produce the standard reference output. The generator shall be modulated as required by the detail equipment specification to produce the standard output. Record the level and frequency of the generator. (See 6.1).
(c) Repeat step (b) with signal generator 1 turned off and signal generator 2 tuned to f_o, with the required modulation. Record the level and frequency of the generator.
(d) For the remainder of the test, turn both signal generators on with signal generator 2 modulated, as required by 6.1 and signal generator 1 modulated.
(e) Increase the output of signal generator 1 by 10 dB over the level obtained in step (b). Leave signal generator 1 at f_o.
(f) Set the output of signal generator 2 at the specified limit level (specified in MIL-STD-461) above that required to obtain the standard reference output in step (c).
(g) With both signal generators on, scan with signal generator 2 above and below f_o, starting at the frequencies corresponding to those at the specified limit level (specified in MIL-STD-461) down on the response (selectivity) curve, scan to frequencies given by $f=f_o \pm IF$.
(h) Monitor the output of the test sample. The frequency of any response shall be measured and recorded.
(i) When a response is found, the modulation of signal generator shall be removed. If the response disappears, it is due to corss-modulation and its level and frequency shall be recorded.

6. Notes.-

6.1 The signal generator used for this test shall always be modulated in the same manner as described in the section pertaining to receiver sensitivity measurements of the detailed equipment specification. When the equipment specification does not define this area, the following shall be used:

(a) AM Receivers.- The signal generator shall be 30 percent modulated by a 400 Hz sine wave.

(b) SSB and FM Receivers.- The signal generator shall be unmodulated (A_0 emission).

(c) Pulsed Receivers.- The modulation pulse shall be adjusted so that 80 percent of its spectral energy lies within the 3-dB bandwidth of the receiver.

6.2 Because some generators may drift on frequency, it may be necessary to retune each generator to be sure that the maximum response is being measured.

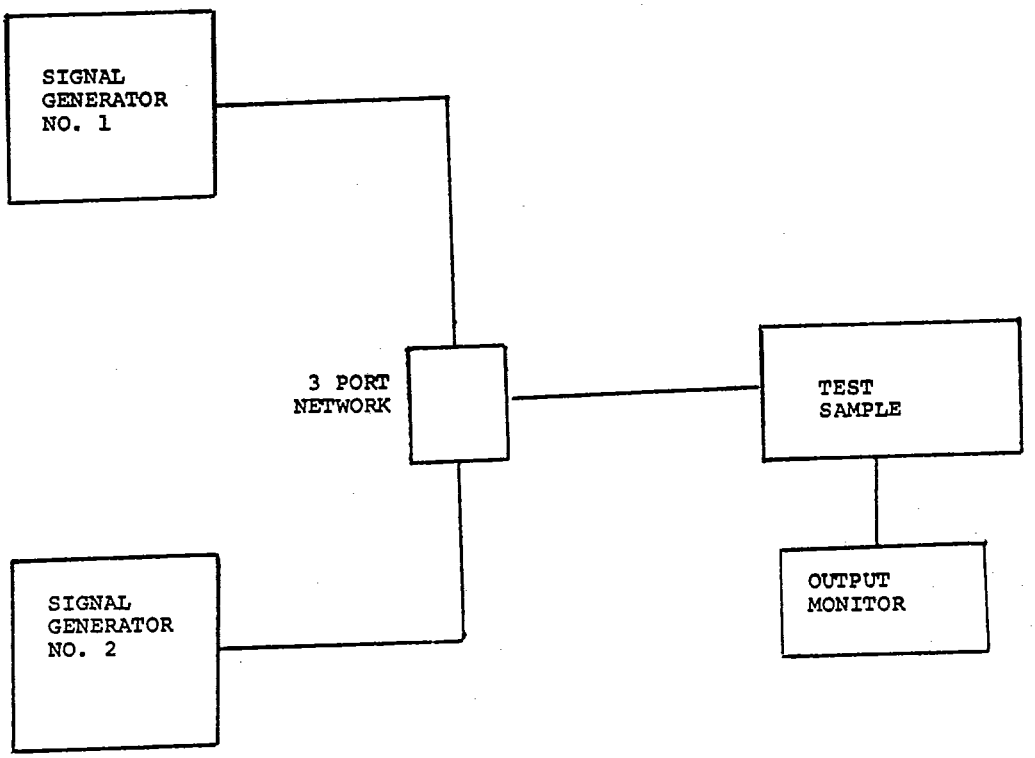


Figure CS05-1 - Conducted susceptibility, 30 Hz to 10 GHz, cross modulation

METHOD CS06

CONDUCTED SUSCEPTIBILITY, SPIKE, POWER LEADS

1. Purpose.- The purpose of this test is to determine equipment susceptibility to spike interference on power lines.

2. Applicability.- This test shall be performed on all ungrounded a.c. and d.c. input power leads of Class I equipment (see MIL-STD-461).

3. Apparatus.- The test apparatus shall consist of the following:

(a) Spike Generator with characteristics as follows:

(1)	Pulse Width	= 10 microseconds
(2)	Pulse Repetition Rate	= 3 to 10 p.p.s.
(3)	Voltage Output	= Not less than 200 V. peak
(4)	Output Control	= Adjustable from 0 to 200 V. peak
(5)	Output Spectrum	= 160 dB μv/MHz at 25 kHz decreasing to 115 dB v/MHz at 30 MHz
(6)	Phase Positioning	= 0 to 360 degrees
(7)	Source Impedance (with injection transformer)	= 0.06 ohms
(8)	Transformer (current capacity)	= 30 amperes
(9)	External Synch	= 50 to 800 Hz
(10)	External Trigger	= 0 to 20 p.p.s.

(b) Capacitor.- The 10 microfarad feedthrough capacitor as specified for Method CE01.

(c) Oscilloscope.- Any oscilloscope with 10-MHz bandwidth and adequate sweep rates is acceptable.

4. Test Procedure.- Test procedures shall be as follows:

(a) Connect test sample and test instrumentation as shown in Figure CS06-1 for equipments powered from a.c. lines and Figure CS06-2 for equipments powered from d.c. lines.

(b) Series, shunt, or both test methods may be used provided that approval has been granted by the procuring activity.

(c) When a generator with a high source impedance is used, its output shall be loaded and calibrated as indicated in Figure CS06-3.

(d) The applied spike amplitude, rise time, and duration, as measured by the oscilloscope across the input terminals of the test sample, shall follow the typical wave shape specified in the applicable limits.

(e) Synchronization and triggering shall be used to position the spike to specific test sample signal conditions which will produce maximum susceptibility.

(f) Positive and negative, single and repetitive (6 to 10 p.p.s) spikes shall be applied to the test sample's ungrounded input lines for a period not to exceed 30 minutes in duration. Spikes shall be synchronized to the power line frequency and positioned on each 90 degree phase position for a period not less than 5 minutes. Positioning of the spike from 0 to 360 degrees of the power line frequency is also required. Spike synchronization frequency shall be varied from 50 to 800 Hz and its effect on equipment susceptibility noted. On equipment employing digital circuitry, the spike shall be triggered to occur within the time frame of any gate or pulse generated by the logic circuitry.

(g) If susceptibility occurs, determine and record its threshold level, repetition rate, phase position on the a.c. waveform, and time occurrence on digital gates.

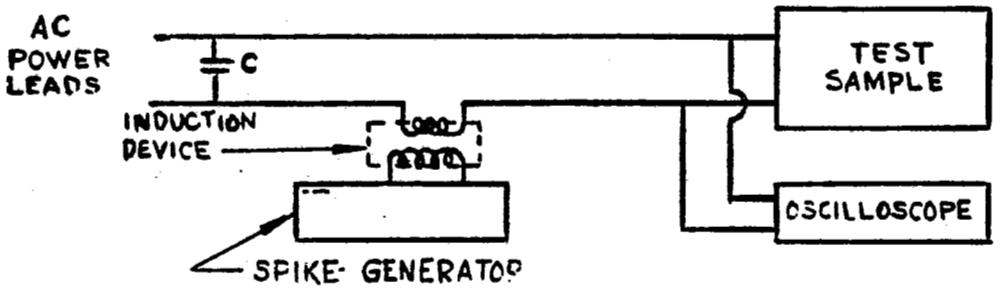


FIGURE CS06-1. Conducted susceptibility, spike, power leads; series injection

L = 20 μh

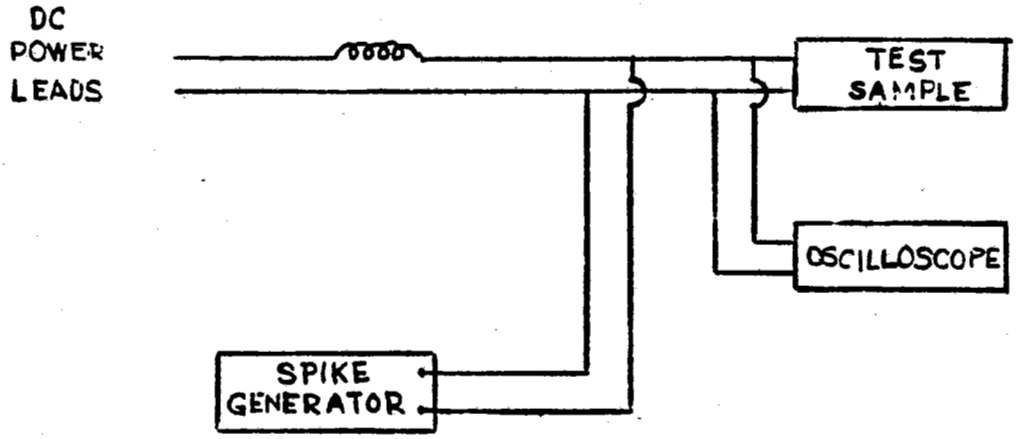
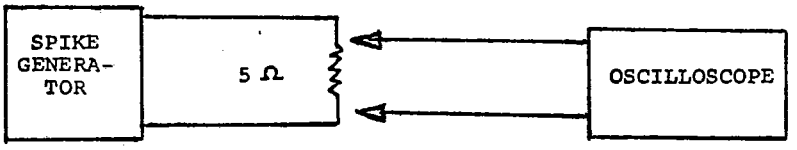


FIGURE CS06-2. Conducted susceptibility, spike, power leads; parallel injection



CONNECT A CALIBRATED 5 ohm NON-INDUCTIVE LOAD RESISTOR TO GENERATOR TO VERIFY SPIKE CHARACTERISTICS

Figure CS06-3 Calibration of spike characteristics

METHOD (T) CS07

CONDUCTED SUSCEPTIBILITY, SQUELCH CIRCUITS

1. Purpose.- The purpose of this test is to determine whether the circuit characteristics are adequate so as to prevent the circuit from opening upon application of impulse signals at the equipment input terminals.

2. Applicablility.- This method is applicable to electronic equipment using squelch circuits.

3. Apparatus.- The test apparatus shall consist of the following:

(a) Signal generator.
(b) Impulse generator.
(c) Matching network.

4. Test Setup and Procedure.- The test setup and procedure shall be as specified hereinafter.

4.1 Test 1.-

4.1.1 The test setup shall be as shown in Figure (T)CS07-1a.

4.1.2 The squelch circuit shall be adjusted so that it opens at the test sample's r.f. input voltage specified by the individual equipment specification.

4.1.3 If necessary, a matching network may be used between the impulse generator and test sample.

4.1.4 The squelch circuit shall not open when the output of the impulse generator, set at the value specified in the applicable limits is applied to the input terminal of the test sample.

