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FCC Methods of Measurements for Determining Compliance of Radio Control and Security Alarm Devices and Associated Receivers

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1.0 INTRODUCTION

The FCC amended Part 15 of its rules to permit the operation of a low power radio control or security alarm transmitter without an individual license. These rules, in Sections 15.201 through 15.215, are in addition to the provisions for other low power communication devices in Subparts D and E of Part 15. Section 15.122 in Subpart D provides for transmitters which emit periodic transmissions. Devices operating under Section 15.122 should also use this procedure in determining compliance. The requirements for the receiver are in Subpart C of Part 15. In addition to meeting certain technical requirements, the radio control transmitter and receiver must also be certificated by the Commission in accordance with the procedures in Subpart B of Part 15 and Subpart J of Part 2. Certification by the Commission is a prerequisite for marketing the equipment pursuant to Subpart I of Part 2.

2.0 SCOPE

This procedure describes methods for measuring both a radio control transmitter and its associated receiver to show compliance with the technical requirements. Both radiated and conducted measurements are covered in this procedure.

3.0 DEFINITIONS

3.1 AMBIENT LEVEL

The magnitude of radiated or conducted signals and noise existing at a specific test location and time.

3.2 CONDUCTED RADIO NOISE

Radio-noise propagated from the device back into the public electrical power network via the supply cord.

3.3 EMISSION

Electromagnetic energy produced by a device which is radiated into space or conducted along wires and is capable of being measured.

3.4 EQUIPMENT UNDER TEST (EUT)

The representative unit of a system or component of a system being tested or evaluated.

3.5 RADIO FREQUENCY (RF) ENERGY

Electromagnetic energy at any frequency in the radio spectrum between 10 kHz and 3,000,000 MHz.

4.0 GENERAL TEST CONDITIONS

4.1 TEST STANDARDS

A radio control transmitter and its associated receiver must be measured at a test facility which assures valid repeatable measurement results. A measurement is valid to the extent that it is a true representation of the characteristic being measured and when the same procedure yields repeatable results. Radiated measurements shall be made in an open field (see 4.1.1). Alternatively, radiated measurements may be made at a facility which produces results that are correlateable to the open field results. Pursuant to Section 15.38 of FCC Rules, a description of the measurement facility must be either, on file with the Commission, or filed with the application for certification. To determine the suitability of a particular facility for making radiated tests, a site calibration curve may be required with the description required by Section 15.38.

> NOTE: FCC Bulletin OST 55 Characteristics of Open Field Test Sites provides further guidance on open field test sites and site calibration measurements.

4.1.1 OPEN-FIELD TESTS

Radiated measurements shall be made in an open, flat area characteristic of cleared, level terrain. Such test sites shall be void of buildings, electric lines, fences, trees, etc., and free from underground cables, pipelines, etc, except as required to supply and operate the EUT. The ambient radio-noise levels and other undesired signals shall be sufficiently low so as not to interfere with the measurements. A suggested layout of an open-field test site is shown in Figure 1, where all reflecting objects lie outside the perimeter of the elliptical enclosure. (Note: A metal fence or large reflecting object shall be sufficiently far from the perimeter of the ellipse so as not to introduce additional unknown factors.) The distance from the EUT to the measuring antenna shall be measured from the center of the rotating platform. Site attenuation data should be obtained according to FCC Bulletin OST 55 to ascertain site acceptability.

4.1.2 ELECTRICAL POWER

Power lines to both EUT and test instrumentation shall be kept as short as possible. Although not mandatory, electrical power to the test site should be buried. Adequate isolation shall be incorporated to prevent coupling signals into the test instrumentation via the power lines. Electrical service shall be maintained within 5% of nominal voltage.

4.1.3 EUT PLACEMENT

The EUT shall be set on a wooden or other non-conducting table/framework in an orientation which yields maximum radiation. If possible, the table shall be mounted on a platform which is capable of being rotated about its vertical axis and remotely controlled from the measuring position. Electrical service to the EUT shall be routed up the center of the table. If a rotatable platform is not used, provisions shall be made for manually orientating the supporting structure. The height of the EUT (measured to its base) above the ground shall be one meter.

4.2 MEASURING INSTRUMENTATION

Radiated and conducted measurements shall be made with a radio-noise meter that conforms with the American National Standard Specifications for Electromagnetic Interference and Field Strength Instrumentation 10 kHz to 1 GHz, C63.2 (1980). Alternatively, a spectrum analyzer may be used, provided the results obtained can be accurately reproduced with a suitable radio-noise meter. If a spectrum analyzer is used care must be taken to avoid measurement of spurious emissions produced by the instrument. Several application notes explaining the proper use of a spectrum analyzer for making EMI measurements are available from Hewlett-Packard, Tektronix and other spectrum analyzer manufacturers.

