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## LAW ENFORCEMENT STANDARDS PROGRAM

# BODY-WORN FM TRANSMITTERS

NILE & CJ
STANDARD

U.S. DEPARTMENT OF JUSTICE
Law Enforcement Assistance Administration
National Institute of Law Enforcement and Criminal Justice

# LAW ENFORCEMENT STANDARDS PROGRAM

# BODY-WORN FM TRANSMITTERS

A Voluntary National Standard Promulgated by the
National Institute of Law Enforcement and Criminal Justice

DECEMBER 1978

**U.S. DEPARTMENT OF JUSTICE**
Law Enforcement Assistance Administration
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## NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE

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### ACKNOWLEDGMENTS

This standard was formulated by the Law Enforcement Standards Laboratory of the National Bureau of Standards under the direction of Marshall J. Treado, Program Manager for Communications Systems, and Jacob J. Diamond, Chief of LESL. NBS Electromagnetics Division staff members responsible for the preparation of the standard were Harold E. Taggart, project manager, Raymond N. Jones, Leon F. Saulsbury, and John L. Workman.

# NILECJ STANDARD FOR BODY-WORN FM TRANSMITTERS

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GPO Jacket No. 272-388

# FOREWORD

Following a Congressional mandate[1] to develop new and improved techniques, systems, and equipment to strengthen law enforcement and criminal justice, the National Institute of Law Enforcement and Criminal Justice (NILECJ) has established the Law Enforcement Standards Laboratory (LESL) at the National Bureau of Standards. LESL's function is to conduct research that will assist law enforcement and criminal justice agencies in the selection and procurement of quality equipment.

In response to priorities established by NILECJ, LESL is (1) subjecting existing equipment to laboratory testing and evaluation and (2) conducting research leading to the development of several series of documents, including national voluntary equipment standards, user guidelines, state-of-the-art surveys and other reports.

This document, NILECJ-STD-0214.00, Body-Worn FM Transmitters, is a law enforcement equipment standard developed by LESL and approved and issued by NILECJ. Additional standards as well as other documents are being issued under the LESL program in the areas of protective equipment, communications equipment, security systems, weapons, emergency equipment, investigative aids, vehicles and clothing.

This equipment standard is a technical document consisting of performance and other requirements together with a description of test methods. Equipment which can meet these requirements is of superior quality and is suited to the needs of law enforcement agencies. Purchasers can use the test methods described in this standard to determine firsthand whether a particular equipment item meets the requirements of the standard, or they may have the tests conducted on their behalf by a qualified testing laboratory. Law enforcement personnel may also reference this standard in purchase documents and require that any equipment offered for purchase meet its requirements and that this compliance be either guaranteed by the vendor or attested to by an independent testing laboratory.

The necessarily technical nature of this NILECJ standard, and its special focus as a procurement aid, make it of limited use to those who seek general guidance concerning body-worn FM transmitters. The NILECJ Guideline Series is designed to fill that need. We are issuing guidelines to this as well as other law enforcement equipment within the constraints of available funding and the overall NILECJ program.

The guideline documents being issued are highly readable and tutorial in nature, in contrast to the standards, which are highly technical and intended for laboratory use by technical personnel. The guidelines provide, in non-technical language, information for purchasing agents and other interested persons concerning the capabilities of equipment currently available. They may then select equipment appropriate to the performance required by their agency. Recommendations for the development of particular guidelines should be sent to us.

NILECJ standards are subjected to continuing review. Technical comments and recommended revisions are invited from all interested parties. Suggestions should be ad-

[1] Section 402(b) of the Omnibus Crime Control and Safe Streets Act of 1968, as amended.

dressed to the Program Manager for Standards, National Institute of Law Enforcement and Criminal Justice, Law Enforcement Assistance Administration, U.S. Department of Justice, Washington, D.C. 20531.

Lester D. Shubin,
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Criminal Justice

# NILECJ STANDARD FOR BODY-WORN FM TRANSMITTERS

## 1. PURPOSE AND SCOPE

The purpose of this document is to establish performance requirements and methods of test for body-worn frequency modulated transmitters of three watts or less used by law enforcement agencies.

## 2. CLASSIFICATION

For the purposes of this standard, FM transmitters are classified by their operating frequencies.

### 2.1 Type I

Transmitters which operate in the 400-512 MHz band.

### 2.2 Type II

Transmitters which operate in the 150-174 MHz band.

### 2.3 Type III

Transmitters which operate in the 25-50 MHz band.

## 3. DEFINITIONS

The principal terms used in this document are defined in this section. Additional definitions relating to law enforcement communications are given in LESP-RPT-0203.00, Technical Terms and Definitions Used with Law Enforcement Communications Equipment, (Radio Antennas, Transmitters and Receivers) [12].

### 3.1 AM Hum and Noise

The amplitude modulation present on an unmodulated carrier.

### 3.2 Audiofrequency Harmonic Distortion

Nonlinear distortion characterized by the appearance in the output of integral multiples of an audiofrequency input signal.

### 3.3 Audiofrequency Response

The degree of precision with which the frequency deviation of a transmitter responds to a designated audiofrequency signal level.

## 3.4 Authorized Bandwidth

The maximum width of the band of frequencies specified by the Federal Communications Commission to be occupied by an emission, i.e., 20 kHz for public safety agencies. [5]

## 3.5 Carrier Output Power

For a transmitter, the radiofrequency power available at the antenna terminal when no modulating signal is present.

## 3.6 FM Hum and Noise

The frequency modulation present on an unmodulated carrier.

## 3.7 Frequency Deviation

In frequency modulation, the difference between the instantaneous frequency of a modulated carrier and the unmodulated carrier frequency.

## 3.8 Frequency Stability

The ability of a transmitter to maintain an assigned carrier frequency.

## 3.9 Modulation Limiting

That action, performed within an FM transmitter, which intentionally restricts the signal to the required spectral limits.

## 3.10 Nominal Value

The numerical value of a device characteristic as specified by the manufacturer.

