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PROPOSED IRE STANDARDS ON RADIO INTERFERENCE: MEASUREMENT OF RADIO NOISE, GENERATED BY MOTOR VEHICLES, AFFECTING MOBILE COMMUNICATIONS RECEIVERS IN THE FREQUENCY RANGE 25 TO 1000 MC

1. INTRODUCTION

The purpose of this standard is to provide a uniform method of measurement of radio noise generated by a motor vehicle, which may affect the performance of mobile communications receivers in the vehicle.

2. NATURE OF RADIO NOISE

The radio frequency noise generated by motor vehicle electrical systems is characterized by a broad frequency spectrum, portions of which noise may be sufficient to degrade received signal intelligibility. Vehicular radio noise has been shown, experimentally, to be essentially impulsive in nature. The repetitition rate of these impulses will depend upon the nature of the ignition system. A measure of the radio noise level can be obtained by a substitution method using a standard impulse noise source. The indicated radio noise level obtained is a measure, but not a complete measure, of the interference effect.

2.1 Definitions

For the purpose of this standard, the following definitions will apply:

2.1.1 Spectrum The spectrum of a voltage impulse is defined as

twice the magnitude of the Fourier transform of the impulse. It is a function of frequency and is given in units of volts-seconds, volts per cycle per second, etc. Volts per cycle per second are often expressed in terms of microvolts per Kilocycle per second and microvolts per megacycle per second.

2.1.2 Frequency Selective Voltmeter A selective radio receiver, with provisions for output indication. For the purpose of this standard, it must indicate the peak value of the applied signal, and meet the performance characteristics described in paragraph 3.1.4.

2.1.3 Impulse Generator A standard reference source of broadband impulse energy. For the purpose of this standard, characteristics described in paragraph 3.1.3 must be met.

2.1.4 Impulse Bandwidth The ratio of the peak sine wave response of the measuring instrument in terms of microvolts referred to its input terminals, to the known spectrum of the impulse generator in terms of microvolts per unit bandwidth necessary to obtain the same peak response.

2.2 Sources of Vehicular Radio Noise

Motor vehicle radio noise arises principally from the ignition circuits of gasoline engine-driven vehicular equipment in which steep wavefront electrical transients are generated by the high voltage electrical discharge such as occur across the distributor or spark plug gaps. A secondary, but nonetheless troublesome, source of noise is the battery charging circuit, in which electrical transients are generated as a result of commutation by the charging generator and by the regulator. Other lesser sources of noise which occasionally are troublesome are the fan belt, gauges and instruments, and the generator shaft.

2.3 Vehicular Radio Noise Field

Mobile communications receivers have, in general, the same order of sensitivity as the best available measuring equipment. Therefore, the measuring antenna must be in close proximity to the vehicle being tested. Under these circumstances, the antenna is immersed in a very complex field exhibiting high field strength gradients. At low frequencies, the induction field predominates while at higher frequencies the radiation field predominates. Therefore, the method of measurement relies on the specification of measurement antenna type together with antenna placement and orientation with respect to the vehicle under test.

3. METHOD OF MEASUREMENT

This standard describes a method of measurement of the radio noise in terms of the spectrum output of the calibrated impulse generator. Figure 1 illustrates the measuring principle. The radio noise at each desired frequency is measured as the open circuit antenna terminal voltage, in terms of microvolts per megacycle bandwidth. The measurement is accomplished by a substitution method using a calibrated impulse generator which is series-injected into the antenna circuit of the receiving antenna in such a manner as to make the absolute value of the measurement independent of antenna and instrument input impedances. When the radio noise and the calibrated impulse generator inputs, applied consecutively, produce the same peak response from the frequency selective voltmeter, the measured value of the radio noise is equal to the impulse generator output corrected for the attenuation of the calibrated injection network and for the loss occurring in the cable connecting the impulse generator to the injection network.

3.1 Test Equipment

The frequency selective voltmeter when used with a calibrated

impulse generator and an appropriate series injection network shall be capable of measuring open circuit antenna voltage in terms of microvolts per megacycle bandwidth or in terms convertible thereto.