4.2.1 MEASURING INSTRUMENT CALIBRATION

The calibration of the measuring instrument shall be checked frequently enough to assure its accuracy. Adjustments shall be made and correction factors applied in accordance with instructions contained in the manual for the measuring instrument.

4.2.2 DETECTOR-FUNCTION SELECTION AND BANDWIDTH

For radio-noise meters or spectrum analyzers which include weighting circuits, the detector shall function in an average reading mode. The 6 dB bandwidth of the measuring instrument shall not be less than 100 kHz for field strength measurements over the frequency range of 30 to 1000 MHz. Above 1000 MHz, the

measurement bandwidth shall be 1 MHz or greater. Post detector video filters may be used in the case of peak reading spectrum analyzers if correlation can be shown to an average reading radio-noise meter. Alternatively, field strength meters and spectrum analyzers without weighting circuits may be employed, provided measurements are made on the peak basis and recorded as observed. For pulsed, broadband emissions the measured data shall be corrected for pulse desensitization factor (see spectrum analyzer application notes on the subject - i.e. Hewlett Packard AN 150-2). With this correction applied to peak indications, if the duty cycle is known or can be measured, average values of emanations can be calculated. When determining the pulse desensitization correction factor for a given emission, it may be necessary to vary the above specified minimum bandwidth of the measuring instrument.

NOTES

1. the above specified bandwidths have tolerances as prescribed in ANSI standard C63.2-1980.

2. If bandwidths greater than those specified in 4.2.2 are used, higher readings may result for EUT's with broadband emanations.

3. Data taken with measuring instrumentation employing logarithmic amplifiers when using the average function will represent the average of the logarithm of the voltage level. If the emanation observed is pulsed, broadband observed values will be materially lower than the true average of voltage. Instrument overload is likely to occur with linear RF systems if the emission pulse duty cycle is less than that for which the measuring instrumentation is rated.

4.2.3 UNITS OF MEASUREMENTS

Measurements of radiated emissions shall be reported in terms of microvolts per meter at a specified distance. The indicated readings on the spectrum analyzer or the radio-noise meter shall be converted to microvolts per meter by use of appropriate conversion factors. Measurements of conducted emissions shall be reported in terms of microvolts.

4.2.4 ANTENNAS

A calibrated, tuned, half-wavelength dipole antenna shall be used for measuring the level of radiated emissions. Other linearly polarized antennas are acceptable provided the results obtained with such antennas are correlateable to levels obtained with a tuned dipole. The antenna shall be capable of measuring both horizontal and vertical polarizations and being varied in height from 1 to 4 meters.

4.2.5 PRELIMINARY TESTING AND MONITORING

Preliminary radiated measurements should be made inside, preferably in an enclosure, at a closer distance than specified for compliance to determine the emission characteristics of the EUT. If a spectrum analyzer is not used, radio-noise measurements should be monitored using either a headset or loudspeaker as an aid in detecting ambient signals and selecting problem frequencies. Precautions shall be taken to ascertain that the use of a headset or speaker does not affect the radio-noise meter indication during testing.

4.3 FREQUENCY RANGE TO BE SCANNED

For radiated measurements, the frequency range specified in §15.142 of Part 15 Subpart D shall be searched and all emissions from the EUT that are within 10 dB of the appropriate limit shall be measured and reported. For conducted measurements, the frequency range of 450 kHz to 30 MHz shall be searched and all emissions from the EUT that are within 10 dB of the appropriate limit shall be measured and reported. To facilitate testing with a radio-noise meter, the frequency range covered in the particular test should be scanned while monitoring with a headset or speaker. If any indicated peaks appear while scanning, readings shall be taken at the frequencies where they occur. The scan rate shall be such that emissions above radio-noise meter sensitivity are not omitted from detection.

> NOTE: Automatic scan techniques are acceptable but the maximum scan speed is limited by the response time of the measurement system and the repetition rate of the radio-noise to be measured.

4.4 DATA-REPORTING FORMAT

The measurement results expressed in accordance with 4.2.3, and specific limits where applicable, shall be presented in tabular and/or graphical forms showing level vs. frequency. Instrumentation, instrument and bandwidth settings, detector function, EUT arrangements, sample calculation with all conversion factors and all other pertinent details shall be included along with the measurement results.

4.5 RADIATED TEST PROCEDURE

A transmitter and its associated receiver shall be tested separately. The EUT complete with its antenna shall be placed on a supporting table at the specified height and oriented on the table for maximum radiation (See Figure 1). After the EUT and test equipment are warmed up and operating, the table shall be rotated either automatically or manually until maximum radiation

is indicated on the test instrumentation which has been tuned to the frequency being measured. The height of the measuring antenna shall also be varied between 1 and 4 meters (measured to the center of the antenna) for both horizontal and vertical polarization. The maximum reading shall be recorded. The transmitter shall operate continuously in its normal operating mode for the purpose of those measurements.