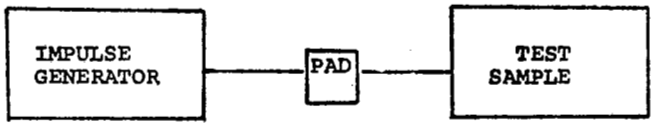
4.2 Test 2.-

4.2.1 The test setup shall be as shown in Figure (T) CS07-1b.

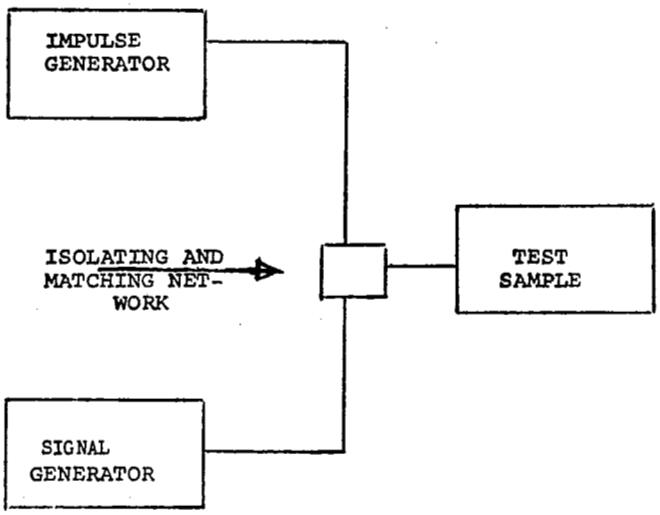
4.2.2 The squelch circuit shall be adjusted so that it opens at the test sample's r.f. input voltage specified by the individual equipment specification or the contract or order.

4.2.3 Networks shall be used as required to isolate the generators from each other, and to match them to the test sample.

4.2.4 The squelch circuit shall not open when two signals are applied at the test sample input. One shall be an unmodulated r.f. signal at f_o (test sample's center frequency) whose amplitude is 2/3 the r.f. voltage used in the second step (see 4.2.2) to adjust the squelch threshold. The second signal is an impulse signal whose amplitude is the same as the limit specified in MIL-STD-461.



a. TEST 1



b. TEST 2

Figure (T) CS07-1 - Conducted susceptibility, squelch circuits

METHOD CS08

CONDUCTED SUSCEPTIBILITY, 30 HZ TO 10 GHZ

REJECTION OF UNDESIRED SIGNALS AT INPUT TERMINALS

(1-SIGNAL GENERATOR METHOD)

1. Purpose.- This method specifies test procedures for determining input-terminal spurious response rejection using one signal generator.

2. Applicability.- This test shall apply over the frequency range indicated in 6.2 to any receiver or tuned amplifier operating in the frequency range of 30 Hz to 10 GHz.

3. Apparatus.- The test apparatus shall consist of the following:

(a) Signal generator capable of delivering the required levels over the applicable frequency range.
(b) Filters to eliminate signal-generator spurious outputs.
(c) Equipment to monitor test sample performance.

4. Symbols.- Symbols shall be as follows:

f_o = test sample's tuned frequency.
IF = test sample's intermediate frequency.
f_{LO} = test sample's local oscillator frequency.

5. Test Setup and Procedures.- The test setup and procedures shall be as follows:

(a) Set up the test instrumentation as shown on Figure CS08-1.
(b) Adjust the output of the signal generator, tuned to f_o, to give the standard reference output on the test sample. The signal generator shall be modulated as indicated in 6.1.
(c) Increase the output of the signal generator to the specified limit above that obtained in step (b) and scan the signal generator over the required frequency range (see 6.2). Check all responses to assure that a spurious response is being measured and not an intermodulation product.
(d) When a true spurious response is obtained, decrease the generator's output until the standard response is obtained. Record the frequency and level required to obtain the standard reference output. Calculate the difference in dB between this level and that obtained in step (b). This is the spurious response rejection.

6. Notes.-

6.1 The signal generator used for this test shall always be modulated in the same manner as specified in the section pertaining to receiver sensitivity measurements of the detailed equipment specification. When the equipment specification does not define this area, the following shall be used:

(a) AM Receivers.- The signal generator shall be 30 percent modulated by a 400 Hz sine wave.
(b) SSB and FM Receivers.- The signal generator shall be unmodulated (A_o emissions.)
(c) Pulsed Receivers.- The modulation pulse shall be adjusted so that 80 percent of its spectral energy lies within the 3-dB bandwidth of the receivers.

6.2 The applicable frequency range for this test is as specified in 6.2.1 and 6.2.2.

6.2.1 Amplifiers.- The signal generator shall be scanned from 0.05 f_1 to f_1 and from f_2 to 20 f_2 where f_1 is the lower amplifier cutoff frequency and f_2 is the upper cutoff frequency.

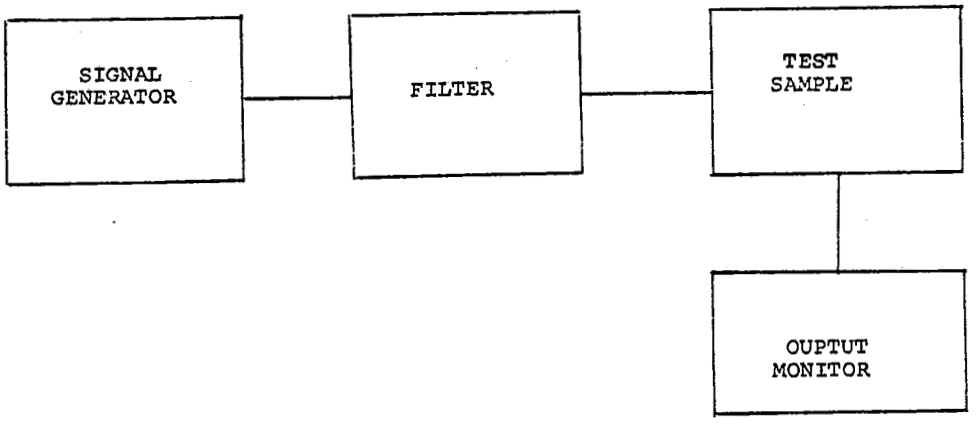
6.2.2 Receivers.- The signal generator shall be scanned over the entire frequency range determined from the listing shown herein. The frequency range between the 80-dB down points on the selectivity curve are exempt from this test. The lower frequency limit shall be the lowest value obtained from Column A and the upper frequency limit shall be the highest value found in column B (this upper limit shall not exceed 10 GHz).

Column A	Column B
$IF/_5$	$5f_{LO}$ +IF
$0.05\ f_o$	$20\ f_o$

When testing multiple conversion receivers, the IF of Column A shall be the lowest intermediate frequency while the IF and f_{LO} in column B shall be the highest frequencies associated with the receiver.

6.2.3 Receivers with waveguide input.- The required frequency range shall be from 0.08 f_{co} to the higher level obtained from Column B but shall not exceed 10 GHz (f_{co} is the waveguide cutoff frequency.)

6.3 All signal generators emit a substantial amount of harmonics and other spurious energy. Care shall be taken not to mistake an emission of the generator falling on f_o for spurious response of the equipment. It is possible to have spurious responses at fo/2, fo/3, fo/4, and so forth which are not due to generator harmonics.



NOTE: Impedance match shall be maintained between signal generator and filter and between filter and test sample.

Figure CS08-1 - Conducted susceptibility, 30 Hz to 10 GHz, rejection of undesired signals at input terminals, (1-signal generator method)

METHOD RE01

RADIATED EMISSION, 30 Hz TO 30 kHz, MAGNETIC FIELD

1. Purpose.- This method is used for measuring magnetic field radiated from electrical, and electro-mechanical equipment.

2. Application.- An equipment to which this method is applicable shall be measured for radiated magnetic field from each unit, cable (including control, pulse, IF, video, antenna transmission lines and power cables), and interconnecting wiring over the frequency range of 30 Hz to 30 kHz. This applies to the transmitter fundamental, and spurious and oscillator radiation, but does not include radiation emanating from antennas. Equipment operating at frequencies above 30 MHz are exempt from this test.

3. Apparatus.- The test apparatus shall consist of the following:

(a) Loop Sensor.- As indicated in MIL-STD-461 (AT-205/URM-6 or equal).
(b) EMI Meter.- The EMI meter and loop combination shall be capable of measuring magnetic flux densities at least 6 dB below the applicable limit for this test. In addition, the meter shall be tunable with a bandwidth no greater than 10 Hz at the 3-dB points.

4. Test Procedure.- The test procedures shall be as follows:

(a) Position the loop sensor approximately 7 cm from one face of the test sample, with the plane of the loop parallel to the face of the test sample. The loop shall be located at a point which may be considered a leakage point (seam, joint, connector, or cable), as approved in the test plan.
(b) Scan the EMI meter from 30 Hz to 30 kHz to locate the frequencies of maximum radiation, considering the test sample's critical frequencies (for example, those which intentionally exist in the equipment due to its design, such as power frequencies and its harmonics, local oscillator frequency, and so forth), if known, and record these frequencies.
(c) Tune the EMI meter to one of the frequencies located in (b) above and position the loop sensor 7 cm from the surface of the test sample, with the plane of the loop parallel to the surface. For cables, the planes of the loop and the cable shall coincide, and the distance between the center of the loop and the cable shall be 7 cm.
(d) Monitor the output of the EMI meter while moving the loop sensor over the entire face of the test sample. The point of maximum radiation shall be noted.
(e) At the point of maximum radiation, orient the plane of the loop sensor to give a maximum reading on the EMI meter and record this reading.
(f) Repeat steps (c) thru (e) for, at least two frequencies of maximum radiation/octave below 200 Hz and three frequencies of maximum radiation/octave above 200 Hz.
(g) Repeat steps (a) thru (f) for each face of the test sample.

METHOD RE02

RADIATED EMISSION, 14 KHz TO 10 GHz, ELECTRIC FIELD

1. Purpose.- This method is used for measuring radiated electromagnetic emissions from electronic, electrical, and electromechanical equipment.

2. Applicability.- Any equipment or device to which this method is applicable shall be measured for radiated emissions from all units, cables (including control, pulse, IF, video antenna transmission lines, and power cables), and interconnecting wiring. This method applies to the transmitter fundamental, spurious radiation, oscillator radiation, and broadband emissions, but does not include radiation emanating from an antenna.

2.1 Applicable Frequency Range for Test.-

2.1.1 Electronic Equipment.-

(a) Narrowband emissions shall be measured from 14 kHz to 10 times the highest used or intentionally generated frequency, or 1 GHz, whichever is greater; however, the measure frequency shall not exceed 10 GHz.
(b) Broadband emissions shall be measured from 14 kHz to 1 GHz.

2.1.2 Electrical Equipment (Classes IIB and IIC).-

(a) Class IIB items shall be tested from 150 kHz to 400 MHz, except electrical hand tools, which shall be tested from 150 kHz to 30 MHz.
(b) Class IIC items shall be tested from 150 kHz to 1 GHz.

3. Apparatus.- Test apparatus shall consist of the following:

(a) Test antennas.
(b) EMI Meters.
(c) 10-Microfarad Feed-Through Capacitor.

4. Test Set-Up and Procedure.-

4.1 Test Setup.- The basic test set-ups shall be as shown in Figures RE02-1 and RE02-2.

4.1.1 Nonportable Equipment.- Equipment which is permanently connected either physically or electrically, to a vehicle, system, or installation shall be tested in accordance with the setup shown in Figure RE02-1.

4.1.2 Portable equipment, including hand tools, adminstrative office machines, manpack operable equipment, and test equipment shall be tested in accordance with the setup shown in Figure RE02-2.

4.1.3 Equipment falling into both of the categories indicated in 4.1.1 and 4.1.2 shall be tested both ways, unless otherwise specified by the procuring activity or as approved in the test plan.

4.2 Procedure.- The test procedures shall be as follows:

(a) Probe the test sample as indicated in Section 4 of this standard to locate the points of maximum radiation from the test sample.
(b) Select and position the test antennas as indicated in Section 4 of this standard. In the frequency range of 25 to 200 MHz, position the test antenna so as to make both vertical and horizontal measurements.
(c) For each test antenna, scan the applicable frequency range of this test with the EMI meter and take measurements as required.