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3.1.1 The antenna shall be of the type shown in Figures 2 and 3.

3.1.2 All measurements shall be performed using an injection network meeting the performance requirements detailed in Figure 4. A typical injection network device which meets the specified performance requirements is shown in Figure 5.

3.1.3 The calibrated impulse generator,[1] when applied to a 50 ohm resistive load, shall provide an output which is flat within ± 1.0 db over the frequency range of interest with maximum output sufficient to measure the desired range of spectrum. The impulse generator shall provide for output adjustment within ± 1.0 db. At other than maximum output, the impulse generator output shall be within ± 2 db of indicated output. A pulse repetition frequency between 30 and 400 impulses per second shall be available.

3.1.4 The frequency selective voltmeter shall possess the following electrical characteristics as a minimum performance requirement.

3.1.4.1 An impulse signal of 30 microvolts per megacycle per second applied across the input terminals must produce at least a 2 db rise in peak meter indication. For instruments with aural-slide-back peak detectors, a 30 microvolts per megacycle per second signal shall produce usable audio response.

3.1.4.2 The spurious response rejection shall be at least 35 db.

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[1] Impulse generators are often calibrated by comparison with a sine wave signal generator. When this is to, the reading of the impulse generator is 0.707 of the true spectrum value.

3.1.4.3 The pulse turn-over effect shall produce no more than ± 0.5 db change in peak meter indication. This test is performed by reversing the polarity of an applied impulse generator signal of 10,000 microvolts per megacycle per second at the input terminals with minimum input attenuation required to keep the meter on scale. The frequency spectrum of the impulse generator used to perform this test shall be at least as broad as that of the impulse generator used in performing the measurements described in 3.2.

3.1.4.4 If a meter indicator is used, the peak meter indication shall not change more than 0.5 db when a constant amplitude impulse generator signal is varied from 50 to 400 impulses per second.

3.1.4.5 The input impedance shall be nominally 50 Ω.

3.1.4.6 The impulse bandwidth shall not exceed one percent of the frequency to which the voltmeter is tuned.

3.2 Test Procedure

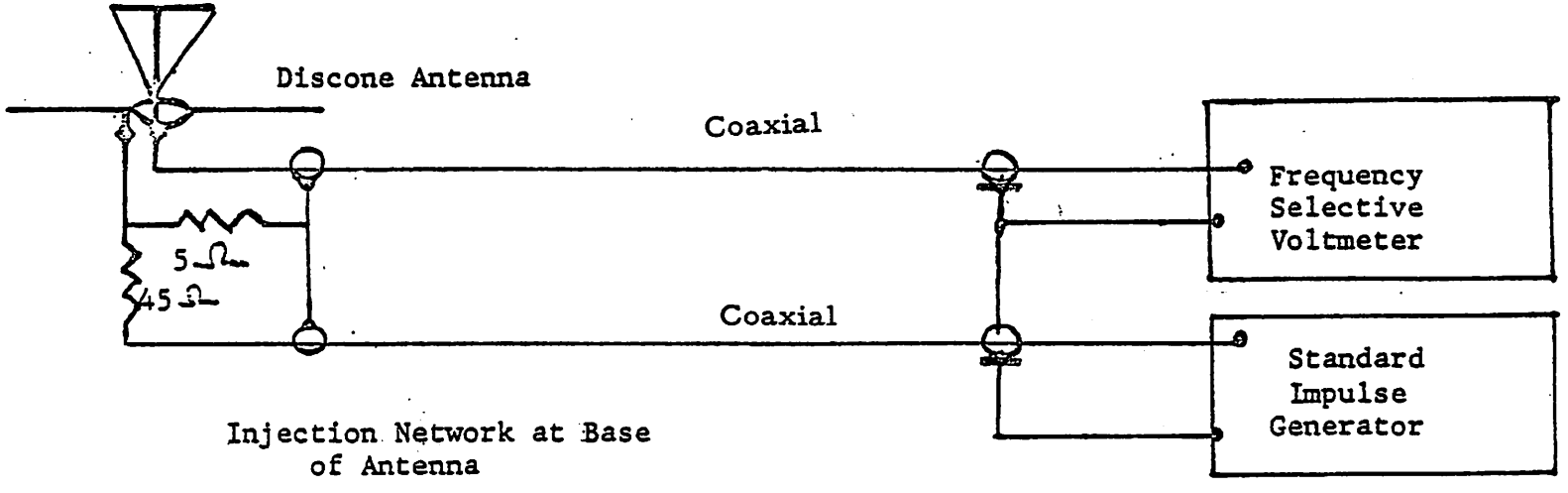
Radio noise shall be measured at the front and rear of the vehicle over the frequency range of interest. In the event radio noise from sources other than the vehicle is encountered at the frequency of interest, measurement shall be made at the nearest unoccupied frequency. The vehicle and test equipment antenna shall be arranged as shown in Figure 6 with the antenna configuration as shown in Figure 2. The measuring equipment shall be located at least 20 feet from the measuring antenna and the vehicle under test. For each measurement the level recorded shall be the maximum value observed, when the vehicular engine speed is varied smoothly from idle to race.