4.6 CONDUCTED TEST PROCEDURE

Measurement of radio frequency energy conducted from the EUT back into the electrical supply shall be made in accordance with conducted powerline measurements specified in FCC Measurement Procedure MP-4 entitled "FCC Methods of Measurements of Radio Noise Emissions from Computing Devices". The input signal to the receiver during these tests shall be at a level sufficient to produce maximum levels of line conducted emissions. However, the input signal level shall not exceed the point where system overload occurs. When possible, the input signal shall be directly coupled to the receiver. When this is not feasible, the input signal may be indirectly coupled to the receiver via a radiating coil or antenna. The signal applied to the receiver during measurements shall have the same characteristics as the signal associated with normal operation of the receiver.

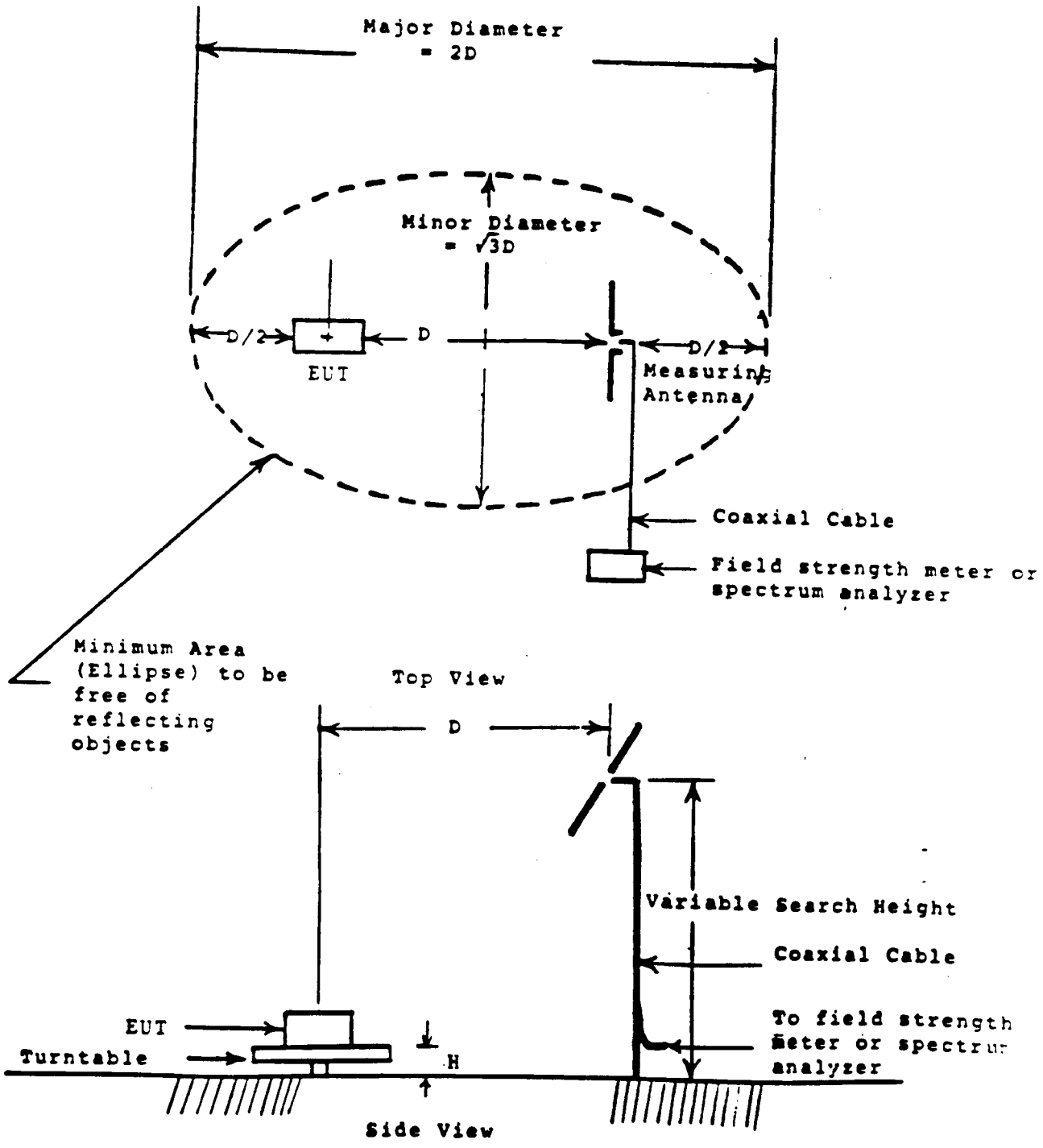

FIGURE 1. Equipment Arrangement