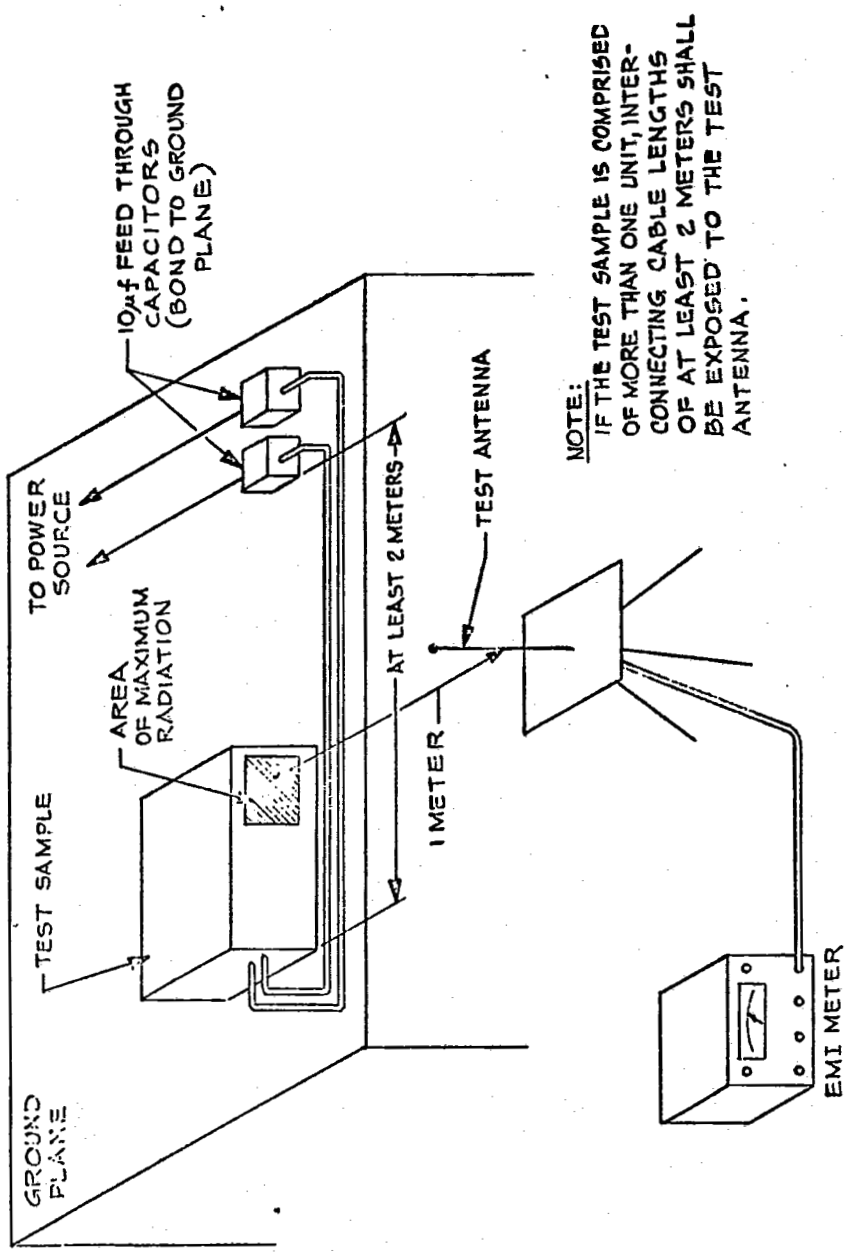


Figure RE02-1 - Typical test setup for radiated measurements

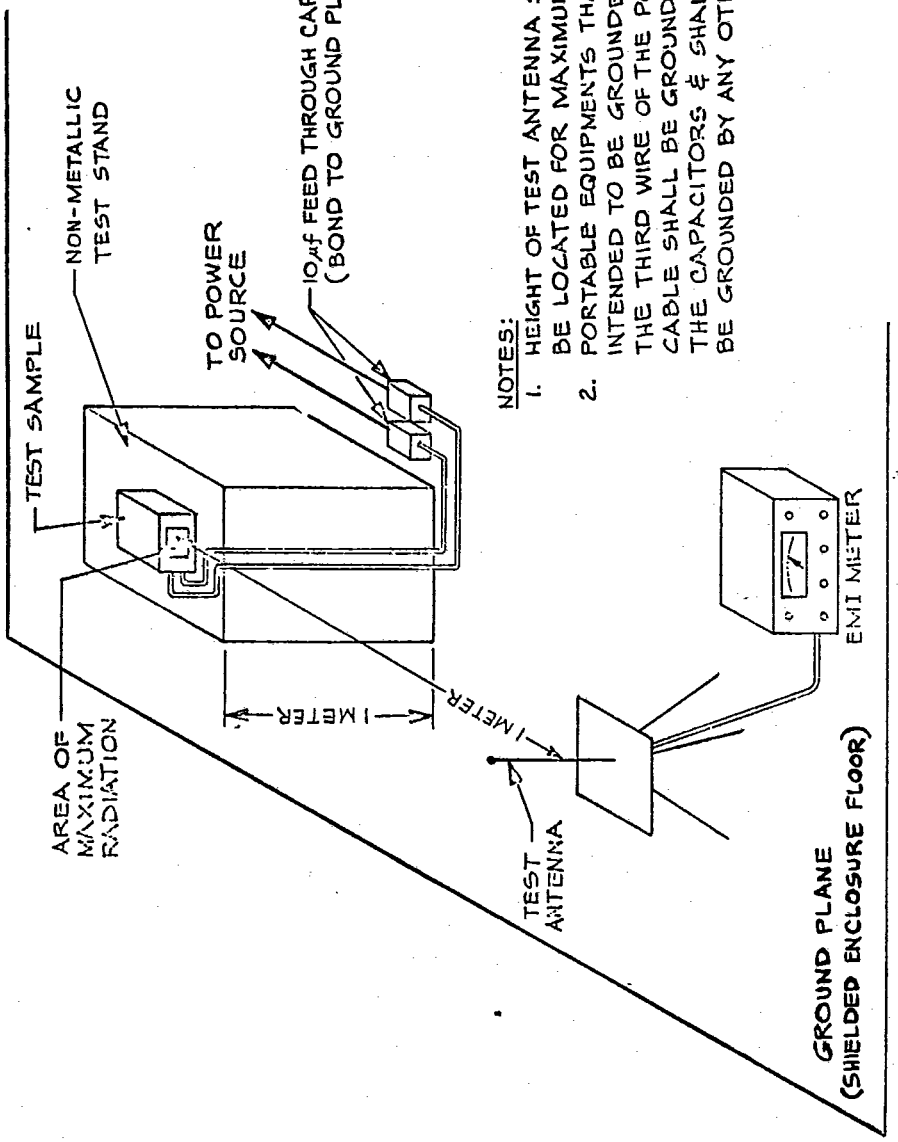


Figure RE02-2 - Typical test setup for radiated measurements on portable equipment.

METHOD RE03

SPURIOUS AND HARMONIC EMISSIONS, 10 kHz TO 40 GHz

1. Purpose.- This method is used for measuring transmitter spurious and harmonic emissions in the radiated field.

2. Applicability.- This method is applicable when the direct coupled techniques of Method CE06 cannot be applied. When both CE06 and RE03 can be applied, Method CE06 should be used. This procedure, however, shall be used when the following conditions prevail:

(a) The transmitter output power is greater than 5 kilowatts average.
(b) The fundametal frequency is above 1.24 GHz.
(c) The test sample's antenna is an integral part of the transmitter and cannot be replaced by a suitable dummy load.

3. Frequency range of test.- Frequency ranges of the test shall be as follows:

Equipment operating frequency	Frequency range of test
10 to 30 kHz	10 kHz to 10 MHz
30 to 300 kHz	10 kHz to 100 MHz
0.3 to 3 MHz	10 kHz to 600 MHz
3 to 30 MHz	10 kHz to 1000 MHz
30 to 300 MHz	1.0 to 3,000 MHz
300 to 1,240 MHz	10 MHz to 12,400 MHz
1,240 MHz and above	The lowest frequency of test shall be: (a) coaxial transmission lines 200 MHz (b) waveguide transmission lines 0.8 f_{co} The upper frequency limit shall be as follows:

Equipment operating frequency (GHz)	Upper Frequency Limit[1/]	
	Required	Optional
1.24 to 5.0	10 GHz	40 GHz
above 5.0	20 GHz	40 GHz

[1/] When specified in equipment specification.

4. Apparatus.-

4.1 Select the instrumentation from the following for tests over the frequency range 0.01 to 1,000 MHz.

(a) EMI meter.
(b) Necessary attenuators or amplifiers as may be required to insure suitable signal levels at EMI meter input terminals.
(c) Antennas:
  (1) 0.01 to 25 MHz - 0.5 meter effective length rod
  (2) 25 to 200 MHz - 132 cm biconical antenna
  (3) 200 to 1000 MHz - cavity backed spiral antenna, AEL Mode ASN-1232(or equal)

4.2 The following instrumentation shall be used for measurements above 1,000 MHz.

(a) Spectrum Analyzer - Hewlett Packard Model 851B display section with Model 8551B rf section.

(b) Traveling-wave tube amplifiers - Watkins-Johnson Models or equal.
WJ-268 1-2 GHz
WJ-269 2-4 GHz
WJ-271 4-8 GHz
WJ-276 8-12 GHz
(c) Preselectors-Watkins-Johnson yig filters. Model as follows (or equal):

581-04 1 to 2 GHz
582-03 2 to 4 GHz
583-03 4 to 8 GHz
584-03 8 to 12 GHz
(d) Frequency counter - Systron Donner Model 1037BD (or equal)
(e) Signal generators necessary to cover the frequency range of test
(f) Antennas:
(1) 1 to 12 GHz
Cavity backed spiral - AEL Model ASN-116 (or equal)
Cavity backed spiral mounted in a 3-foot dish - AEL Model ASN-1242 (or equal)
(2) 12 to 40 GHz
Use the antenna constructed in accordance with Drawing ES-DL-201090.

5. Symbols.- Symbols shall be as follows:

(a) P_R = Power delivered to spectrum analyzer's input terminals.
(b) P_T = Power delivered to the transmitter's antenna (dBm).
(c) G_T = Gain of the transmitting antenna over an isotropic radiator. This value is expressed in dB.
(d) λ = Wavelength of the transmitted signal in meters.
(e) D = Maximum dimension of the receiving antenna in meters.
(f) d = Maximum dimension of the transmitting antenna in meters.
(g) G_R = the gain of the receiving antenna over an isotropic radiator, + gain of the TWT's - cable losses - attenuation-insertion loss of yig filters, and so forth. This factor should include a -3 dB correction if the transmitting antenna is linearly polarized.
(h) R = Separation between antennas in meters.
(i) h = Height above ground in meters.
(j) P_T = 80 dB below the transmitter power at f_o.
(k) T = Pulsewidth in microseconds.
(l) Fs = Desired frequency in GHz.
(m) N = Harmonic number shown on the spectrum analyzer.
(n) f_{LO} = Local oscillator frequency of spectrum analyzer as measured by the counter.
(o) F_{IF} = Intermediate frequency of the spectrum analyzer.
(p) Ei = Measured field strength in volts/meters.
(q) W = Transmitted (radiated) power in watts.

6. Test procedure for measurements above 1000 MHz.- Test procedures for measurements above 1000 MHz shall be as follows:

(a) Select the receiving antenna, TWT's or attenuators which will yield sufficient gain so that the applicable equation below may be satisfied. (This is to be done by trial and error).

(1) $P_R = P_T + G_T - 20 \log 4\pi + 40 \log \frac{\lambda}{(D+d)} + G_R$
Use this equation when $d \geq 0.4D$

(2) $PR = P_{T+G}T - 20 \log 8\pi + 40 \log \frac{(\lambda)}{} + G_R$
Use this equation when $d < 0.04\ D$

In the above equations:

P_R, should be set for approximately 0 dBm so that sufficient sensitivity remains to measure spurious responses.
P_T = may be an approximate value derived from the transmitter's design data, for the purpose of selecting the test setup.

(b) Use one of the following equations to solve for the distance separating the transmitting and receiving antennas.