## 3.11 Occupied Bandwidth

The width of the frequency band containing those frequencies at which a total of 99 percent of the radiated power appears, extended to include any discrete frequency at which the power is at least 0.25 percent of the total radiated power.

## 3.12 Rated Capacity, Battery

A designation by the battery manufacturer which indicates the approximate capacity, in ampere-hours or milliampere-hours, at typical discharge rates.

## 3.13 Sampler

A series device which couples energy over a broad frequency range from a transmission line into a third port. The attenuated output signal from the third port has the same waveform as the original signal.

## 3.14 Service Life

The length of time that a primary cell (or battery) or a fully charged secondary cell (or battery) will provide satisfactory service under specified conditions.

## 3.15 Sideband Spectrum

The emissions generated by a modulated transmitter that are within 250 percent of the authorized bandwidth, i.e., ±25 kHz.

## 3.16 SINAD Ratio

A measure of the audio output of a receiver, expressed in decibels, equal to the ratio of (1) signal plus noise plus distortion to (2) noise plus distortion; from *SI*gnal *N*oise and *D*istortion *Ratio*.

## 3.17 Spurious Emission

Any part of the radiofrequency output that is not a component of the theoretical output or exceeds the authorized bandwidth.

## 3.18 Standing Wave Ratio (SWR)

The ratio of the maximum to the minimum voltage or current appearing along a transmission line.

## 3.19 Transmitter Efficiency

The ratio of (1) the rf output power delivered to a standard output load to (2) the dc input power to the transmitter.

# 4. REQUIREMENTS

## 4.1 Transmitter Performance

The transmitter performance shall meet or exceed the requirements for each characteristic as given below and in table 1. These performance requirements meet or exceed those given in the Rules and Regulations of the Federal Communications Commission (FCC). In addition to the requirements listed, all of the licensing and operating requirements of the FCC Rules and Regulations shall apply.

**TABLE 1. Minimum Performance Requirements for Body-Worn FM Transmitters**

| Transmitter Characteristic | Requirement Frequency Band (MHz) 25-50 | 150-174 | 400-512 [1] |
|---|---|---|---|
| **Radio Frequency Carrier Characteristics** | | | |
| A. Carrier Output Power Variance | −0.5, +3 dB | −0.5, +3 dB | |
| B. Output Power Variance (supply voltage varied ±10%) | ±3 dB | ±3 dB | |
| C. Output Power Variance (supply voltage varied −20%) | ±6 dB | ±6 dB | |
| D. Carrier Frequency Tolerance | 0.002% | 0.003% | |
| E. Frequency Stability (supply voltage varied ±15%) | 0.002% | 0.003% | |
| F. AM Hum and Noise Attenuation | 34 dB | 34 dB | |
| G. Transmitter Efficiency | 30% | 40% | |
| **Audiofrequency Modulation Characteristics** | | | |
| H. Audiofrequency Harmonic Distortion | 5% | 5% | |
| I. FM Hum and Noise Attenuation | 40 dB | 40 dB | |
| J. Frequency Deviation | 10% | 10% | |
| **Electromagnetic Compatibility Characteristics** | | | |
| K. Radiated Spurious Emissions | 43 dB | 43 dB | |
| L. Sideband Spectrum (±10 kHz frequency separation) | 25 dB | 25 dB | |
| M. Sideband Spectrum (±20 kHz frequency separation) | 50 dB | 60 dB | |
| **Battery Characteristic** | | | |
| N. Service Life | 90% | 90% | |

[1] Performance requirements will be added when available.

## 4.2 User Information

### 4.2.1 Transmitter

Nominal values for the carrier output power, carrier frequency, transmit current and each transmitter characteristic addressed in this standard shall be included in the information supplied to the purchaser by the manufacturer or distributor. The manufacturer shall specify the required battery voltage, indicate the magnitude of the audio input signal necessary for rated system deviation and provide sufficient audio input impedance information to enable test personnel to design an impedance matching network for use between the audio generator and transmitter audio input circuits.

### 4.2.2 Battery

A nominal value for the service life of each battery shall be included in the information supplied to the purchaser by the transmitter manufacturer or distributor. In addition, the manufacturer or distributor shall label each battery to include:

(a) nominal voltage
(b) battery type and model
(c) rated capacity
(d) indication of polarity
(e) indication if battery is rechargeable
(f) month and year of manufacture

## 4.3 Radio Frequency Carrier Characteristics

The radio frequency carrier characteristics of output power, frequency stability, AM hum and noise level and transmitter efficiency shall be measured in accordance with paragraph 5.3.

### 4.3.1 Output Power

Transmitter input power is specified by the FCC [5]. The carrier output power delivered to a standard output load shall be within −0.5, +3 dB (Item A, Table 1) of the nominal value at all times except for the initial one second after applying power. When the standard supply voltage is varied plus and minus 10 percent, the output power shall not vary more than ±3 dB (Item B). When the standard supply voltage is varied minus 20 percent, the output power shall not vary more than ±6 dB (Item C).

### 4.3.2 Frequency Stability

The carrier frequency shall be within (Item D) of the assigned value at all times during the standard duty cycle except for the initial one second after applying power. When the standard supply voltage is varied plus and minus 15 percent, the frequency stability shall be (Item E).

### 4.3.3 AM Hum and Noise Level

The AM hum and noise level shall be attenuated a minimum of 34 dB (Item F) below the unmodulated nominal carrier output power level.

### 4.3.4 Transmitter Efficiency

The trasmitter efficiency shall be (Item G) or greater.

## 4.4 Audiofrequency Modulation Characteristics

The audiofrequency modulation characteristics of harmonic distortion, FM hum and noise level, audiofrequency response, frequency deviation and modulation limiting shall be measured in accordance with paragraph 5.4.

### 4.4.1 Audiofrequency Harmonic Distortion

The maximum audiofrequency harmonic distortion shall be 5 percent (Item H).

### 4.4.2 FM Hum and Noise Level

The FM hum and noise level shall be attenuated a minimum of 40 dB (Item I).