3.3 Test Conditions

3.3.1 Test Area The measurement site shall be open flat terrain at a considerable distance (100 feet or more) from reflecting or conducting

objects such as large buildings, buried pipes, electrical lines, metallic fences, and trees. The ambient interference at the test area shall be at least 6 db below the test limit at any frequency of interest.

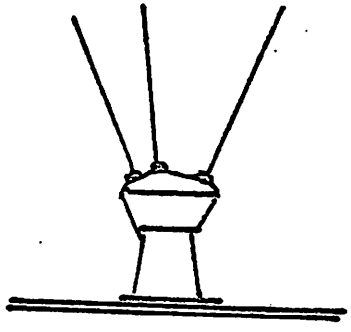
3.3.2 Vehicle Condition The vehicle under test shall be dry and the engine compartment closed.



NOTE: Impulse Generator may be Incorporated as an Integral Part of Frequency Selective Voltmeter

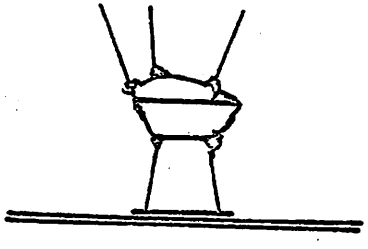
Fig. 1 - Principle of Measurement of Open Circuit Antenna Voltage with Antenna and Injection Network