(1) When $d < 0.4\ D$

$$R = \frac{2D^2}{\lambda}$$

(2) When $d \geq 0.04D$

$$R = \frac{(D+d)^2}{\lambda}$$

(c) Solve the following equation to determine the height above ground for both receiving and transmitting antennas.

$$h = \frac{D^2}{d}$$

(d) To complete the test setup analysis, calculate the received power at the highest frequency of test from the following:

$$P_R = \frac{P_t G_T G_R \lambda^2}{(4\pi R)^2}$$

Verify that the value of P_R from the above equation is at least 10 dB above the minimum sensitivity of the spectrum analyzer used. If the received power is below the sensitivity of the spectrum analyzer, increase the gain of the receiving loop by either removing attenuation or by adding addition amplification.

(e) Set up the test instrumentation as illustrated in Figure RE03-1 or RE03-2, whichever is applicable, using the values derived above to establish the distances, receiver loop, and so forth.

(f) Measure and record the value of the power delivered to the transmitting antenna using the following procedure:

(1) Adjust the spectrum analyzer to receive the transmitted signal assuming a signal level of -10 dBm at the input terminals. Adjust the spectrum analyzer bandwidth so that it may properly display the incoming signal. For pulsed transmitters, the bandwidth should be set for approximately 2/T.

(2) Key the transmitter and align both receiving and transmitting antennas so that the main lobes of both antennas are coincident. This is accomplished by adjusting the azimuth and elevation angles of both antennas so that a maximum aptitude is displayed on the spectrum analyzer.

(3) Adjust the spectrum analyzer controls to obtain maximum resolution of the transmitted signal on the CRT display. Once this is accomplished, do not readjust the controls until the measurement is completed.

(4) Disconnect the spectrum analyzer from the measurement antenna and connect it to the substitution generator.

(5) Adjust the output of the substitution generator to produce the same spectral envelope on the spectrum analyzer as indicated with the transmitted signal. The signal generator shall be modulated in a manner similar to the modulation used in the transmitter.

(6) Measure and record the power delivered to the spectrum analyzer input from the calibrated signal generator.

(g) Verify the measurement technique and calibration at f_o by substituting into the following equation.

$$P_T = \frac{(4\pi R_2)^2 P_R}{G_T G_R \lambda^2}$$

The above value of P_T should be within $\pm$ 2 dB of the value measured by the power monitor connected to the transmitters output. If the error is greater than $\pm$ 2 dB, check test setup for errors in distance measurement, sbustitution, drift, correction factors used in calibration, ground reflections, improper antenna alignment, and so forth.

(h) Repeat procedure (f) for the remaining frequency range of test. While scanning for spurious and harmonic outputs, the transmitting and receiving antennas should be aligned so that the main lobes of both antennas at f_o are coincident.

7. Notes.-

(a) When performing these tests, it may be necessary to enclose the measurement equipment in a shielded enclosure. This necessity arises from the fact that the spectrum analyzer may be susceptible to radiated fields. It is recommended that the spectrum and analyzer be disconnected from the measurement antenna and the display checked to verify that a back door response is not being measured.

(b) When using the TWT's and yig filters, these parts should be located as near the antenna as possible. This is done so that maximum signal may be applied to the TWT input.

(c) It is necessary to monitor continually the transmitter's output power during test. If the power at f_o changes by more than $\pm$ 2 dB, the test shall be terminated until such time that the original output is obtained. Duty cycle considerations shall be adhered to, and should be established as defined in the equipment's test plan.

(d) To measure the frequency of the incoming signal, note the signal identifier and harmonic number of the spectrum analyzer. Since the frequency counter-measures the spectrum analyzer's local oscillator, the frequency of the desired signal is derived from

$$F_S = N F_{LO} \pm F_{IF}$$

(e) The same procedure may be applied at the lower frequencies to measure harmonic and spurious outputs. A simplification results, however, since the same antennas are used as in Method RE02. Since field strength can be readily measured, the power radiated can be derived from the following equation:

$$W = \frac{R^2 E_i^2}{30}$$

RADIATED EMISSIONS

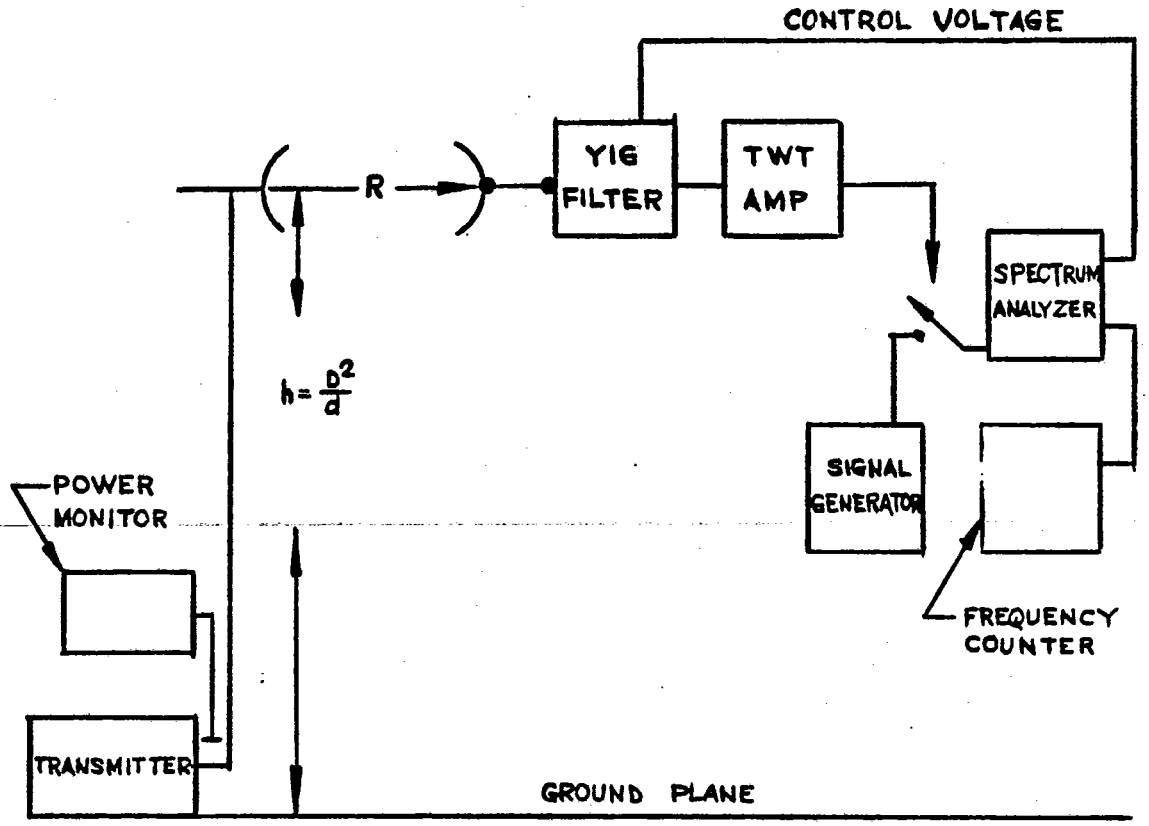


FIGURE RE03-1. Typical test setup —spurious and harmonic emissions

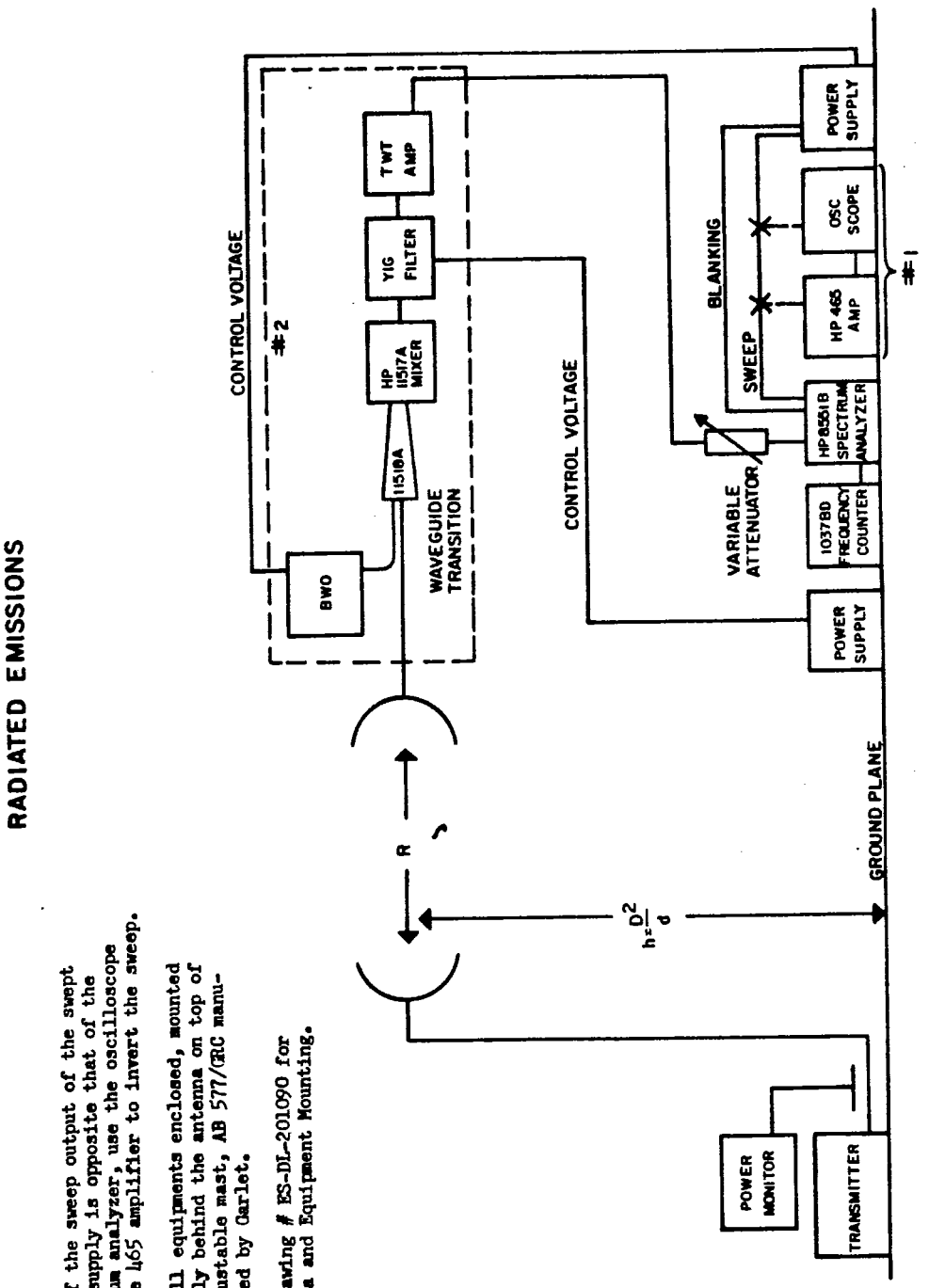


Figure RE03-2 - Typical setup - spurious and harmonic emission

METHOD (T) RE04

RADIATED EMISSION, 20 Hz TO 50 kHz, MAGNETIC FIELD

1. Purpose.- This method is used to measure radiated magnetic fields emitted from electronic, electrical, and electromechanical equipment.

2. Application.- Any equipment to which this test method is applicable will be measured for radiated magnetic fields from all units, cables, (including control pulse, IF, video, antenna transmission line and power cables) and interconnecting wiring over the frequency range of 20 Hz to 50 kHz. This method applies to the transmitter fundamental, and all spurious emanations, but does not include desired radiation emanating from antennas. Equipments that operate at frequencies above 30 MHz or are not capable of producing magnetic field, either intentional or unintentional, are exempt from these measurements.

3. Apparatus.- The following test apparatus shall be used and assembled as shown in Figure (T) RE04-1.

(a) Magnetic field sensor and electronics.- Capable of measuring 40 dB below nano tesla (dBnT) at 25 Hz.
(b) EMI Meter.- Any narrowband EMI meter with adequate sensitivity, bandwidth, and other characteristics is applicable.
(c) Calibrator.- The calibrator shall be capable of generating known magnetic fields at a minimum of 10 frequencies over the 20-Hz to 50-kHz range.
(d) 10-Microfarad Feed-through Capacitor.