### 4.4.3 Audiofrequency Response

The audiofrequency response shall not vary more than +1, −3 dB from a true 6 dB per octave pre-emphasis characteristic from 0.3 to 3 kHz as referred to the 1 kHz level, as shown in figure 1, with the exception that a 6 dB per octave roll-off from 2.5 to 3 kHz may be present.

### 4.4.4 Frequency Deviation

The maximum frequency deviation shall be within 10 percent (Item J) of ±4.5 kHz.

### 4.4.5 Modulation Limiting

The instantaneous peak and steady state frequency deviation shall be within 10 percent (Item J) of ±kHz with a 20 dB increase in audio above the normal audio input level.

## 4.5 Electromagnetic Compatibility Characteristics

The electromagnetic compatibility characteristics of radiated spurious emissions and sideband spectrum shall be measured in accordance with paragraph 5.5.

### 4.5.1 Radiated Spurious Emissions

Each radiated spurious emission shall be attenuated a minimum of 43 dB (Item K) $+10 \log_{10}$(power output in watts) decibels below the field strength of the carrier.

### 4.5.2 Sideband Spectrum

Each spurious sideband emission shall be attenuated greater than 25 dB (Item L) when its frequency is separated from the assigned carrier by plus and minus 10 kHz, and shall be attenuated greater than (Item M) when its frequency is separated from the assigned carrier by plus and minus 20 kHz.

## 4.6 Battery Service Life

The service life of each primary and secondary battery shall be at least 90 percent (Item N) of the nominal service life specified by the manufacturer in accordance with paragraph 4.2.2, when measured in accordance with paragraph 5.6. A random sample shall be tested; its size shall depend on the lot size and is given in table 2.

**TABLE 2. Sample Size**

| Lot Size | Sample Size | Lot Size | Sample Size |
|---|---|---|---|
| Up to 300 | 3 | 801-1300 | 7 |
| 301-500 | 4 | 1301-3200 | 10 |
| 501-800 | 5 | 3201-8000 | 15 |

# 5. TEST METHODS

## 5.1 Standard Test Conditions

Allow all measurement equipment to warm up until the system has achieved sufficient stability to perform the measurement. Unless otherwise specified, perform all measurements under standard test conditions.

### 5.1.1 Standard Temperature

Standard ambient temperature shall be between 20°C (68°F) and 30°C (86°F).

### 5.1.2 Standard Relative Humidity

Standard ambient relative humidity shall be between 10 percent and 85 percent.

### 5.1.3 Standard Supply Voltage

The standard supply voltage shall be the required battery voltage as specified by the manufacturer in accordance with paragraph 4.2.1 and shall be applied to the transmitter power supply input terminals. Tests may be performed using either a battery of the same type as normally used in the equipment or a well-filtered electronic dc supply. In the latter case, it shall be adjusted to within 1 percent of the voltage required.

### 5.1.4 Rated System Deviation

Rated system deviation shall be ±5 kHz.

### 5.1.5 Standard Test Modulations

#### 5.1.5.1 Audiofrequency Test Modulation

Audiofrequency test modulation shall be 1 kHz (from a source with distortion less than one percent) at the level required to produce 60 percent of rated system deviation (i.e., ±3 kHz).

#### 5.1.5.2 Electromagnetic Compatibility Test Modulation

Electromagnetic compatability test modulation shall be a 2.5 kHz sine wave at an input level 16 dB greater than that required to produce 50 percent of rated system deviation at 1 kHz.

### 5.1.6 Standard Radiation Test Site

The standard radiation test site shall be located on level ground which has uniform electrical characteristics (i.e., ground constants). Reflecting objects (especially large metal objects), trees, buildings, and other objects which would perturb the electromagnetic fields to be measured should not be located closer than 90 m (295 ft) from any test equipment or equipment under test. All utility lines and any control circuits between test positions should be buried underground. The ambient electrical noise level shall be as low as possible and shall be carefully monitored to insure that it does not interfere with the test being performed. Preferably, the test site should be equipped with a remotely controlled turntable located at ground level.

### 5.1.7 Standard Duty Cycle

Standard duty cycle shall be continuous operation of the transmitter.

### 5.1.8 Standard Test Frequency

The standard test frequency shall be the transmitter operating frequency.

## 5.2 Test Equipment

The test equipment discussed in this section is limited to that equipment which is the most critical in making the measurements discussed in this standard. All other test equipment shall be of comparable quality.

### 5.2.1 Test Receiver

The test receiver shall include a standard audio output load as specified by the manufacturer of the test receiver (paragraph 5.2.1.6) and shall have the characteristics specified in the following paragraphs.

#### 5.2.1.1 Audio Response

The audio response characteristics shall not vary more than 1 decibel from a 750 microsecond de-emphasis characteristic when the system deviation is held constant and the modulation frequency is varied between 0.05 and 3 kHz.

#### 5.2.1.2 Harmonic Distortion

The audiofrequency distortion shall be less than 1 percent at standard modulation. The harmonic distortion at 1 kHz (for larger than rated system deviation) shall be less than 3 percent. The harmonic distortion shall be measured when the test receiver is tuned to a nominal 1 millivolt rf source which is modulated by a sine wave at a level which produces a system deviation 50 percent greater than rated system deviation (i.e., ±7.5 kHz).

#### 5.2.1.3 Audio Hum and Noise Level

The unsquelched audio hum and noise level shall be at least 55 dB below the audio output power when measured with a 1 millivolt input signal.

#### 5.2.1.4 Adjacent Channel Interference

The test receiver shall differentiate by 85 dB or more between a desired modulated signal and a modulated adjacent channel signal 30 kHz on either side, when the adjacent channel interference degrades the desired signal from 12 dB SINAD to 6 dB SINAD.

#### 5.2.1.5 Selectivity

The test receiver shall have a bandwidth of 24 to 30 kHz at the -80 dB points.

#### 5.2.1.6 Standard Audio Output Load

The standard audio output load shall consist of a resistor whose resistance is equal to the impedance of the load into which the test receiver normally operates.

