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Spectrum Management and Telecommunications

Compliance Specification for Terminal Equipment, Terminal Systems,
Network Protection Devices, Connection Arrangements and Hearing Aids Compatibility

Part V: Requirements and Test Methods for Magnetic Output from Handset Telephones for Hearing Aid Coupling and for Receive Volume Control

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1. Introduction

This Part provides the technical requirements for handset telephones to be hearing aid compatible. A telephone set is defined as hearing aid compatible if it complies with the technical requirements, given in this Part, to couple magnetically with hearing aids and to provide volume control.

The requirements of this Part are derived from:

CSA Standard CAN/CSA-T515-97, Telecommunications – Telephone Terminal Equipment – Acoustic and Magnetic Field Requirements for Handset Telephones for Use by the Hard of Hearing.

2. General Requirements

These requirements apply to all analogue and digital handset telephones. Handset telephones must meet all applicable technical requirements of CS-03, including the technical requirements of this Part.

3. Exemptions

Certain handset telephone types are exempt from the requirements of this Part. They are:

- (1) cellular telephones; and
- (2) secure telephone units.

4. Magnetic Output

4.1 Requirements

4.1.1 General

The parameters below, descriptive of the magnetic field at points in the measurement plane, shall be used to ascertain adequacy for magnetic coupling. The three parameters are: axial field intensity; radial field intensity; and magnetic field intensity frequency response associated with the resulting field vector.

4.1.2 Axial Field Intensity

When measured as specified in Section 4.2 of this Part, the axial component of the magnetic field directed along the measurement axis and located at the measurement plane shall be greater than -22 dB relative to 1 A/m, for an input of -10 dBV at 1000 Hz (see Figure 1.0 and Figure 2.0).

Note: If the magnitude of the axial component exceeds -19 dB relative to 1 A/m, relaxation in the frequency response is permitted (see Section 4.1.4, in particular Figure 4.1 and Figure 4.2).

4.1.3 Radial Field Intensity

When measured as specified in Section 4.2, radial components of the magnetic field as measured at four points 90 degrees apart, and at a distance greater than or equal to 16 mm from the measurement axis (as selected in axial field intensity measurement) shall be greater than -27 dB relative to 1 A/m, for an input of -10 dBV at 1000 Hz (see Figure 1.0 and Figure 2.0).

4.1.4 Magnetic Field Intensity Frequency Response

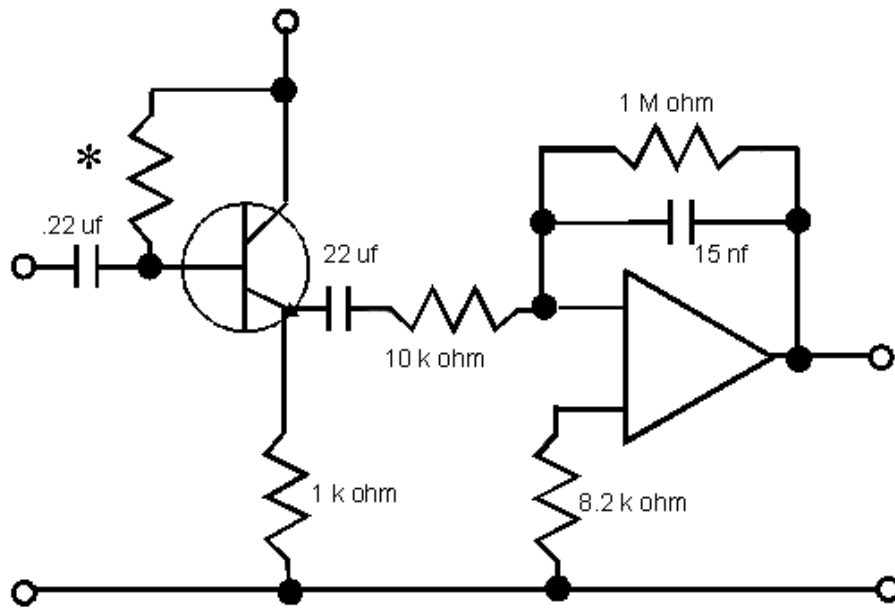
The frequency response of the magnetic field intensity as measured in Section 4.2 shall fall within the acceptable region of Figure 4.1, Figure 4.2, Figure 4.3 or Figure 4.4 over a frequency range of 300 Hz to 3300 Hz.