4. Test Procedure.- The basic test setup is shown in Figure (T) RE04-2.

4.1 The point of maximum radiation at a distance of 1 meter from the test sample to the top of the sensor shall be located as indicated as follows:

4.1.1 For test samples generating only broadband emissions (that is not intended to generate or receive signals.)

(a) Position the sensor at the 1 meter distance indicated above and opposite the center of the test sample.
(b) Scan the full range of the EMI meter for the frequency giving the maximum indication.
(c) At the frequency in (b) move the sensor horizontally to determine the location of the maximum emission level. This location shall be the sensor position.

4.1.2 For Test samples intended to generate or receive signals.-

(a) Position the sensor as in 4.1.1 (a).
(b) Set the test sample to one of its critical frequencies.
(c) Scan the full range of the EMI meter for the frequency giving the maximum indication.
(d) At the frequency in (c) above, move the sensor horizontally to determine the location of the maximum emission level. This location shall be the sensor position.

4.2 At the point of maximum emission, scan the EMI meter over the range of 20 Hz to 50 kHz and record data as required.

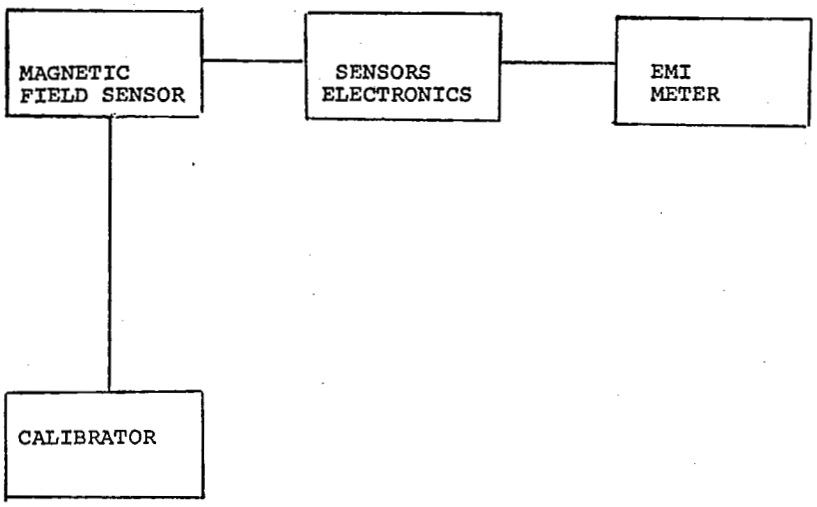


Figure (T) RE04-1 - Measuring apparatus

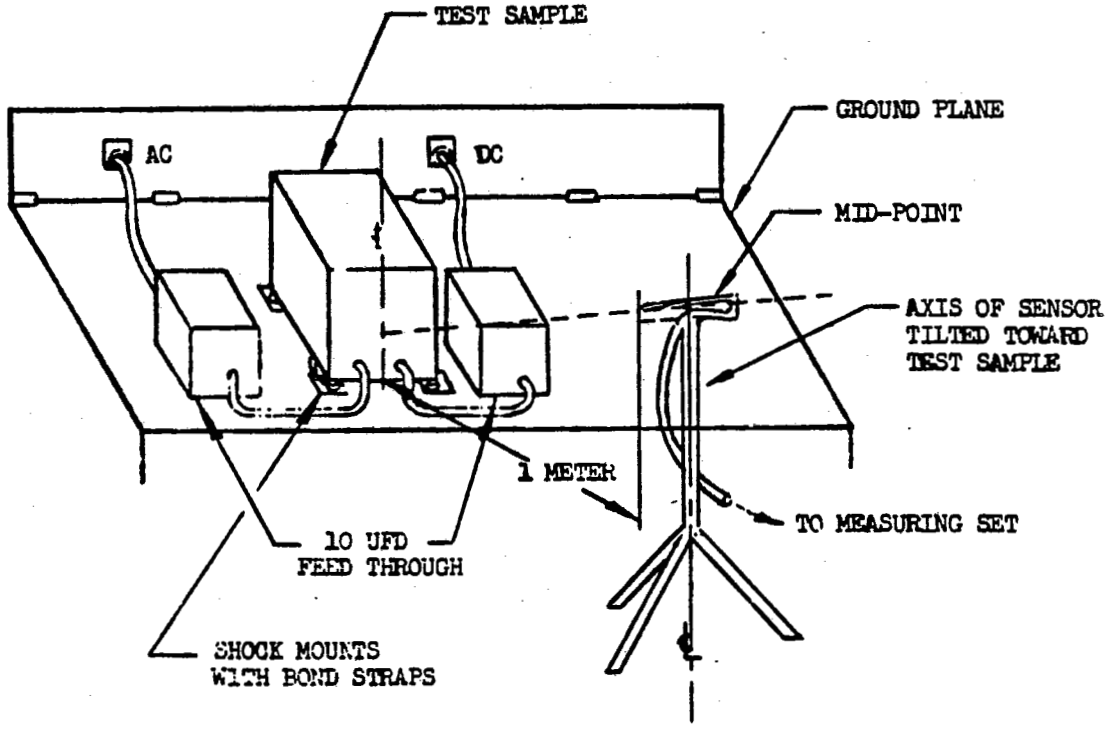


FIGURE (T) RE04-2. Typical test setup for radiation measurements (magnetic field sensor)

METHOD RE05

RADIATED EMISSION, BROADBAND, 150 kHz TO 1 GHz

VEHICLES AND ENGINE-DRIVEN EQUIPMENT

1. Purpose.- The purpose of this method is to establish test setups and procedures for measuring broadband radiated emissions of vehicles and engine-driven equipment, including the electrical equipment, subassemblies, parts and accessories installed thereon.

2. Applicability.- This test method is applicable to the measurement of radiated broadband interference emitted by the following classes of equipment:

Tactical vehicles, Class IIIA - test from 150 kHz to 1 GHz
Engine generators, Class IIIB, - test from 150 kHz to 1 GHz
Special-purpose vehicles and engine-driven equipment, Class IIIC. - test from 150 kHz to 400 MHz.

3. Apparatus.- Interference measuring equipment, and antennas, shall be as specified in MIL-STD-461 for radiated measurements in the required frequency range.

4. Test Setup.-

4.1 The vehicle or equipment to be tested shall be set up in a fixed position on the earth (see MIL-STD-461 for general test conditions) and operated in a manner to cause maximum radiation within normal operating procedures. The tests shall be performed with all electrical equipment in operation, and electrical load conditions adjusted so that the charging system, including output voltage regulators, is in operation throughout the test.

4.2 The measuring antennas, within the limits stated below, shall be located and oriented vertically for maximum pickup at as many positions around the test sample as are necessary to obtain an effective test of the maximum radiation. The horizontal distance from the reference point of the antenna to the outer perimeter of the test sample shall be one meter. The elevation of the antenna reference point above ground shall be from one to two meters, as necessary for maximum pickup, except as follows:

(a) To measure radiation from top openings over engine compartments of tanks and other vehicles having such openings, the antenna shall be placed as follows, while maintaining a clearance of one meter between the vehicle and the reference point of the antenna.
  (1) The 41-inch rod shall be tilted over the engine compartment from the end of the vehicle, keeping the antenna horizontal in the vertical longitudinal center plane of the vehicle.
  (2) The biconical antenna shall be placed with its axis horizontal over the center of the opening, and in the vertical longitudinal center plane of the vehicle.
  (3) The conical spiral antenna shall be placed with the point down, axis vertical, over the center of the opening.

5. Procedure.- The test procedure shall be as follows:

(a) Scan and record the emission level as a function of frequency, for the full required frequency range, in each position of the measurement antenna.
(b) The frequency range from 25 to 200 MHz shall be scanned with the biconical antenna alternately vertical and horizontal, at the positions chosen for the vertical tests, except for measurements over top openings.

6. Notes.

6.1 Unless otherwise specified in the equipment specification, starting motors and switches associated with starting, short-duration starting aids, and engine-protective warning devices no not require tests. However, low-air warning devices for air-brake vehicles are required to meet the emission limits while indicating low air pressure.

6.2 Technical assistance may be requested of the procuring activity when applying this standard to unusal equipment such as mobile railroad equipment and watercraft. The measuring antenna in these cases shall be placed where the communication receiving antenna would be placed for acutal use.

METHOD RE06

RADIATED EMISSION, 14 kHz to 1 GHz, OVERHEAD POWER LINES

1. Purpose and Applicability.- The purpose of this procedure is to measure radiated emissions from overhead power lines operating at voltages from zero to 1000 kV. The measurements shall be made in the frequency range from 14 kHz to 1 GHz.

2. Apparatus.- Test apparatus shall consist of the following:

(a) EMI Meter (in PEAK position)
(b) Antennas

3. Test Setup and Procedure.-

3.1 Make.- The test setup shall be as shown in Figure RE06-1.

3.2 Measurement Locations.- Measurements will usually be required near a critical area. In order to determine if the power line is the source of interference, measurements will be necessary at two or more locations along the line length. For voltages from 0 to 70 kV, measurements are made opposite tower or pole on one side only. For voltages from 70 to 1000 kV, measurements shall be made on both sides of the tower as shown in Figure RE06-1.

3.3 Nonpower line interference.- If it is suspected that the emission measured is other than from the power line, readings at several frequencies should be taken at several distances greater than 50 feet, perpendicular to this power line. Typical measurements of interference from power lines show a $1/d^3$, $1/d^2$, or $1/d$ relationship with distance from the line, depending on the frequency.

4. Notes.-

4.1 Antenna isolation.- Proximity effects from nearby objects shall be avoided when making measurements. Measurement of radiated broadband impulse-type interference will be influenced by conducting objects, including personnel, in close proximity to the antenna.

4.2 Monitoring.- Meters, either indicating or graphic, should be installed near the measurement location to monitor the line interference while measurements are being made. Readings should be repeated if the monitor shows greater than 6-db changes. It may be necessary to determine that the entire length of line is within the same weather environment before proceeding with further measurements; otherwise the effects of both fair and foul weather data will be included in the line measurement.

4.3 Operating condition.-

4.3.1 The transmission line shall be operated near normal operating voltage, during the entire time of test. The actual voltage or variations thereof can be determined from indicating meters usually available at a sub-station.

4.3.2 Weather conditions.- Measurements shall be made at a time when humidity and temperature conditions do not cause condensation of moisture on the overhead lines. This specification is intended for both dry and wet (rain or snow) weather conditions; however, the entire length of the line shall be under the same conditions. It is permissible to avoid measurements during short term dry spells, when insets, dirt, dust, and vegetation gather on the conductor or other line parts and may cause high interference levels.

