An American National Standard

IEEE/IHF Standard Methods of Testing Frequency Modulation Broadcast Receivers

1. Introduction

1.1 Scope. This standard defines conditions and methods of measurement for determining performance characteristics of monophonic and stereophonic FM (frequency modulation) broadcast receivers so that the results may be compared to measurements of other receivers or by other observers. It contains material not previously available in a single standard and replaces withdrawn IEEE Std 185-1947, Methods of Testing Frequency Modulation Broadcast Receivers and its supplement, Tests for Effects of Mistuning and Downward Modulation. See Refs [1]–[5] for further information.

Measurements are described for equipment designed to receive 88 to 108 MHz band FM broadcasts made in accordance with the present rules of the FCC (Federal Communications Commission). The tests apply to receivers powered by ac lines, by batteries, and by automobile generator and storage battery systems. The methods may be used for frequency modulation receivers for other services by applying the proper system requirements.

Techniques herein enable evaluation of complete receiver performance, with no provision for testing individual circuits or components. The standard methods described do not involve injection or extraction of signals at other than the normal input and output terminals, nor are internal modifications specified to inhibit normal receiver operation, although this may be desirable for diagnostic purposes. Because receiver designs vary too much for convenient use of a single test procedure, supplementary and alternative tests are included.

To facilitate interpretation of the test results, each test is designed to determine a single characteristic with as little interference as possible from other parameters, such as the audio-amplifier performance. Acoustic measurements are not included. Refs [6]–[11] should be consulted for acoustic tests and complete amplifier measurement methods.

This standard applies to receivers with internal amplifiers for driving loudspeakers, and to tuners designed for connection to external amplifiers. The term *receiver* is used to include tuners where no distinction is required. If a receiver has audio input terminals, the audio-frequency section will be tested before measuring the radio reception characteristics. If a receiver has output terminals for connection to a tape recorder or external amplifier, the performance as a tuner may be measured as well as overall receiver performance.

Measurements of radiation and conducted interference are not within the scope of this standard. The allowable limits for such radiation and the measurement methods are described in the FCC *Rules and Regulations* [12]. Measurement methods are also described in Refs [13]–[17].

Limiting values of the various quantities for acceptable performance are not specified. Some tutorial material is included to help in evaluation of the measurement results.

2. Definitions

frequency deviation. The difference between the instantaneous frequency of the modulated wave and the carrier frequency.

maximum system deviation. The greatest deviation specified in the operation of the system.

NOTE: Maximum system deviation is expressed in kilohertz. In the case of FCC authorized frequency modulation broadcast systems in the range from 88 to 108 MHz, the maximum system deviation is ± 75 kHz.

monophonic. Audio information carried by a single channel.

NOTE: A monophonic receiver responds only to main channel signals, lacking the capability of detecting subcarrier information. The main channel signals may be either monophonic or the left-plus-right (L+R) information from the left and right channels of a composite stereophonic signal. Monophonic receivers have no output from L = −R stereophonic signals. Stereophonic receivers may be manually or automatically switched to the monophonic mode, responding only to monophonic or main channel L+R signals.

SCA subcarrier modulation. The FCC permits broadcasters to transmit privileged information and control signals on subcarriers as specified under the SCA (Subsidiary Communications Authorization), but only when transmitted in conjunction with broadcast programming.

With monophonic broadcasting, the SCA service may use from 20 to 75 kHz with no restriction on the number of subcarriers, but the total SCA modulation of the RF (radio frequency) carrier must not exceed 30 percent and the crosstalk into the main channel must be at least 60 dB down.

With stereophonic broadcasting, the SCA service is limited to 53 — 75 kHz, 10 percent modulation of the carrier, and must still comply with the 60 dB crosstalk ratio. A 67 kHz subcarrier with ±6 kHz modulation is often used.

separation. The process of deriving individual channel signals (for example, for stereophonic systems) from a composite transmitted signal.