4.1.4.1 For receivers with an axial field intensity that is greater than -19 dB relative to 1 A/m, when measured as specified in Section 4.2, the frequency response shall fall within the acceptable region of Figure 4.1 if an integrator is used, or Figure 4.2 if no integrator is used.

4.1.4.2 For receivers with an axial field intensity that is less than -19 dB but greater than -22 dB relative to 1 A/m, when measured as specified in Section 4.2, the frequency response shall fall within the acceptable region of Figure 4.3 if an integrator is used, or Figure 4.4 if no integrator is used.

Note: (a) As an alternative, the requirements in this section have been written to permit frequency response tests to be conducted with an integrator. For an ideal coil, the probe coil voltage increases at a slope of 6 dB per octave in a constant magnetic field. To express test results in magnetic field intensity, it is necessary to either convert the coil probe voltage arithmetically or observe the probe coil voltage through an appropriate integrator (a low-pass filter). A typical example of such an integrator taken from CSA Specification CAN3-T515-M85 and IEEE Specification 1027 is given below. It will also be necessary to calibrate either the coil alone, or the coil in companion with an integrator, to establish absolute field intensity at 1 kHz and relative response across the frequency band of interest.

(b) The procedures for calibration of the probe coil are given in IEEE Specification 1027, Section 5.



* Select the value of this resistor to provide suitable collector current

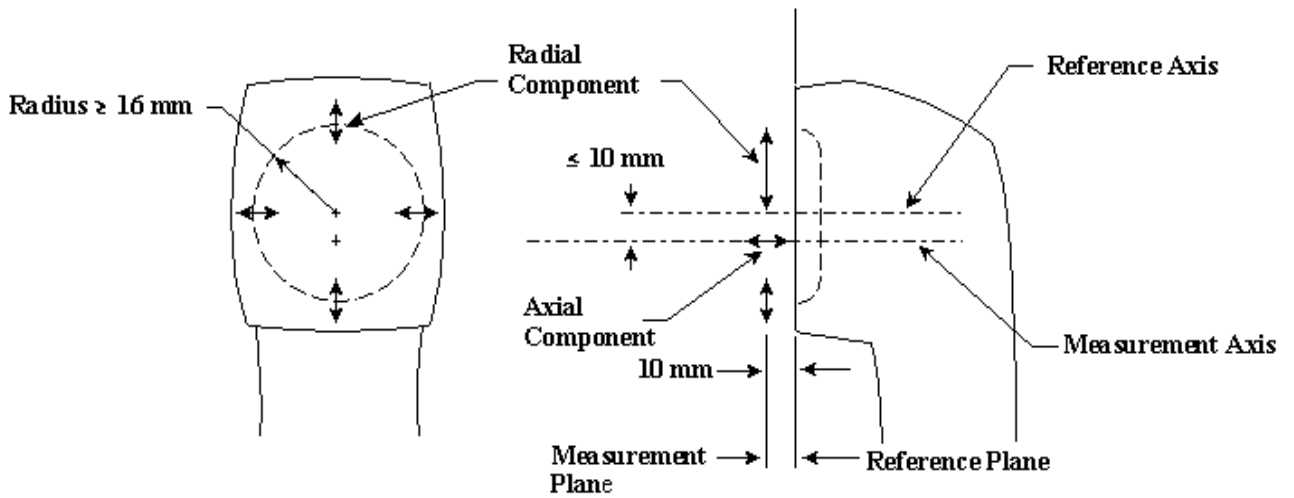
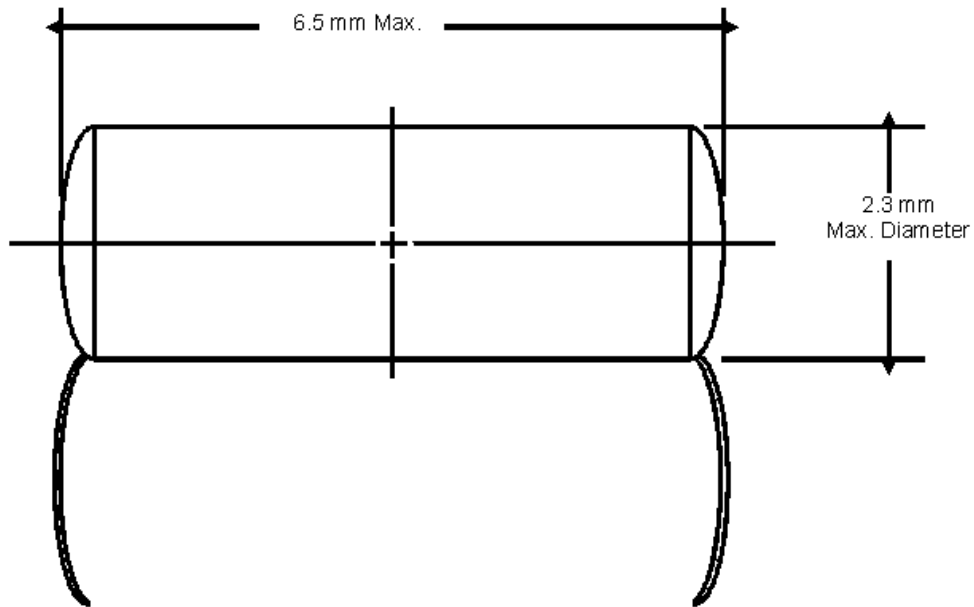