4.4 Measurements with the biconical antenna shall be made in both the vertical and horizontal positions.

4.5 Measuring antenna shall be positioned on a tripod/meter above ground.

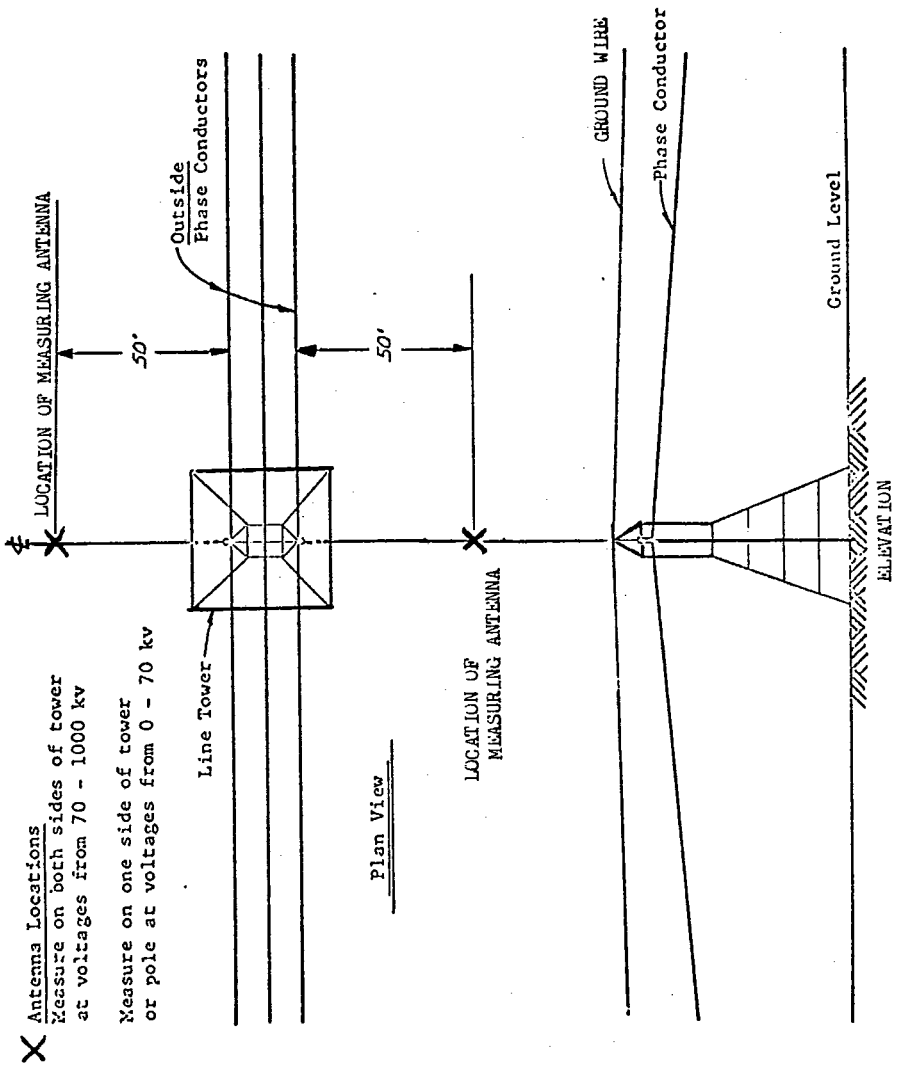


Figure RE06-1 - Antenna locations interference measurements for power lines from 0 - 1000 kv.

METHOD RS01

RADIATED SUSCEPTIBILITY, 30 Hz to 30 kHz, MAGNETIC FIELD

1. Purpose.- The purpose of this test method is to determine whether Class I equipment (see MIL-STD-461) is susceptible to magnetic field radiation.

2. Applicability.- This method is applicable in the frequency range of 30 Hz to 30 kHz to Class I equipment, its cables, and connectors. Equipment operating at frequencies greater than 30 MHz are exempt from this test.

3. Apparatus.- Test apparatus shall consist of the following:

(a) Radiating Loop.- The radiating loop shall be as shown in MIL-STD-461. The loop is capable of producing a magnetic flux density of 5×10^{-5} Tesla/Ampere at a point approximately 5 cm from the face of the loop. It shall be supported on a wooden form or similar non-conducting material.

(b) Signal Source.- The signal source shall be as specified in MIL-STD-461. The loop shall be supplied with sufficient current capable of producing magnetic flux densitites 20 to 30 dB greater than the applicable limit at the test frequency.

(c) EMI Meter or Narrow band VTVM.- The EMI Meter or Narrowband VTVM shall be capable of reading levels as low as 30 μv in the 30-Hz to 30-kHz frequency range. The equipment shall have a 10-Hz or narrower bandwidth at the 3-dB points.

4. Test Setup and Procedures.- Test setup and procedures shall be as follows:

(a) Position the field radiating loop 5 cm from the surface of the test sample. The plane of the loop shall be parallel to the plane of the test sample's surface. (See Figure RS01-1.)

(b) Supply the loop with sufficient current to produce magnetic flux densitites approximately 20 to 30 db greater than the applicable limit at the test frequencies.

(c) Move the loop over the entire surface and signal input and output cables and connectors to determine the point at which the applied field produces the maximum effect on the test sample.

(d) With the loop at the point of maximum susceptibility, adjust the loop current until the performance of the test sample is not affected by the applied field.

(1) For test samples with an aural output, adjust the loop current until the test sample gives a reading 20 dB greater than its internal noise. If a 20-dB value connot be obtained, a 6-dB interference signal-to-noise ratio will be used.

(2) For test samples with outputs other than aural, the degree of degradation shall be defined in the test plan.

(3) For test samples with aural and nonaural outputs, the test shall be performed to meet both steps (d) (1) and (d) (2).

(e) Record the magnitude of the magnetic field density produced by the source and the maximum value of magnetic flux density required by step (d) above.

(f) Repeat steps (a) through (e) at the test frequencies approved in the test plan.

5. Notes.-

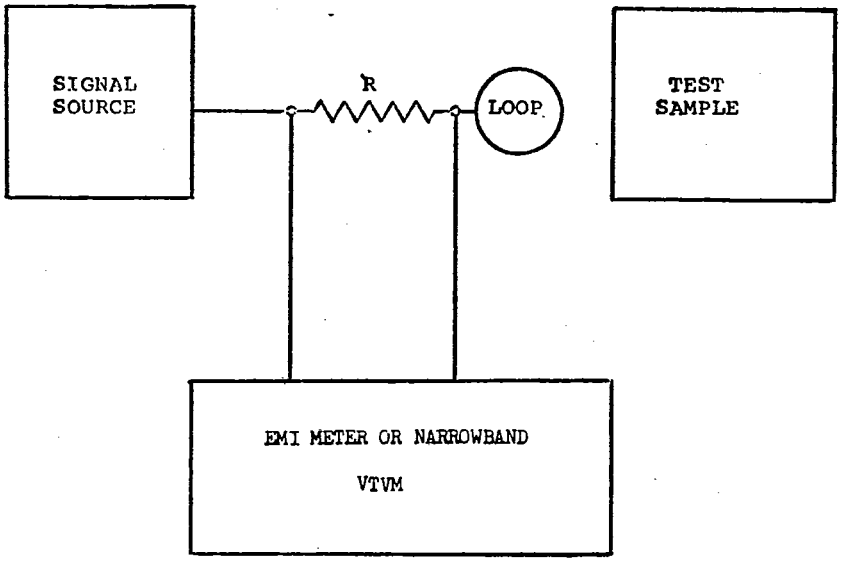
5.1 The magnitude of the magnetic flux density produced by the magnetic field source will be converted to a value representing the equivalent interfering magnetic flux density for a 6-dB signal-to-noise ratio in a system bandwidth of 1 Hz. To make this conversion, the calculations specified hereinafter are necessary:

5.1.1 If a 20-dB interfering signal-to-noise ratio was used the magnetic flux density recorded in step 4 (e) shall be reduced by 14 dB.

(a) If the bandwidth of the tunable voltmeter or EMI meter is greater than that of the test sample or if the overall bandwidth of the test sample plus measuring instrument is greater than 1 Hz, the value will be further reduced by a factor of 10 log Δf_v where Δf_v is the 3-dB bandwidth of the EMI meter or tunable voltmeter. This final value shall be recorded at that frequency.

(b) If the overall bandwidth of the test sample, plus measuring instruments, is less than 1 Hz, or if the bandwidth of the tunable voltmeter or EMI meter is less than that of the test sample, the magnetic flux density recorded shall be increased by a factor $10 \log \frac{1}{\Delta f_s}$, where Δf_s of the overall 3 dB bandwidth of the test sample. This final value shall be recorded and compared with the limit.

5.1.2 If a 6-dB signal-to-noise ratio was used, the magnetic flux density recorded in step 4(e) shall be approxiately adjusted as specified in 5.1.1(a) and 5.1.1(b).



R = Resistor of 1 ohm (A 1-volt output to the voltmeter yeilds a 1 amp input to the loop)

Figure RS01-1 - Radiated Susceptibility, 30 kHz to 30 kHz, magnetic field

METHOD RS02

RADIATED SUSCEPTIBILITY, MAGNETIC INDUCTION FIELDS

1. Purpose.- The purpose of this test is to determine the existance of susceptibility to magnetic induction fields.

2. Applicability.- This procedure is applicable for Class I equipment (see MIL-STD-461).

3. Apparatus.- The test apparatus shall consist of the following:

(a) Spike Generator.- Spike generators shall be as specified in Method CS06 of this standard.
(b) Step-down Transformer and Variac.- The step-down transformer and variac shall be capable of carrying the currents required by this test.
(c) Oscilloscope.-

4. Test Setup and Procedures.-

4.1 Cable Susceptibility Test (Test 1).- The cable susceptibility test shall be performed as specified hereinafter.

4.1.1 Power Frequency Test.- Tape two current-carrying insulated wires to each wire bundle in the test setup with the current carrying wire around the wire bundle, spiralling at two turns per meter (equally spaced) and running the entire length of the bundle to within 15 cm of each end connector. (See Figure RS02-1(a)). Apply the required current at the test sample power frequency(ies) to one test wire at a time. Monitor for susceptibility.

4.1.2 Spike Test.- Make the test setup as shown in Figure RS02-1(b). Repeat 4.1.1 applying the required spike, and monitor for susceptibility.

4.2 Case Susceptibility Tests (Test 2).- The case susceptibility test shall be performed as specified hereinafter.

4.2.1 Case Test.- Wrap several turns of insulated wire around each case in the test sample. These turns should be located as shown in Figure RS02-2(a) and held in place by tape. Apply the current specified in the applicable limits at the test sample's power frequency (ies) through the wire and monitor the test sample for malfunction, degradation of performance, and changes in indication.

4.2.2 Spike Test.- Make the test setup as shown in Figure RS02-2(b). Repeat 4.2.1 applying the required spike and monitor for susceptibility.

5. Notes.-

5.1 A.c. power input and output leads are exempt from the cable test.

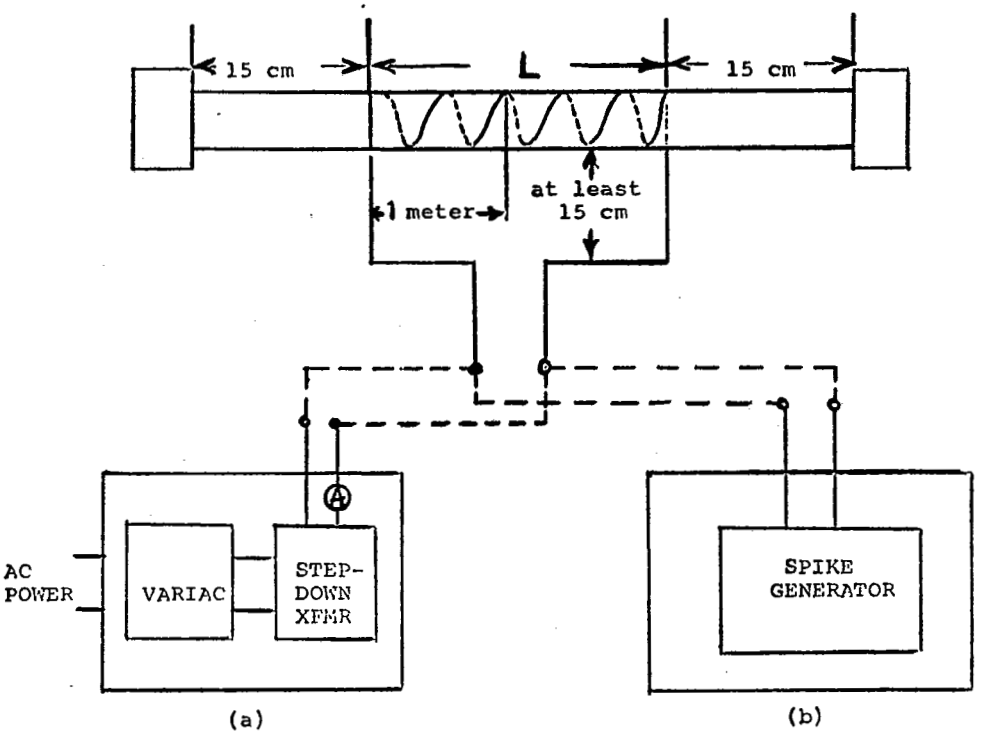
5.2 It is not the intention of the cable test to test individual wires but to test groups or bundles or wires. The bundles should be made up as specified in the contract or order or installation instructions.