### 5.2.2 Deviation Meter

The deviation meter shall be capable of measuring the peak deviation of a modulating waveform with an uncertainty no greater than 5 percent of the deviation being monitored.

### 5.2.3 Standard Audio Input Load

The standard audio input load shall consist of a low-noise resistor whose resistance is equal to the specified input impedance of the transmitter.

### 5.2.4 Standard RF Output Load

The standard rf output load shall be a 50 ohm resistive termination having a standing wave ratio (SWR) of 1.1 or less at the standard test frequencies. If connectors and cables are used to attach the standard output load to the transmitter, the combined SWR, including the load, shall be 1.1 or less.

### 5.2.5 Band Rejection Filter

The band rejection filter shall have a minimum insertion loss of 40 dB for all frequencies within ±0.01 percent of the carrier frequency.

## 5.3 Radio Frequency Carrier Tests

### 5.3.1 Output Power Tests

Operate the transmitter without modulation. Measure the output power as shown in figure 2, using standard supply voltage and a power meter accurate to 5 percent. Change the standard supply voltage plus 10 percent, allow it to stabilize at least 15 seconds, and determine the output power. Repeat this for changes in standard supply voltage of minus 10 percent and minus 20 percent.

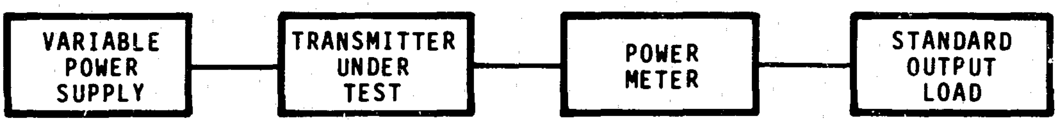


FIGURE 2. *Block diagram for output power measurement.*

### 5.3.2 Frequency Stability Test

Operate the transmitter without modulation. Measure the frequency as shown in figure 3, using standard supply voltage. Change the standard supply voltage plus 15 percent, allow it to stabilize for 15 seconds, and determine the change in frequency. Repeat this for a change in standard supply voltage of minus 15 percent.

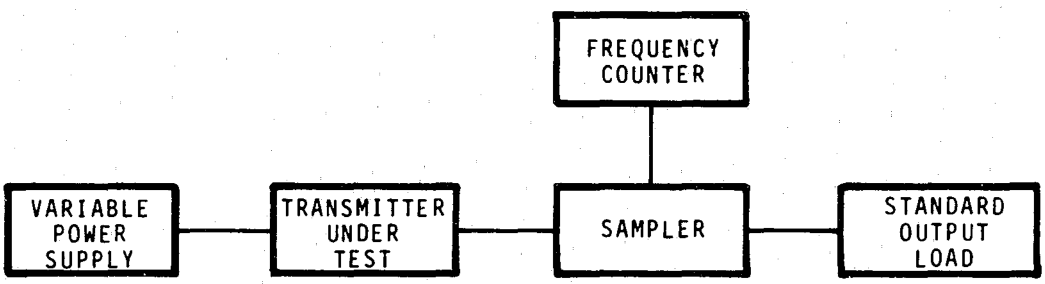


FIGURE 3. *Block diagram for frequency stability measurement.*

### 5.3.3 AM Hum and Noise Level Test

Interconnect the transmitter and test equipment as shown in figure 4. Use a linear peak-carrier responsive AM detector to detect the sampled output of the transmitter. With the transmitter operating at rated power with no modulation, measure the dc voltage across the detector load resistor with the high-impedance dc voltmeter. Without adjusting the transmitter, measure the peak ac voltage with the oscilloscope. Calculate the AM hum and noise level as $20 \log_{10}(V_p / V_{dc})$, where $V_p$ is the peak ac voltage and $V_{dc}$ is the dc voltage.

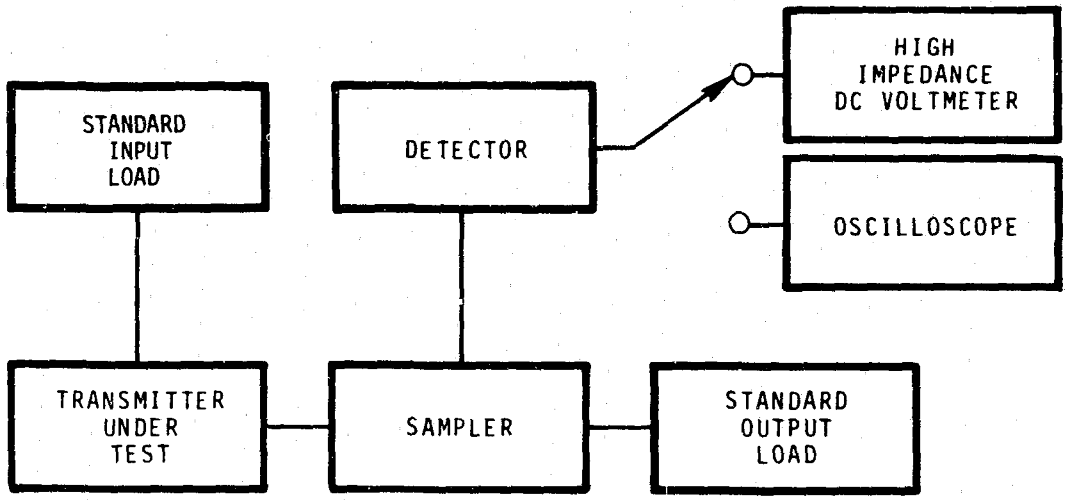


FIGURE 4. *Block diagram for AM hum and noise measurement.*

### 5.3.4 Transmitter Efficiency Test

Interconnect the transmitter and test equipment as shown in figure 5. Adjust the dc power supply until the dc voltmeter indicates the standard supply voltage. Record the output power and the direct current.