Figure 1.0

Reference and Measurement Planes and Axis
(See Section 4.1.2 and Section 4.1.3)



Typical Parameters of Probe Coil

DC resistance: 900 Ohm
Inductance: 150 mH
Sensitivity: -60 dBV/(A/m)
For calibration see IEEE Standard 1027, Section 5.0.

Figure 2.0

Probe Coil (Magnetic Material Core) Parameters

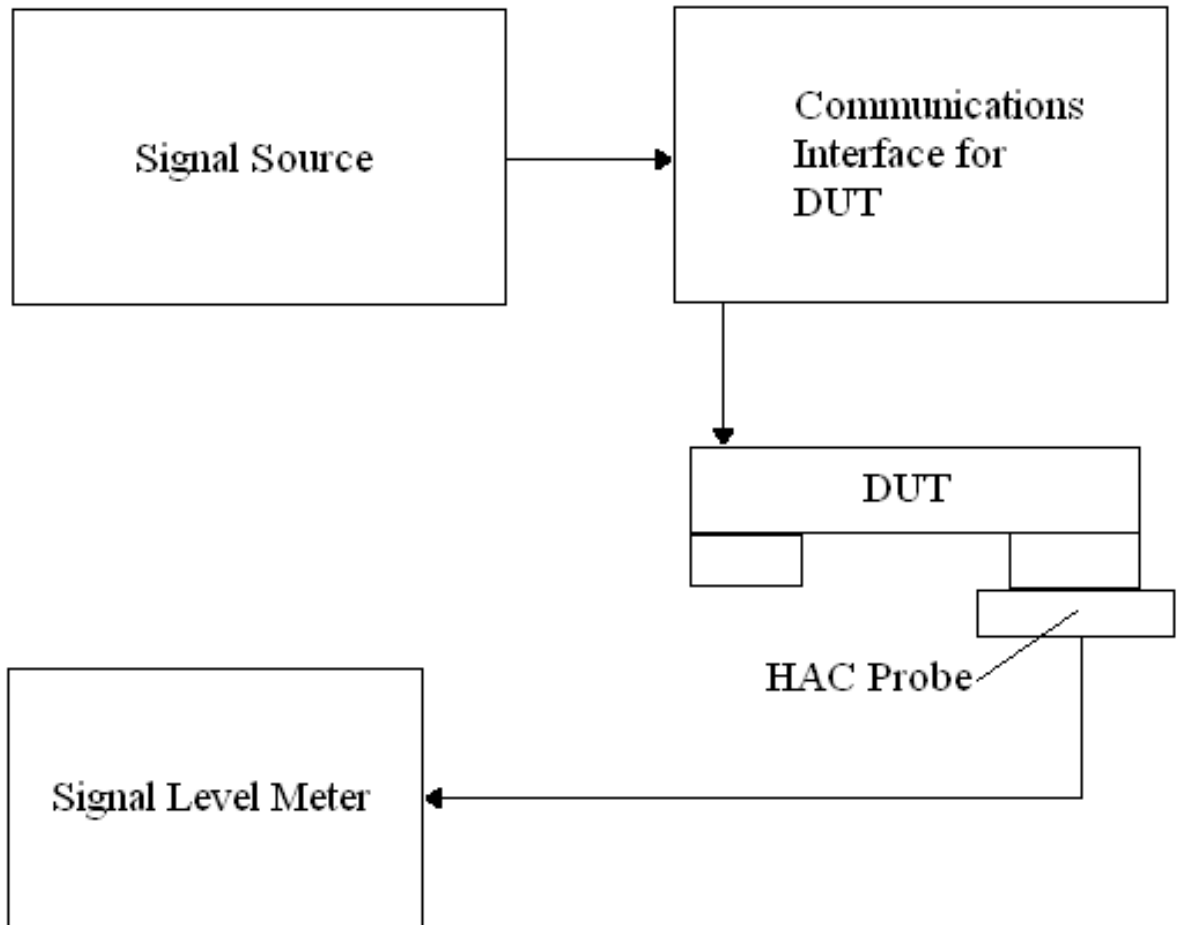


Figure 3.0

Measurement Block Diagram

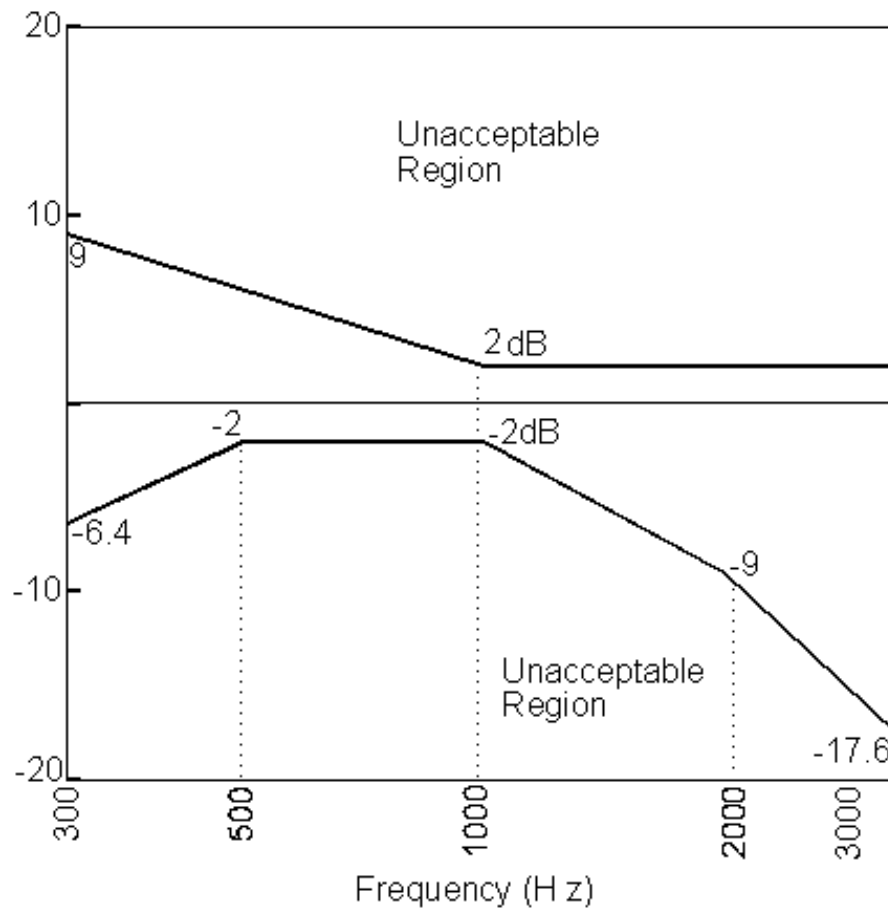


Figure 4.1

Magnetic Field Intensity Frequency Response for Receivers with an Axial Field that Exceeds -19 dB Relative to 1 A/m