5.3 Keep current carrying wires 15 cm away from cable connectors.

5.4 All cables should be at least 5 cm above the ground.

5.5 In order to minimize test time, test as many boxes and wire bundles at the same time as practicable.

5.6 The power frequency used for test purposes is that frequency used in the operational system.



NOTE:

(1) L shall be the length of the cable in the actual installation or 1.5 meters, whichever is less.

Figure RS02-1 - Radiated susceptibility, magnetic induction field, cable test

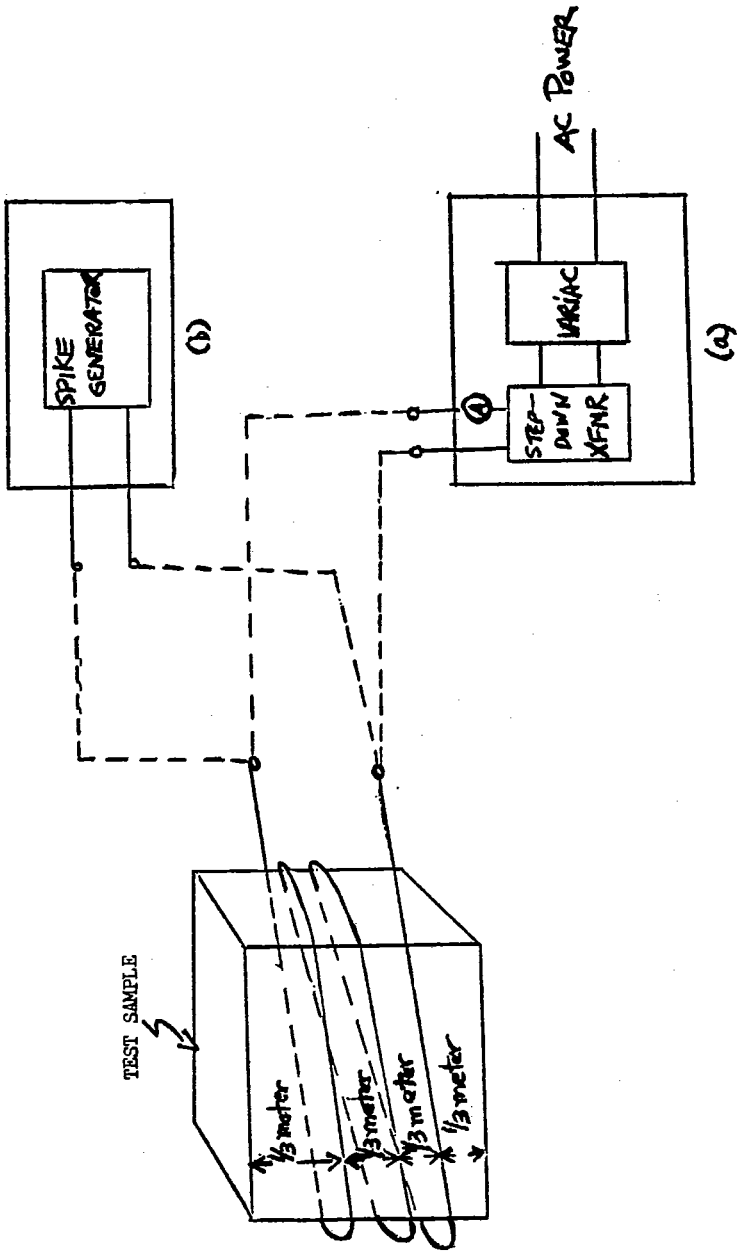


Figure RS02-2 - Radiated susceptibility, magnetic induction field case test

METHOD RS03

RADIATED SUSCEPTIBILITY, 14 kHz to 10 GHz, ELECTRIC FIELD

1. Purpose.- The purpose of this test is to ensure that a test sample does not exhibit any degradation of performance, malfunction, or undesirable effects in the frequency range of 14 kHz to 10 GHz when immersed in an electric field.

2. Applicability.- This test method is applicable to Class I equipment (see MIL-STD-461).

3. Apparatus.- The test apparatus shall consist of the following:

(a) Signal source.
(b) EMI meter,
(c) Antennas (for receiving and transmitting specified Electric Field).
(d) Output Monitor - to monitor performance of test sample.

4. Test Setup and Procedures.-

4.1 The test setup shall be as required by the general testing requirements of this standard for placement of antennas.

4.2 Test signals shall be selected in accordance with MIL-STD-461.

4.3 Fields shall be generated, as required, with the antenna specified in MIL-STD-461. Care shall be taken so that the test equipment is not affected by the test signals.

4.4 The output of the signal generator shall be adjusted so that the generated fields at the test sample correspond to the applicable limit. The specified field strengths shall be established by placing a field measuring antenna at the same distance, or relative location where the test sample will be placed. The power at the input terminals of the transmitting antenna required to establish the specified field shall be monitored and recorded. When a test is performed, this same power shall be applied to the transmitting antenna terminal. When baluns or other matching networks are used, any losses shall be properly compensated.

4.5 Determine those frequencies at which the test sample is susceptible. At these frequencies, determine the threshold of susceptible. Record all pertinent data.

METHOD (T) RS04

RADIATED SUSCEPTIBILITY, 14 kHz to 30 MHz

1. Purpose.- The purpose of this test is to determine equipment susceptibility to radiated fields of specified spectral content and intensity.

2. Application.- This method is applicable to all Class I equipments (see MIL-STD-461) which are of size compatible to the dimensions of this test device and to test limitations herein described. It may be used in lieu of Method RS02 from 14 kHz to 30 MHz, or when high intensity fields are required. It is especially useful when broadband or spike radiated susceptibility tests are required.

3. Apparatus.- The test apparatus shall consist of the following:

(a) Parallel Plate Line (see Figures RS04-1 and RS04-2).
(b) Signal Source capable of delivering the required signals.
(c) EMI meter.
(d) Matching networks (see Figure RS04-3).
(e) 30 KHz Low Pass Filter.

4. Test Procedure.- The test shall be performed as specified hereinafter.

4.1 Set up the equipment as shown in Figure RS04-3 with special emphasis on placing the test sample as much to the center of the line as possible. Interconnecting and power leads shall be kept 4 to 6 centimeters above the ground plane and laid out parallel to the line for a length not less than 2 meters. Select test signals in accordance with applicable requirements of MIL-STD-461 or as specified in the test plan.

4.2 By means of the calibration chart of electric field intensity as a function of the EMI meter reading, corrected by the matching pad insertion loss, adjust the output of the signal generator so that the fields between the plates correspond to the applicable limits.

4.3 The equipment shall be tested at two orientations in it upright position, one where the front face of the equipment is directed out toward the side of the line and another where the face is directed along the length of the line.

4.4 Other orientations as determined by 4.2.4.1 of this standard shall be tested. Sides which have openings for power leads, shafts, ventilation, etc., shall be faced upward toward the top line plate. Care must be taken to preserve the test sample's natural grounding arrangement; for example, if the equipment as it is used in the field does not have direct chassis, grounding such an arrangement shall be retained at all orientations. In no case shall the test sample be closer than 10 cm. to the upper plate.

4.5 Determine the frequencies and the minimum field strength at which the test sample is susceptible. Record all pertinent data.

5. Notes.-

5.1 Especially important to obtaining a uniform field that is accurately represented by the calibration chart, is the loading of the line with a noninductive 83-ohm resistor. This applies equally to the matching network used with the EMI meter. All resistors should be chosen with ± 1 percent of tolerance.

5.2 Care should be taken to assure that the resistive load used will be able to handle the power which is to be applied.

5.3 The EMI meter should be placed outside of the screen room if high intensity fields are being generated. Cables leading to the EMI meter should be kept as short as possible.

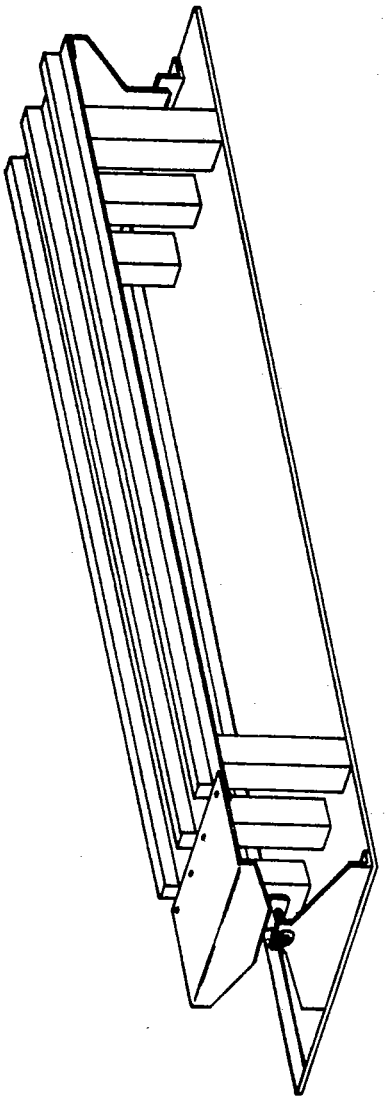


Figure RS04-1 - Parallel strip line for radiated susceptibility tests

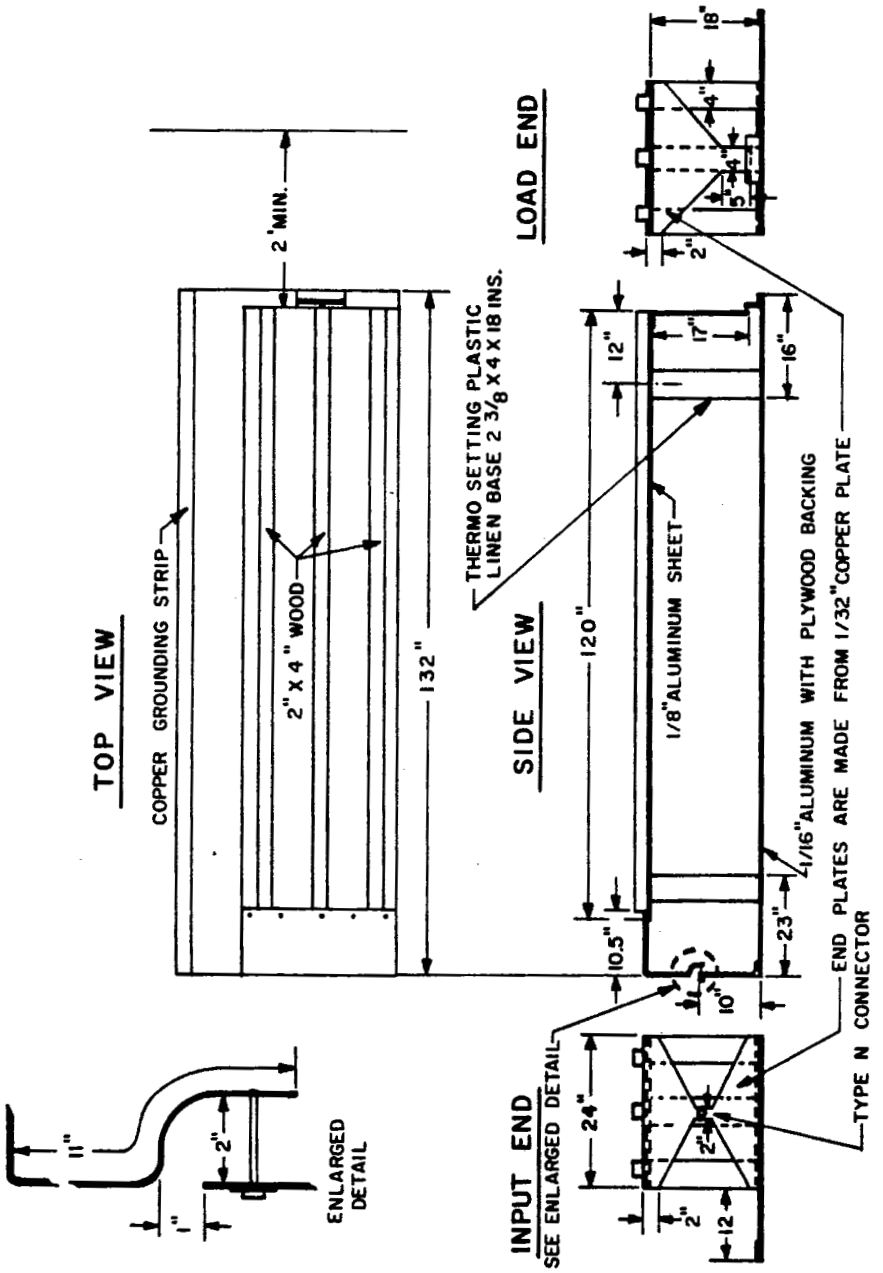


Figure RS04-2 - Parallel strip line for radiated susceptibility tests (top and side view).