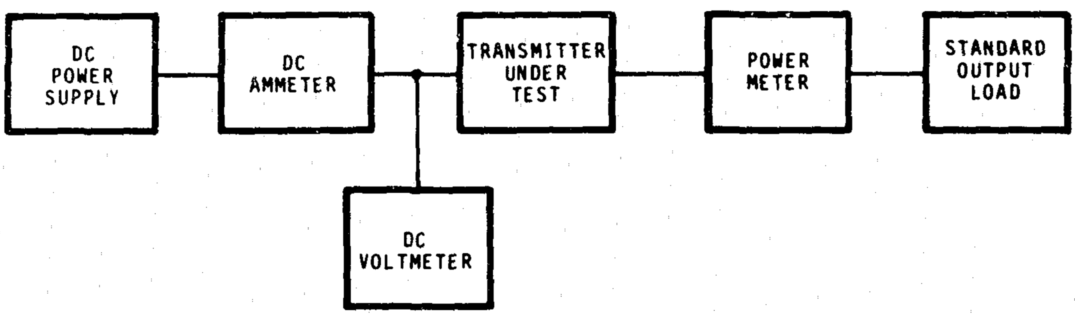


FIGURE 5. *Block diagram for transmitter efficiency measurement.*

Calculate the transmitter efficiency as $100 \bullet P_{rf} / V \bullet A$, where $P_{rf}$ = the output power in watts, V = the standard supply voltage in volts and A = the direct current in amperes.

## 5.4 Audiofrequency Modulation Tests

### 5.4.1 Harmonic Distortion Test

Interconnect the transmitter and test equipment as shown in figure 6. Operate the transmitter at nominal carrier output power and adjust the audio oscillator for audiofrequency test modulation (5.1.5.1), except that the 1 kHz modulating signal shall have a total distortion of 0.5 percent or less. Process the sampled transmitter output with the test receiver (5.2.1). Use the distortion analyzer, across the standard audio output load, to remove the 1 kHz tone and measure the signal, which is a combination of all the noise and harmonic components.

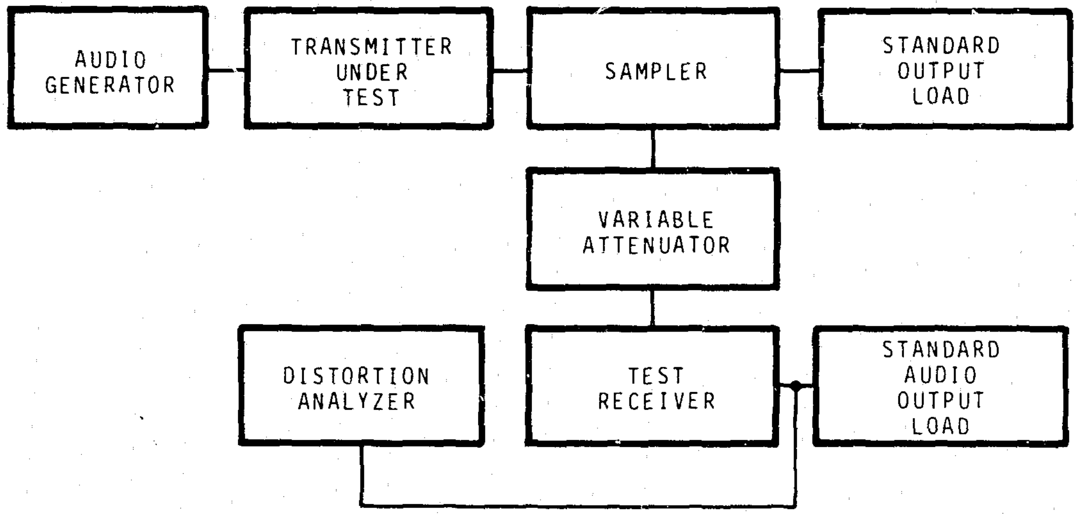


FIGURE 6. *Block diagram for harmonic distortion and FM hum and noise measurements.*

### 5.4.2 FM Hum and Noise Level Test

Interconnect the transmitter and test equipment as shown in figure 6. Operate the transmitter at nominal carrier output power and adjust the audio oscillator for audiofrequency test modulation. Measure the audio output voltage, $V_1$, of the test receiver using the distortion analyzer as a voltmeter. Remove the modulation by disconnecting the audio oscillator and connecting the standard audio input load and measure the resulting audio voltage, $V_2$, at the distortion analyzer. Calculate the FM hum and noise level as $20 \log_{10} (V_1/V_2)$. The method provides reliable measurements up to 50 dB.

### 5.4.3 Audiofrequency Response Test

Interconnect the transmitter and test equipment as shown in figure 7. The matching network is a broadband network which matches the audio generator output impedance to the transmitter audio input impedance.