2 Mast Sections Used in Each Socket



25-100 MCS

1 Mast Section Used in Each Socket

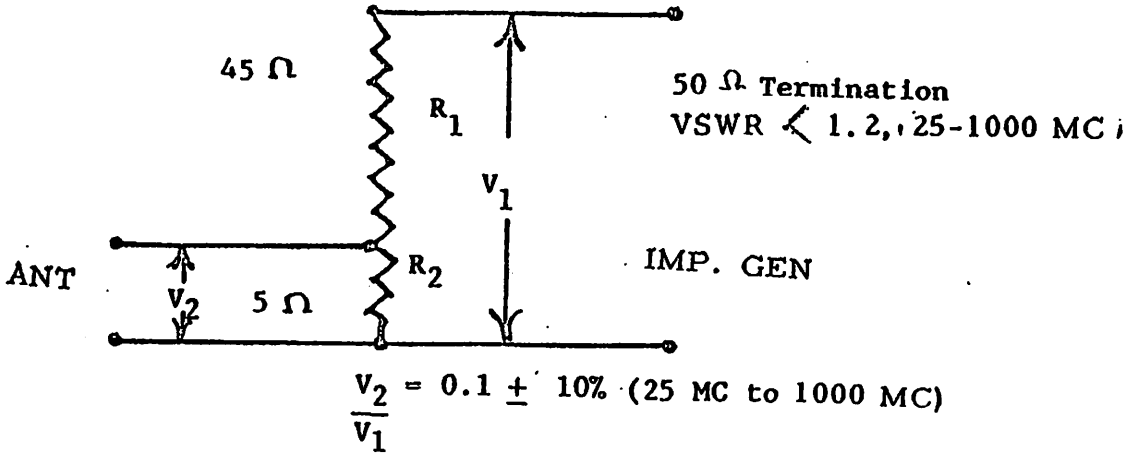


101-300 MCS

NO SECTIONS

301-1000 MCS

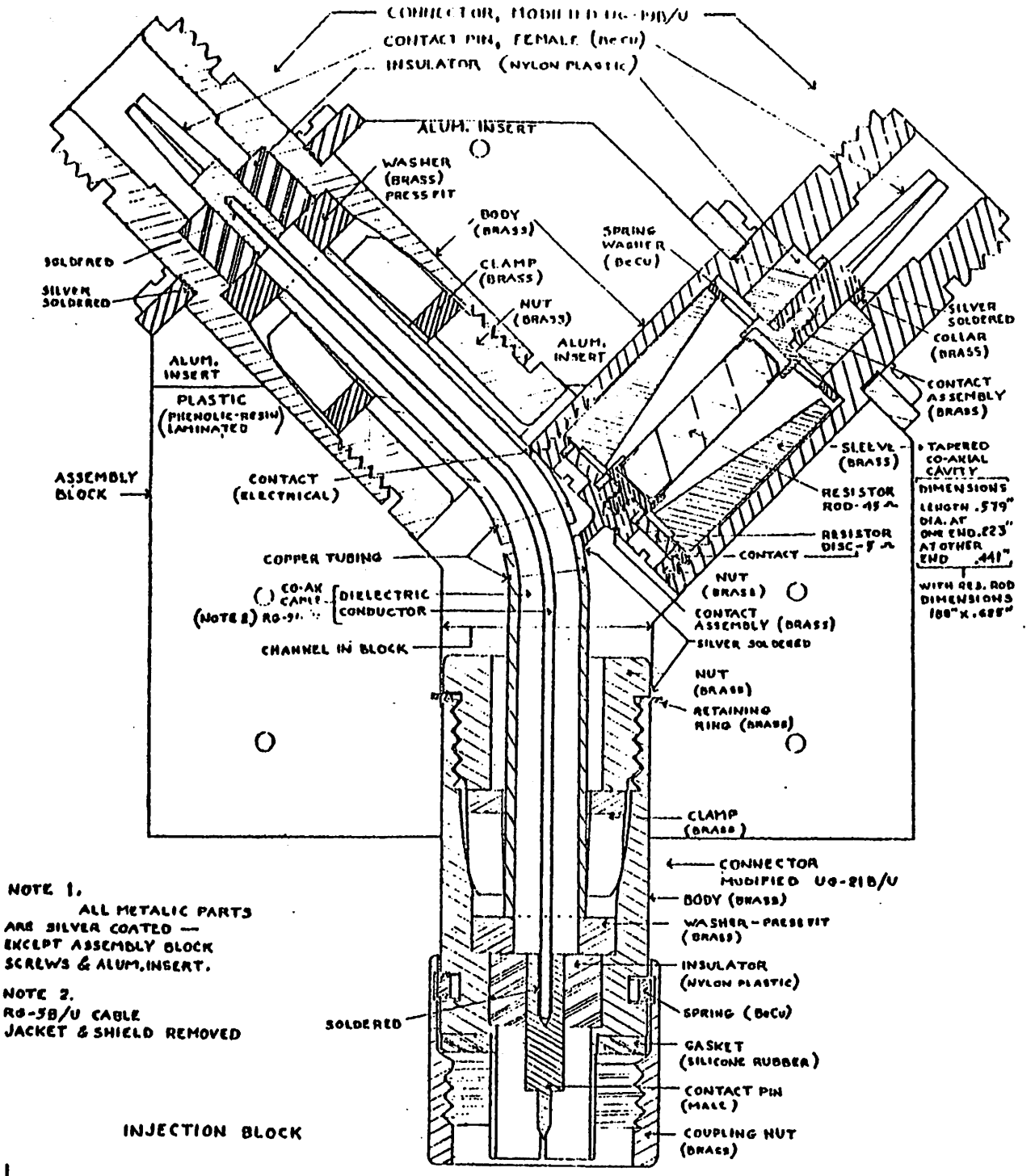
Fig. 2 - Antenna Configurations for Frequency Range 25-1000 MCS