NOTE: Separation describes the ability of a receiver to produce left and right stereophonic channel signals at its output terminals and is a measured parameter for stereo receivers only. Left-channel signal separation is defined as the ratio in dB of the output voltage of the left output of the receiver to that of the right output when an "L"-only signal is received. Right-channel separation is similarly defined.

standard de-emphasis characteristic. A falling response with modulation frequency, complementary to the standard pre-emphasis characteristic and equivalent to an RC circuit with a time constant of 75 μs.

NOTE: The de-emphasis characteristic is usually incorporated in the audio circuits of the receiver.

stereophonic. Audio information carried by a plurality of channels arranged to afford the listener a sense of the spatial distribution of the sound sources.

NOTE: A stereophonic receiver responds to both the L+R main channel and the L−R subcarrier channel of a composite stereophonic signal, so that one output contains substantially only L information, and the other only R. In addition to the main channel, stereophonic program modulation requires transmission of a 19 kHz pilot signal and the sidebands of a suppressed 38 kHz subcarrier carrying L−R information. This combination is called the composite signal, and it may be used alone or with other subcarrier (SCA) signals to frequency modulate the RF carrier.

After pre-emphasis, the left and right channels are added for main channel information. The right-channel program material is subtracted from the left to derive a difference signal that then amplitude modulates a 38 kHz subcarrier. The subcarrier is suppressed, divided by two, and transmitted as a 19 kHz pilot signal to facilitate demodulation of the suppressed carrier information at the receiver.

3. Test Equipment Requirements

All measuring instruments used should be at least five times more accurate than the test result to be recorded so that no more than 20 percent uncertainty will be introduced. If this is not possible, then the accuracy will be stated as a part of the test data.

3.1 RF Generator. This generates an adjustable-frequency RF carrier, with controlled attenuation, provision for frequency and amplitude modulation, meter monitoring of the carrier output, and meter indication of the deviation and modulation depth. An internal fixed-frequency audio generator is usually included to serve as a modulating signal source. Two generators are required for several tests described in Section 6, but only one need be modulated.

3.1.1 *Frequency Range.* While a range of 88 to 108 MHz is adequate for most FM broadcast receiver tests, continuous coverage from the IF (intermediate frequency) of 10.7 MHz to at least 216 MHz is needed for spurious response tests. If a generator with FM modulation capability covers 67 kHz as a carrier frequency, it can be used as an SCA generator (Section 3.4).

Since frequency stability is important, sufficient time should be allowed for warm-up and stabilization. Generator frequencies should be read with a frequency counter except for the tests that do not require exact frequencies.

3.1.2 *Spurious Output.* The carrier output purity is important, particularly in the spurious response measurements. RF output filters may be used if the impedance match and attenuator calibration are not affected. Field-strength meters and spectrum analyzers are convenient instruments for verifying signal purity. The method of frequency generation and the potential spurious output frequencies should be known, so that the receiver responses may be correctly identified. Generators may have fundamental oscillators, oscillator–multiplier combinations, multiple-oscillator mixers, or full synthesis systems. Any response below the tuned frequency of the receiver should be particularly checked, as these are often due to generator harmonics.

3.1.3 *Output Range.* The generators should be capable of providing the standard input levels (Section 5.1), with allowance for dummy antenna attenuation (Section 3.6). Few precision generators are capable of the higher levels, and wide-band or tuned RF amplifiers may be needed to increase the output range. The amplifier output should be checked for harmonic content that could affect some measurements. A suitable meter should be used to calibrate the output and attenuators. Accurate calibration of low signal inputs requires low leakage or other unwanted signal conduction into the receiver.

3.1.4 *Frequency Modulation.* Linear frequency-modulation capability is necessary from 30 to at least 15 000 Hz for monophonic tests, and to 75 kHz for complete stereophonic measurements. Linear deviation to ± 150 kHz is also necessary, with up to ± 300 kHz convenient for measuring many receivers. For linear modulation, the RF bandwidth of the generator must be sufficient to pass the FM signal sidebands without distortion. A straightforward method of checking the modulation capability is based on a wide-band monitor receiver that has a calibrated linear discriminator. Response and linearity of the generator are measured with distortion or harmonic analyzers at the output of the discriminator. The audio generator used for a modulation source must have low distortion.