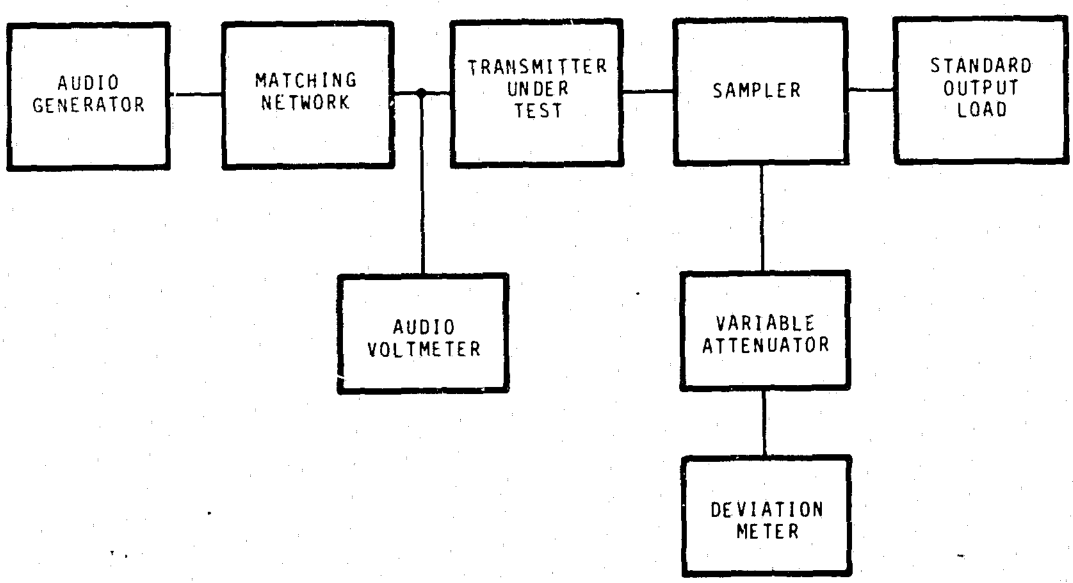


FIGURE 7. *Block diagram for audiofrequency response measurement.*

Apply selected audio frequencies from 0.3 to 3 kHz to the transmitter, and maintain the audio input level at constant 30 percent of rated system deviation (i.e., 1.5 kHz) as observed with the deviation meter. Determine the audio voltmeter reading in decibels relative to the voltmeter reading at 1 kHz, for each test frequency, and draw a graph similar to that shown in figure 1.

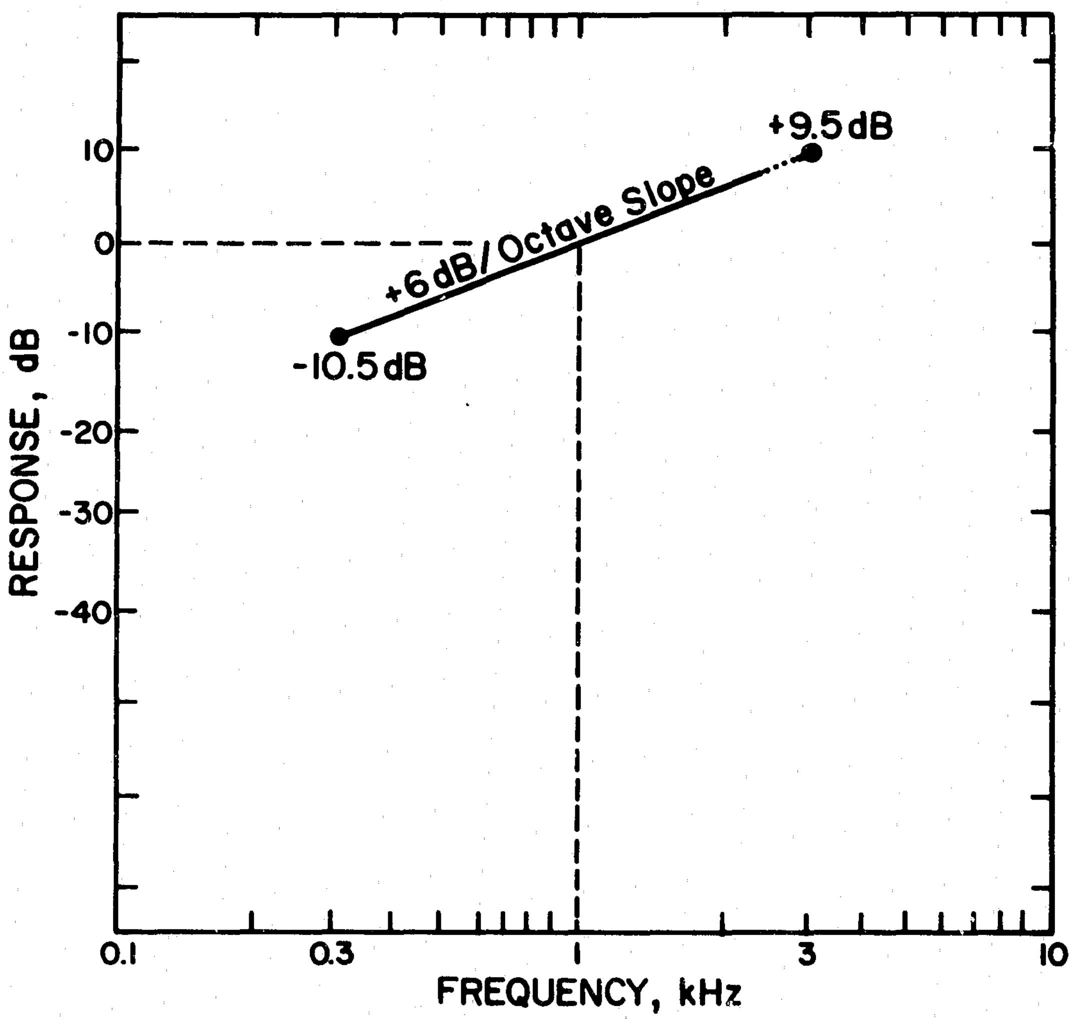


FIGURE 1. *Audiofrequency response characteristics of transmitters.*

### 5.4.4 Frequency Deviation Test

Interconnect the transmitter and test equipment as shown in figure 8 and adjust the transmitter controls for normal operation. Adjust the audio input for audiofrequency test modulation and increase the audio input level until maximum frequency deviation is observed. Measure the frequency deviation with the deviation meter.

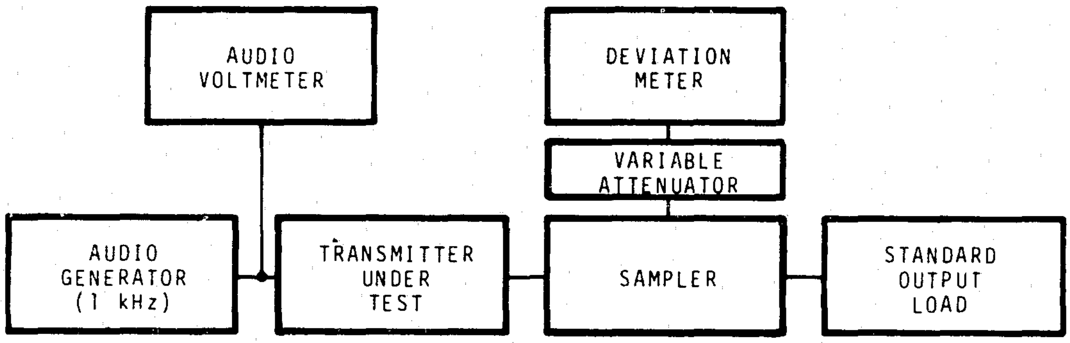


FIGURE 8. *Block diagram for frequency deviation and modulation limiting measurements.*

### 5.4.5 Modulation Limiting Test

Interconnect the transmitter and test equipment as shown in figure 8 and adjust the transmitter controls for normal operation. Adjust the audio input for audiofrequency test modulation. Increase the audio input level 20 dB. Hold the audio input level constant, vary the frequency from 0.3 to 3 kHz and measure the frequency deviation with the deviation meter.