R_1 Film Type RF Rod Resistor, 45Ω ±5%

R_2 Disk Resistor, 5Ω ±5%

Fig. 4 - Injection Network Characteristics (25 to 1000 MC)



NOTE 1.
ALL METALIC PARTS ARE SILVER COATED — EXCEPT ASSEMBLY BLOCK SCREWS & ALUM. INSERT.

NOTE 2.
RG-58/U CABLE JACKET & SHIELD REMOVED

INJECTION BLOCK

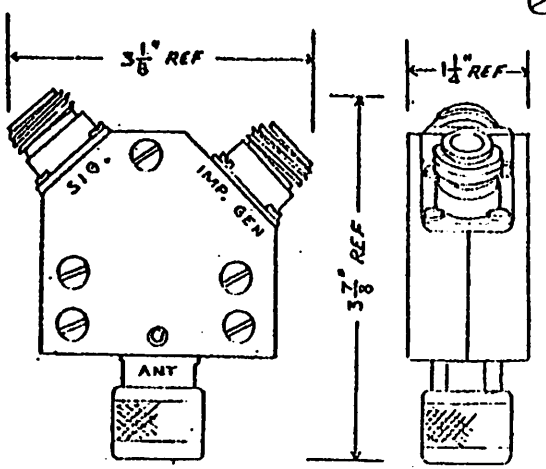
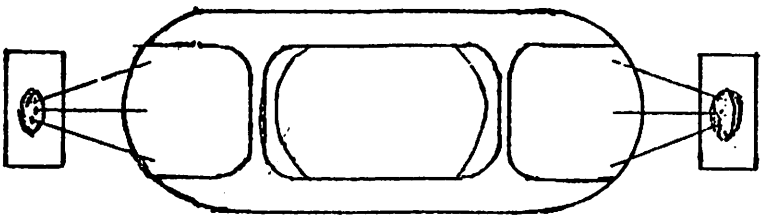
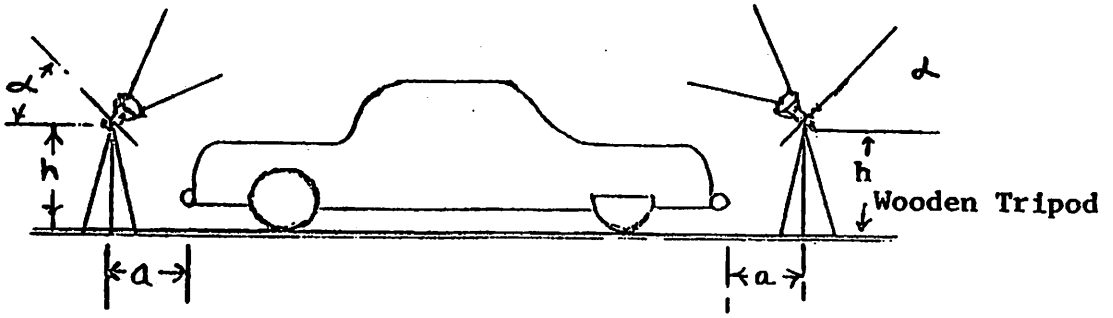


FIG. 5 TYPICAL INJECTION NETWORK ASSEMBLY





a = 4 ft.

h = 4 ft.

$\alpha = 45^{o}$

Fig. 6 - Positioning of Standard Antenna in Radiation Test of Automotive Vehicles