The generator and modulation source distortion must total no more than 20 percent of the distortion result from the receiver tests. Random FM from hum and noise should be held to a similar portion of the test results. The frequency response of the modulator should be verified.

Deviation can be measured with a frequency counter if access to the direct-coupled portion of the generator modulation circuits is available. The linearity and sensitivity of the modulator are determined by relating the direct modulating potential or current to the modulated output frequency.

The deviation meter may not be accurate for stereo modulation. It usually has an average-rectifying characteristic, but is calibrated for peak deviation of sine-wave modulation. It is likely to have a 6 dB error for left- or right-only signals, and a 10 dB error for L – R. To check the reading, record the peak-to-peak oscilloscope indication for sine-wave modulation giving ± 75 kHz deviation. Convert this value to ± volts per kilohertz deviation. Oscilloscope measurement of any modulating signal with more than one frequency component can then be converted to peak-to-peak deviation in kilohertz.

3.1.5 *Amplitude Modulation (AM).* For the AM suppression tests described in Section 6.17, the generator must be capable of at least 30 percent amplitude modulation of its output signal simultaneously with the frequency modulation.

Many generators produce incidental phase and frequency modulation when they are amplitude modulated. The amount is usually specified by the manufacturer, but it should be verified by the monitor receiver described in Section 3.1.4, or by an equivalent method. The error introduced by the incidental modulation may be large enough to invalidate the measurement of AM suppression.

An external amplitude modulator may be used to reduce incidental phase modulation. If a bridge modulator with low-capacity diodes is used, the RF level should be maintained constant by using an external attenuator. Care must be taken to avoid incidental phase modulation from standing waves in the modulator, attenuator, dummy antenna, and cable connections.

Simulated airplane flutter and similar tests require deeper modulation at a very low frequency, but some incidental FM or phase modulation may be tolerated.

3.2 AF Generator. Most RF generators have internal AF (audio-frequency) generators for modulation sources, but usually with only one or two frequencies, and often with too much distortion for the precision readings needed on some receiver designs. The modulation source usually has external terminals that may be used to measure its distortion, or the overall distortion may be measured as described in Section 3.1.4.

An external modulation source is needed for other audio frequencies, and two simultaneous frequencies are needed for several measurements. The external generator must have a range of 30 to 15 000 Hz for response tests and preferably to over 75 kHz for high-frequency filtering tests. The output must be uniform from 30 to 15 000 Hz, though the output may be monitored with an audio voltmeter if necessary. The frequency calibration may be verified with a counter, but the dial indication is usually adequate for all but a few critical tests. The distortion should be verified regularly. A variable electronic filter may be used at the audio generator output for precise measurements.

A function generator with sine-wave output, electronic sweep, and analog drive for an X–Y recorder is convenient for frequency-response measurements, particularly if pre-emphasis is used. Some such generators have a voltage-controlled oscillator that can be modulated with audio frequencies, so that it can also serve as an SCA generator (Sections 3.4 and 7.10).

3.3 Composite Stereo Generator. A composite stereophonic signal generator produces the modulation components described in Section 2 and should have provision for adding a simulated SCA subcarrier. Pre-emphasis networks and self-contained audio generators are desirable, and some commercial generators include a fixed-frequency RF generator with output attenuators. Usually the composite signal is used to modulate an RF generator as described in Section 3.1. Among the required features are: four modulation modes, L only, R only, L = R, and L = −R; pilot signal terminals for external use, pilot switchable on–off and controllable from 0 to 15 percent or more. A "set-modulation" switch is convenient.

The generator may use matrix modulation or time multiplexing, but the main channel-to-subcarrier level differences that may occur with time multiplexing are easier to detect than the phase differences that are common with matrix modulation. The composite generator combines L and R signals from internal or external sources with a pilot signal and generates main and subcarrier components. This is a complex process and careful verification of the modulating signal is important.