## 5.5 Electromagnetic Compatibility Tests

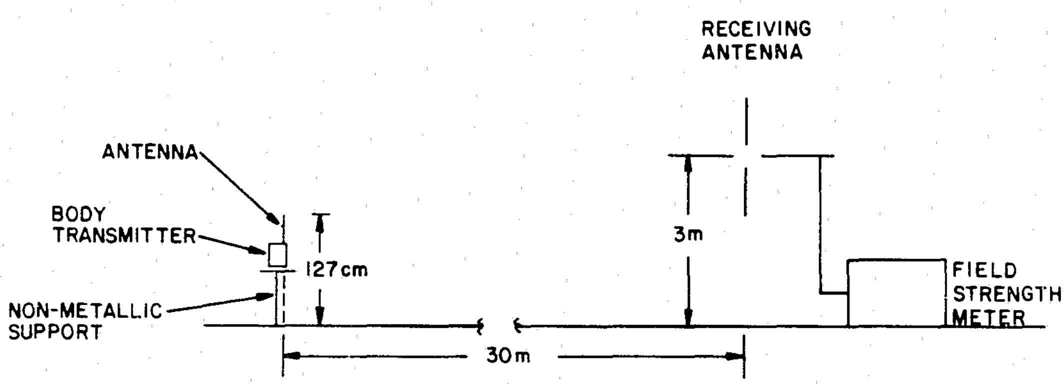


FIGURE 9. *Block diagram for radiated spurious emission measurements.*

### 5.5.1 Radiated Spurious Emission Test

Perform the test at a site that meets the requirements of paragraph 5.1.6. Set up the equipment as shown in figure 9. Place the transmitter, with antenna connected, on a nonmetallic support so that the tip of the antenna is approximately 127 cm (50 in) above the earth. Place the halfwave dipole receiving antenna 30 m (98.4 ft) from the transmitter and 3.0 m (9.8 ft) above the earth. Turn on the transmitter and measure the field strength of the unmodulated carrier frequency in decibels above one microvolt per meter (dB$\mu$V/m) using the technique described in the following paragraph. Then measure the field strength in dB$\mu$ V/m of any radiated spurious emissions, from the lowest radio frequency generated in the transmitter to the tenth harmonic of the carrier. Adjust the receiving antenna to a half-wavelength for each frequency measured.

For the carrier and each spurious frequency, position the horizontally-polarized receiving antenna a quarter wavelength in any direction to obtain a maximum reading on the field strength meter. Rotate the transmitter to further increase this maximum reading. Repeat this procedure of raising and lowering the receiving antenna and rotating the transmitter until the largest signal has been obtained and recorded. Then place the receiving antenna in a vertical position and repeat the procedure for each spurious signal.

The attenuation of each radiated spurious emission is the field strength in dB$\mu$V/m of the carrier frequency minus the field strength in dB$\mu$V/m of the radiated spurious emission.

### 5.5.2 Sideband Spectrum Test

Interconnect the transmitter and test equipment as shown in figure 10. Using the variable attenuator, adjust the unmodulated carrier signal for a full-scale signal of at least 60 dB above the noise as displayed on the spectrum analyzer. Apply electromagnetic compatibility test modulation and measure the average envelope of the resulting spectrum at both plus and minus 10 kHz and plus and minus 20 kHz from the center frequency. Adjust the spectrum analyzer controls so that approximately 50 kHz of transmitter spectrum is centered on the display. The image on the cathode ray tube of the spectrum analyzer should be similar to that shown in figure 11.