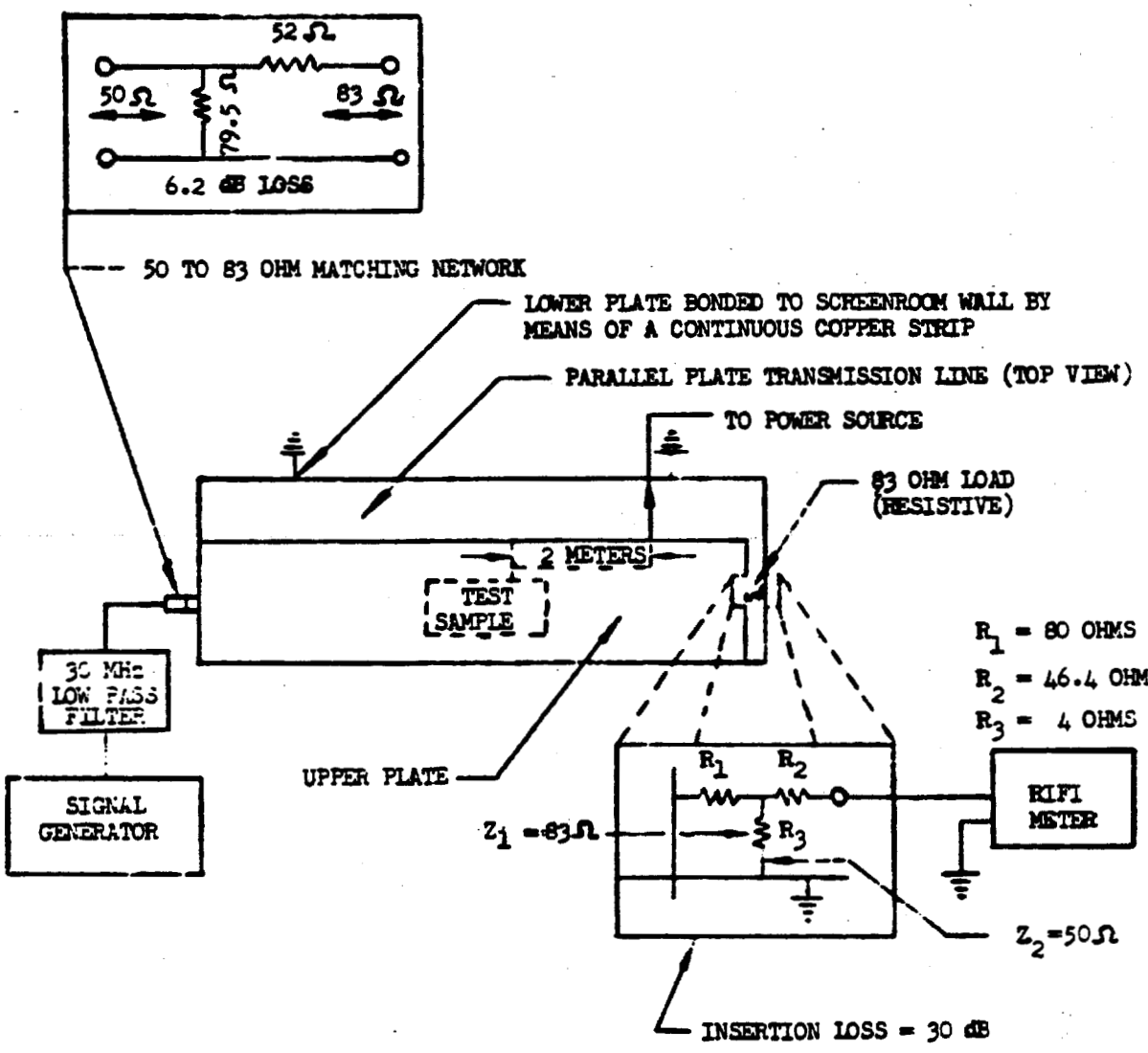


FIGURE RS04-3. Typical setup for susceptibility tests using parallel plate line

METHOD (T) RS04
31 July 1967

*U.S. GOVERNMENT PRINTING OFFICE: 1969-343-226/1164

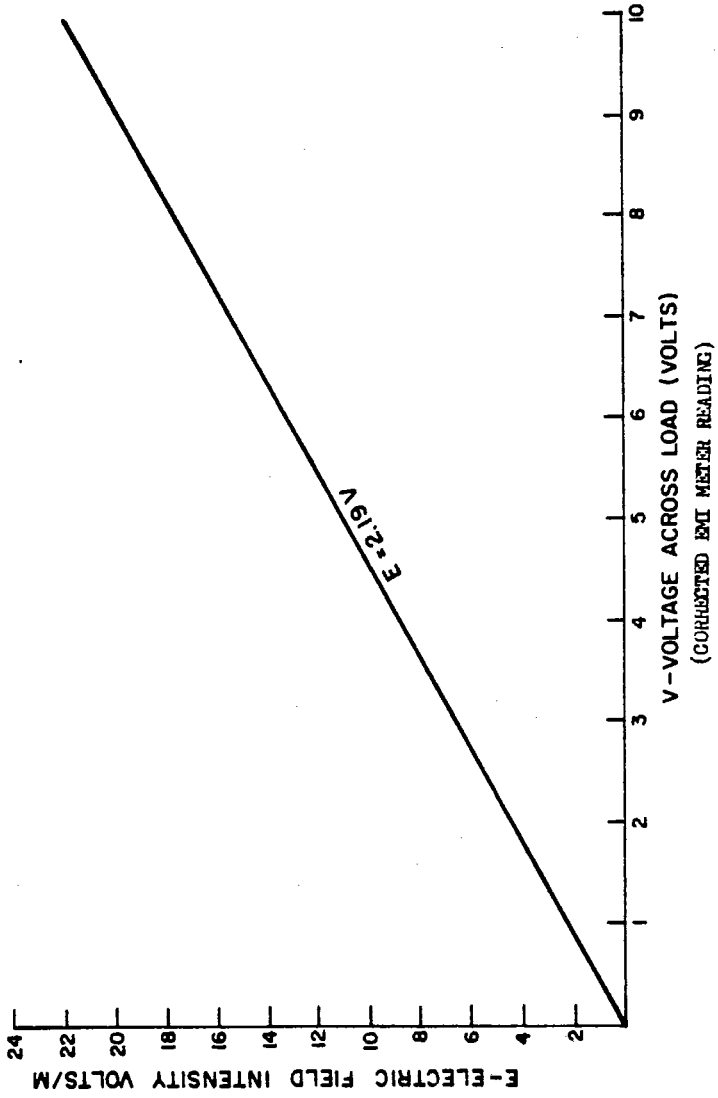


Figure RS04-4 - Line calibration chart

APPENDIX A

INSTRUMENTATION, ELECTROMAGNETIC INTERFERENCE

10. SCOPE

The purpose of this appendix is to list USAF approved instrumentation for measurement of electromagnetic interference.

20. INTERFERENCE MEASUREMENT EQUIPMENT

20.1 Modification. Some equipments require modification for category A approval. These equipments shall not be considered category A until a distinctive nonremovable label has been attached showing that the modifications have been performed. This label shall also list any restriction on usage of the equipment or associated accessories and shall show the number of this standard.

20.2 Equipment categories. Equipments are placed in the following categories.

20.2.1 Category A. Category A equipments are those interference measuring equipments that adequately measure the parameters of interference signals specified by this standard and which have been certified by the Air Force. Any combination of category A equipments may be used for the required measurements.

20.2.2 Category NC. Category NC (not certified) equipments are those existing equipments that do not adequately measure all the parameters of interference signals as specified by this standard. Use of these equipments is not permissible.

20.2.3 Category C. Category C equipments shall not be used unless specifically authorized by the procuring activity. Category C equipments are defined as follows:

20.2.3.1 Category C-1. Category C-1 equipments are those which have been developed recently to meet category A requirements but have not been evaluated by the procuring activity.

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

30. IMPULSE GENERATORS

30.1 By definition, the calibration for broadband measurements is referenced to the rms value of an equivalent sine wave. Correct calibration of impulse generators is subject to verification by witnessing officials, in accordance with MIL-STD-462.

40. DETECTOR FUNCTIONS

Detector functions used for other specifications and standards called field intensity, quasi-peak, average, and carrier, etc., shall not be used except for specialized measurements approved by the procuring activity.

50. SCAN FUNCTION

All measurements shall normally be accomplished using a peak detector with characteristics that permit scanning of octave bands in approximately 1 minute with a frequency resolution of 1 percent of the graph sheet used for recording. Exceptions to this scan time will be considered on an individual test basis.

60. MANUAL FUNCTION

Manual peak detectors often use the slideback principle and require one or more manual operations by the operator. These detectors shall not be used except when specifically authorized.

70. TABLE OF APPROVED EQUIPMENT

Equipment approved by the procuring activity for use with this standard is listed in tables I and II. Contact the Aeronautical Systems Division (ASNAC-30), Wright-Patterson AFB, Ohio, for information on certification procedures. See AFSC DH 1-4 for information on desired chacteristics for instruments.

TABLE A-1. Interference measuring equipment 1/, 3/

Category	Commercial nomenclature	Notes	Manufacturer's code 5/
A	EMC-10	2/	FAIR
	NF-105(T-A, 1, 2, 3)	2/	SING
	NF-112(T-1, 2, 3, 4)	2/	SING
	NM-22A	2/	SELS
	NM-30A	2/	SELS
	NM-52A	2/	SELS
	NM-62A, B	2/	SELS
	FIM-1	2/	POLA
	FIM-2	2/	POLA
	CFI (Below 10 GHz)	2/	POLA
	NF-315A		SING
	EMA-910		SING
	WEI-120A		WEI
	EMC-25		FAIR
	8551B/851B		HP
NC	NM-20A, B, C		SELS
	NM-50A		SELS
C-1	T-X/NF-105	2/	SING
	NM-10A	2/	SELS
	CFI (above 10 GHz)	2/, 4/	POLA
	FIM (above 10 GHz)	2/, 4/	POLA
	NF-112 (above 10 GHz)	2/, 4/	SING

1/ This appendix requires additional equipment capabilities that can be added to existing equipments by the use of internal and external accessories. The additional capabilities are: Semiautomatic scanning, IF output monitoring, X-Y recording, a peak detector with characteristics suitable for scanning, and adequate sensitivity to measure to the limits with at least 6 dB margin.

2/ Applies only to those equipments that have been modified to attain the capabilities shown in 1/. Modified equipments must have a label stating that the approved modifications have been made (see 20.1). Equipments without the approved modifications and accessories are in category NC.

3/ Power supplies using ballast tubes shall not be used.

4/ Equipments above 10 GHz are listed for special projects only.

5/ Manufacturer's codes:

Code	Manufacturer
FAIR	Fairchild Electro-Metrics Division 88 Church Street Amsterdam, New York 12011
HP	Hewlett Packard Company 1501 Page Mill Road Palo Alto, Calif. 94320
POLA	Polarad Electronics Corporation 34092 Queens Boulevard Long Island City, N. Y. 11101
SELS	Stoddart Electro Systems 2045 West Rosecrans Gardena, Calif. 90247
SING	Singer Company Metrics Division 915 Pembroke Street Bridgeport, Conn. 06602
WEI	White Electromagnetics, Inc. 670 Lofstrand Lane Rockville, Maryland 20853

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