Each of the signal characteristics should be verified. A spectrum analyzer can do most of this, and a harmonic analyzer can do fairly well, but other tests can help too. An oscilloscope may be used to verify the subcarrier suppression when L = R = 0. This must not exceed 1 percent deviation and should be nulled if possible. The subcarrier must be the second harmonic of the pilot, which may be verified by a double-trace scope, and the pilot must be within 2 Hz, which can be checked by a counter.

3.4 SCA Generator. The SCA rejection tests of Section 7.10 require a generator with a center frequency from 53 to 75 kHz and FM modulation capability. A 67 kHz center frequency with a ± 6 kHz deviation at 2.5 kHz is satisfactory. Some function generators used for Section 3.2 may serve here too. The center frequency should be verified with a counter, and the remainder of the characteristics checked as in Section 3.1.

3.5 Frequency Counter. A digital counter capable of measuring audio, ultrasonic, and RF frequencies to 216 MHz is required for accurate frequency measurements, particularly generator frequency calibration and verification. Care must be taken that switching transients do not interfere with the receiver measurements.

A low-capacity pickup or insulated FET (field-effect transistor) probe with a wide-band amplifier may be used with a counter to monitor the local oscillator frequency as needed for some of the measurements. Care must be taken that the pickup does not detune the oscillator or introduce coupling errors into other measurements. If the counter sensitivity is high, a tuned loop may be used. If access to the inside of the receiver is necessary to read the oscillator frequency, care must be taken so that the receiver operates normally.

3.6 Dummy Antenna. A dummy antenna is a transformer or network that presents the specified source impedance to the receiver and reflects the specified load impedance to the signal generator. The dummy antennas described below are for connection of one or two generators with 50 Ω internal impedances to receivers designed for 300 Ω balanced, 300 Ω unbalanced, and 75 Ω unbalanced inputs.

Receivers designed for monopole or whip antennas should be measured with a suitable dummy stating the dummy used as part of the test results. The receiver should not be grounded for these tests, and the generator connection to the chassis must be carefully located to correctly simulate the antenna.

The ideal dummy would give loss-free impedance transformation so the generator could be direct reading in available power, but most transformers do not have constant output over the required frequency range. If resistive pads are used, the loss in available power must be subtracted from the generator reading to find the power available to the receiver. This loss is shown for each of the various configurations.

For each dummy antenna shown,

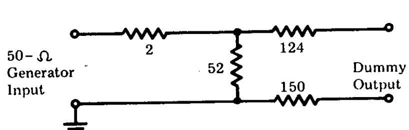
E_G Generator terminated output voltage as usually indicated on the output attenuator, half of the generator open-circuit voltage

E_O Open-circuit voltage at the receiver terminals in terms of E_G

P_L Dummy-antenna power loss in dB

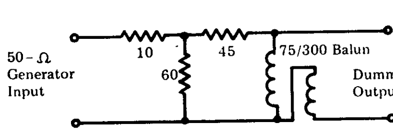
P_A Power available to the receiver in terms of E_G

(1) 300 Ω balanced input, resistive pad, one generator:

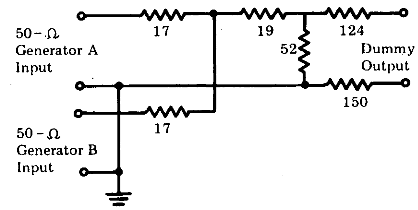


$E_O = E_G$
$P_L = 13.8$ dB
$P_A = \frac{(E_G)^2}{1200}$

(2) 300 Ω balanced input, pad plus balun, one generator:

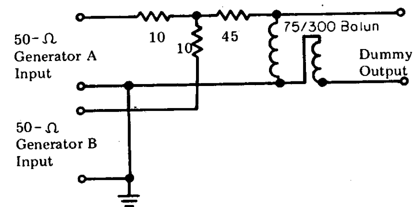


$E_O = 2 E_G$
$P_L = 7.8$ dB
$P_A = \frac{(E_G)^2}{300}$



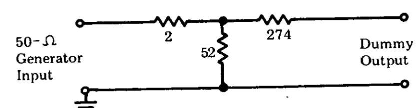
$E_O = .5 E_G$
$P_L = 19.8$ dB
$P_A = \frac{(E_G)^2}{4800}$
(for each frequency)

(3) 300 Ω balanced input, resistive pad, two generators:



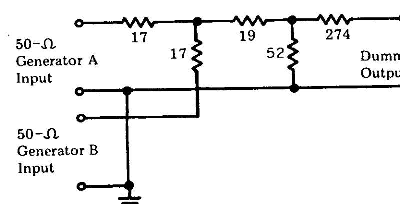
$E_O = 2 E_G$
$P_L = 7.8$ dB
$P_A = \frac{(E_G)^2}{300}$
(for each frequency)

(4) 300 Ω balanced input, pad plus balun, two generators:



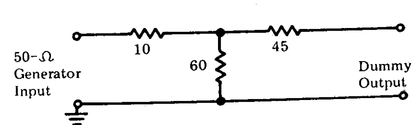
$E_O = E_G$
$P_L = 13.8$ dB
$P_A = \frac{(E_G)^2}{1200}$

(5) 300 Ω unbalanced input, resistive pad, one generator:



$E_O = 0.5 E_G$
$P_L = 19.8$ dB
$P_A = \frac{(E_G)^2}{4800}$
(for each frequency)

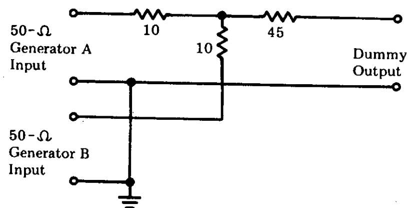
(6) 300 Ω unbalanced input, resistive pad, two generators:



$E_O = E_G$
$P_L = 7.8$ dB
$P_A = \frac{(E_G)^2}{300}$

(7) 75 Ω unbalanced input, resistive pad, one generator:

(8) 75 Ω unbalanced input, resistive pad, two generators:



3.7 Output Load. Each receiver terminal pair designed to supply signal power to a loudspeaker will be terminated with a resistive load having less than 10 percent reactive component at any frequency below 75 kHz. The resistor shall have a value that remains within 1 percent of the load specified by the manufacturer while dissipating the full output of the receiver. If not otherwise specified, an 8 Ω load will be used.

Receiver terminals intended to supply signal voltage to the input of a subsequent amplifier will be terminated with a 100 kΩ ± 5 percent resistor shunted by a 1000 pF ± 5 percent capacitor, unless the manufacturer of the receiver specifies otherwise.

The loading of the receiver output caused by other test equipment will be considered part of the load.

3.8 Output Filters. Except for measurements of the receiver's hum, ultrasonic output, and frequency response, a 200 to 15 000 Hz bandpass filter will be interposed between the output terminals of the receiver and the measuring instruments. The attenuation will not exceed 3 dB at 200 and 15 000 Hz, with a slope on each side of the passband of at least 18 dB per octave, and at least 30 dB attenuation at 19 kHz and above (see Section 7.2). This filter is modified to a 200 Hz high-pass filter for certain tests and to a 15 000 Hz low-pass filter for other specified tests. It becomes a 200 to 1500 Hz bandpass filter for standard AM suppression tests. A variable electronic filter may be used for complete AM suppression tests, or the components due to the addition of AM may be determined with a wave analyzer or spectrum analyzer.

Distortion, hum, and noise introduced by the filter must be included in the maximum allowable 20 percent inaccuracy, and the filter input impedance must be considered part of the output load.

3.9 Output Meter. The audio voltmeter used for output measurements will have average rectifying characteristics and be calibrated to read the rms (root mean square) voltage of a sine wave. It should be accurate to ± 2 percent of full-scale indication from 20 Hz to 200 kHz. The voltmeter's input impedance will be considered part of the receiver load.