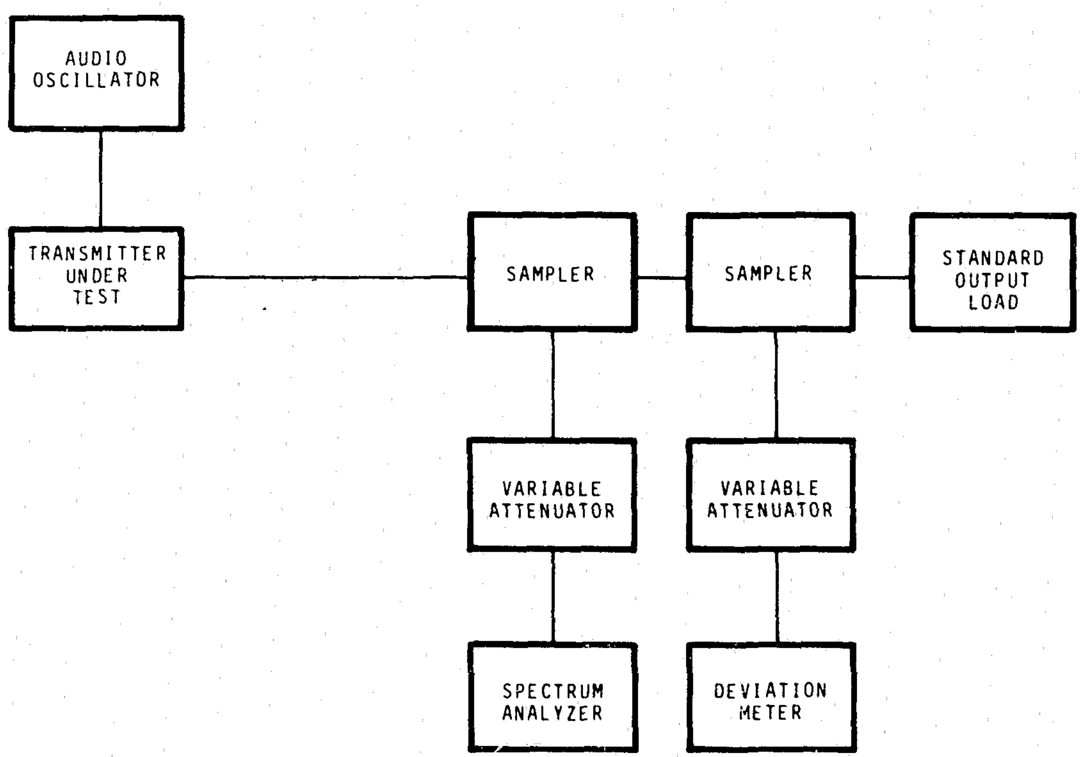


FIGURE 10. *Block diagram for sideband spectrum measurement.*

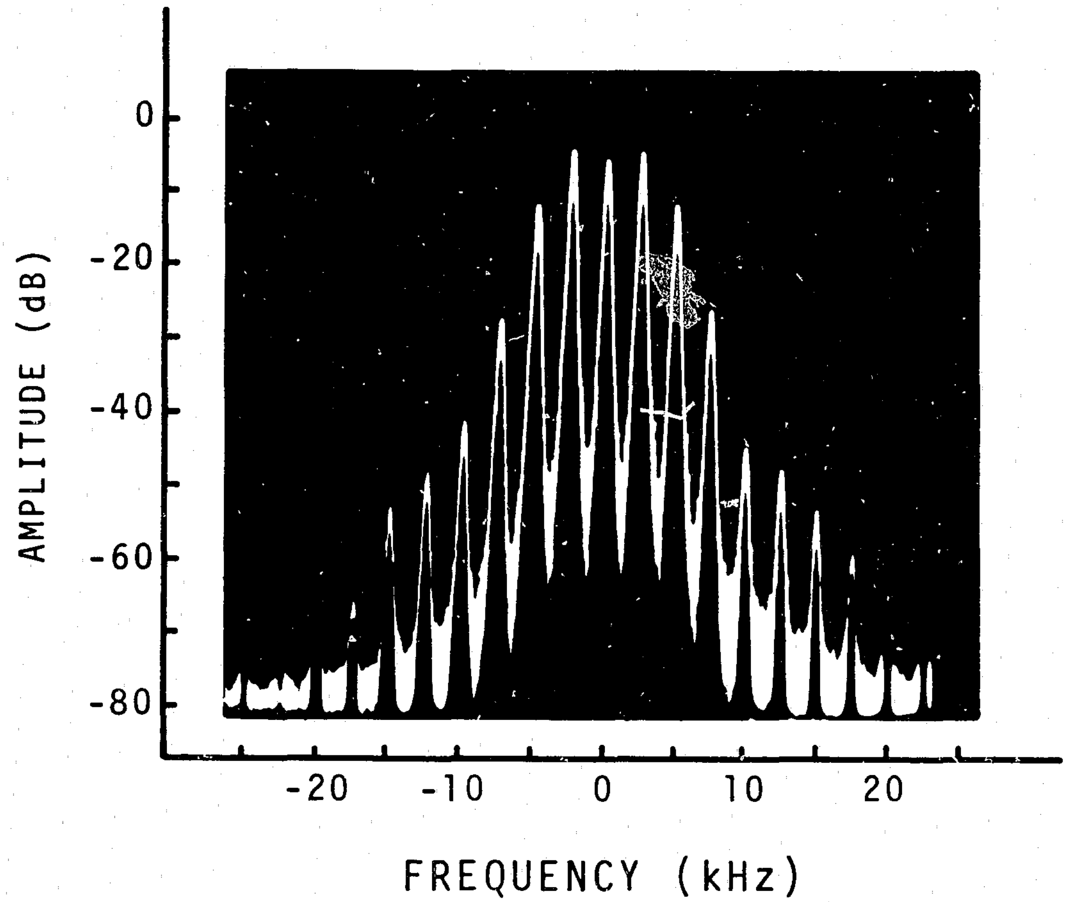


FIGURE 11. *Typical sideband spectrum of a transmitter using a 2.5 kHz tone 16 dB greater than that required to produce ± 2.5 kHz deviation at 1 kHz.*

Record the sideband spectrum attenuations as the differences between the center frequency amplitude and the amplitudes of the sidebands located at ± 10 kHz and ± 20 kHz from the center frequency.

## 5.6 Battery Service Life Test

Interconnect the transmitter/battery combination and the test equipment as shown in figure 12. Activate the transmitter and measure the time required for the nominal output power to decrease 3 dB. Repeat for each battery in the sample.

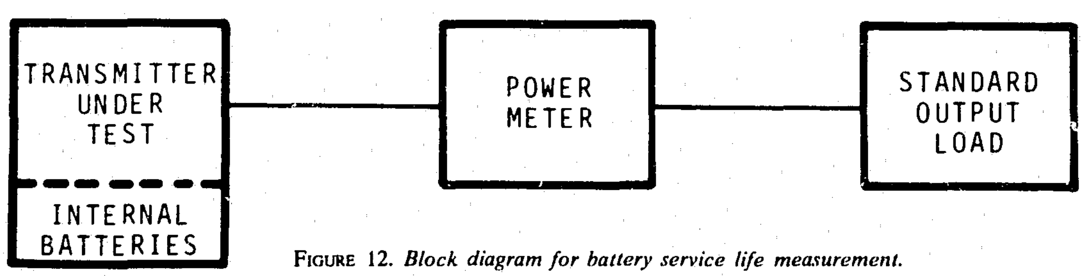


FIGURE 12. *Block diagram for battery service life measurement.*

# APPENDIX A—REFERENCES AND BIBLIOGRAPHY


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