The wide-band mode of the distortion meter (Section 3.11) may be used, with the advantage of using the same meter for distortion measurements, thus reducing the potential inaccuracies.

As specified for some audio measurements, rms true characteristic voltmeters may be used, but the measurement will not correlate with subjective response.

A logarithmic converter and $X-Y$ recorder in combination with a suitable sweep generator is useful in plotting frequency response.

3.10 Oscilloscope. An oscilloscope is necessary for the stereophonic FM measurements and useful for monitoring the output during other tests. It should have a frequency response from dc to at least 200 kHz to permit the calibration of ac waveforms against dc offsets. The linear time-base sweep should allow external triggering, and the scope should permit $X-Y$ displays for viewing Lissajous figures. Dual-trace capability is helpful for equipment verification and many of the measurements.

3.11 Distortion Analyzer. The distortion meter should have average rectifying characteristics and be capable of measuring the total residual hum, noise, and distortion components through subcarrier frequencies to an accuracy of at least ± 5 percent of full-scale indication. The reading of this meter is defined in this standard as distortion. The input impedance will be considered part of the receiver load. A spectrum analyzer is useful for quick evaluation of distortion components.

A narrow-band voltmeter or harmonic analyzer with a range of 50 Hz to 53 kHz and a bandwidth of 1/10 octave or less is useful, particularly for many stereophonic measurements. This may be more informative than total distortion readings. The total distortion is then expressed as

$$K = \frac{\sqrt{A_2^2 + A_3^2 + \ldots + A_n^2}}{\sqrt{A_1^2 + A_2^2 + \ldots + A_n^2}}$$

where A_1 is the fundamental amplitude, A_2 is the second harmonic, etc. K may be expressed in percent or decibels.

Harmonic distortion may also be expressed as the ratio of individual harmonic amplitudes to the amplitude of the fundamental, again in percent or decibels, for each of the significant harmonics.

4. Operating Conditions

Standard test conditions are described in this section. If standard conditions are not possible, then deviations should be stated as part of the test results.

4.1 Precautions. If the receiver uses a line-connected chassis, an isolation transformer should be used. Care should be taken that it does not influence the measurements.

4.2 Shields and Covers. All shields, covers, cases, and bottom plates will be fastened in their normal operating position.

4.3 Accessories. All specified accessory equipment or equivalent substitutes will be connected during tests if the loads or coupling affect the stability or the parameters to be measured. If more than one accessory case or cabinet is available for the receiver, it should be tested in the enclosure causing the highest operating temperature.

4.4 Preconditioning. All units will be preconditioned by operating in their normal position at one-tenth of their rated output for 1 hour or until stable operation is achieved. An exception is prior to the warm-up drift measurements given in Section 6.18.

4.5 Ground Connections. Accurate measurement of many receivers is not possible if a common ground connection causes abnormal coupling or instability. The equipment connected to the input must then be isolated from that connected to the output and from the ac supply to the receiver. Isolation transformers or battery-powered equipment may be necessary. If an isolation transformer is used for the receiver, a secondary-to-ground capacitor may be an adequate substitute for the normally grounded line.

Many portable receivers should not be grounded during measurements.

4.6 Normal Environment. All normal preconditioning and tests will be made in an ambient temperature of 25 °C ± 3 °C, in less than 90 percent relative humidity, and in a screened room with adequate attenuation of extraneous signals.

4.7 Extreme Environment. FM receivers obtaining power from the ac lines are normally used indoors, with a maximum expected ambient temperature range of 15 to 45 °C. The preconditioning and measurements will be repeated at these extremes within ± 3 °C when ac operated receivers are to be tested for full temperature range operation.

Portable and automobile receivers are subjected to lower temperatures and may be measured in an ambient temperature of 5 °C ± 3 °C, with no preconditioning. They may be checked for functional operation below 5 °C and above 45 °C.

4.8 AC Supply. The ac supply will be at 120 V ± 1 percent at 60 Hz ± 2 Hz, and with less than 2 percent total distortion. Line-voltage range tests will be from 105 to 130 V or as marked on the receiver. An ac wattmeter will be used to measure the power drain, usually at minimum volume and at the fraction of reference output required for safety listing.

4.9 Battery Supply. The receiver may be powered by new batteries of the type specified, or a power supply may be substituted that simulates the battery characteristics and is within 3 percent of the nominal voltage for the type specified. Supply currents will be measured for each mode of operation and for various power output levels. Receivers designed for use with both ac and battery supplies will be tested on both for all measurements that are affected by the type of supply.

All tests of the receiver significantly affected by changes in the supply voltages should be repeated using the maximum voltage for the particular type of battery as specified in Table 1. This may be done with actual batteries, if the necessary voltage can be achieved, or by simulation using a low-resistance power supply. The values given in the table assume battery charging circuits to be used in automobile applications, but not in other applications. If charging circuits are used elsewhere, appropriate maximum values should be determined.

Table 1
Battery Supply Voltages

Type of Cell and Receiver	Nominal Voltage	Normal Voltage	Maximum Voltage	Minimum Voltage
Dry cells	1.5			
Transistor radios		1.5	1.6*	0.75
End-of-life tests				0.90
Lead acid storage cells	2.0			
In automobiles		2.4	2.6	1.8
Other receiver types		2.0	2.2	1.8
Nickel-cadmium storage cells with gas vent	1.2			
Automobile receivers			1.6	1.1
Other receiver types		1.2	1.4	1.1
Nickel-cadmium storage cells gas tight	1.2			
Automobile receivers			1.4	1.1
Other receiver types		1.2	1.35	1.1

*The maximum voltage of a dry cell may be as high as 1.7 V, depending upon variables of manufacturing. Where tests are to be carried out at the maximum battery voltage, this should be ascertained from the battery manufacturer and quoted with the test results.

All tests of the receiver significantly affected by changes in the supply voltages should be repeated using the minimum voltage for a particular type of battery, as specified in Table 1. This minimum voltage is developed by the series combination of a low-resistance power supply as used above and a dropping resistor to simulate the increased internal resistance of the supply battery while the receiver current drain is maximized. Should the receiver fail to operate at the recognized minimum supply voltage, the usable range of operation should be noted. In the instance of transistor receivers with very low current drain, it may be desirable to test at the minimum supply voltage that will sustain receiver operation, reducing the supply voltage by increasing the resistance of the series dropping resistor.

5. General Test Procedures

5.1 Input Signal Levels. Input signal levels are expressed in terms of available power, the power delivered by the signal generator and dummy antenna to a matched load, the specified source impedance for which the receiver was designed. The available power is equal to $E^2/4R$, where E is the equivalent open-circuit voltage from the generator or dummy antenna, and R is the internal impedance.

In addition to resolving the 6 dB ambiguity between open-circuit and terminated microvolts, the expression of input levels as available power has been an accepted method for many years and for receivers in many services. It is particularly advantageous when comparing measurements of receivers designed for different source impedances.

Many signal generators are calibrated in terms of power available to a matched load and can be made direct reading by use of a matching balun or transformer that has a flat response over the required frequency range.

5.1.1 ***Available Power.*** For convenient expression of input levels in terms of available power, the reference level chosen is 1 fW (10^{-15} W), stated as 0 dBf.

5.1.2 ***Equivalent Microvolts.*** The reference level of 0 dBf corresponds to an open-circuit voltage of 1.1 μV, and 120 dBf corresponds to an open-circuit voltage of 1.1 V, both at a 300 Ω impedance level. For example, if the sensitivity of a receiver is 10 dBf, the equivalent open-circuit voltage at 300 Ω is 3.5 μV.

Fig 1 shows the relationship between available power, open-circuit microvolts, and terminated microvolts for 300 and 75 Ω impedances.

5.1.3 ***Mean Signal Input.*** Mean signal input is chosen as 65 dBf, which corresponds to an open-circuit input voltage of 1950 μV at 300 Ω.