Using Integrator (See Section 4.1.4 and Figure 3.0)

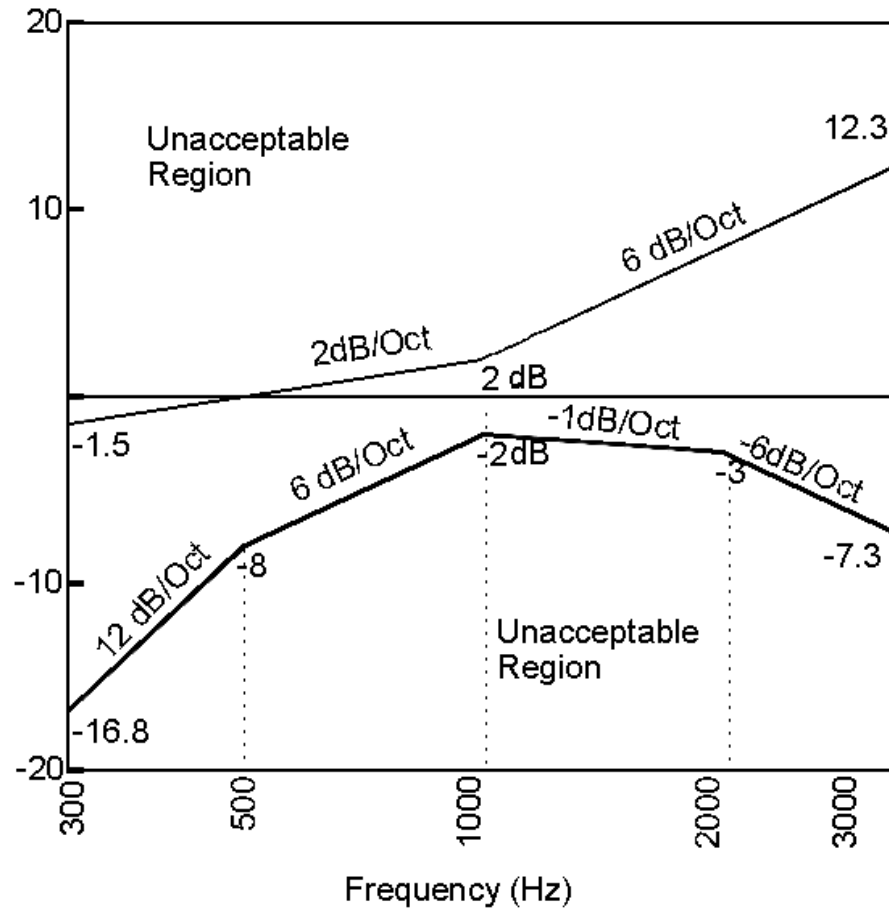


Figure 4.2

Magnetic Field Intensity Frequency Response for Receivers with an Axial Field that Exceeds -19 dB Relative to 1 A/m Without Using Integrator (See Section 4.1.4 and Figure 3.0)

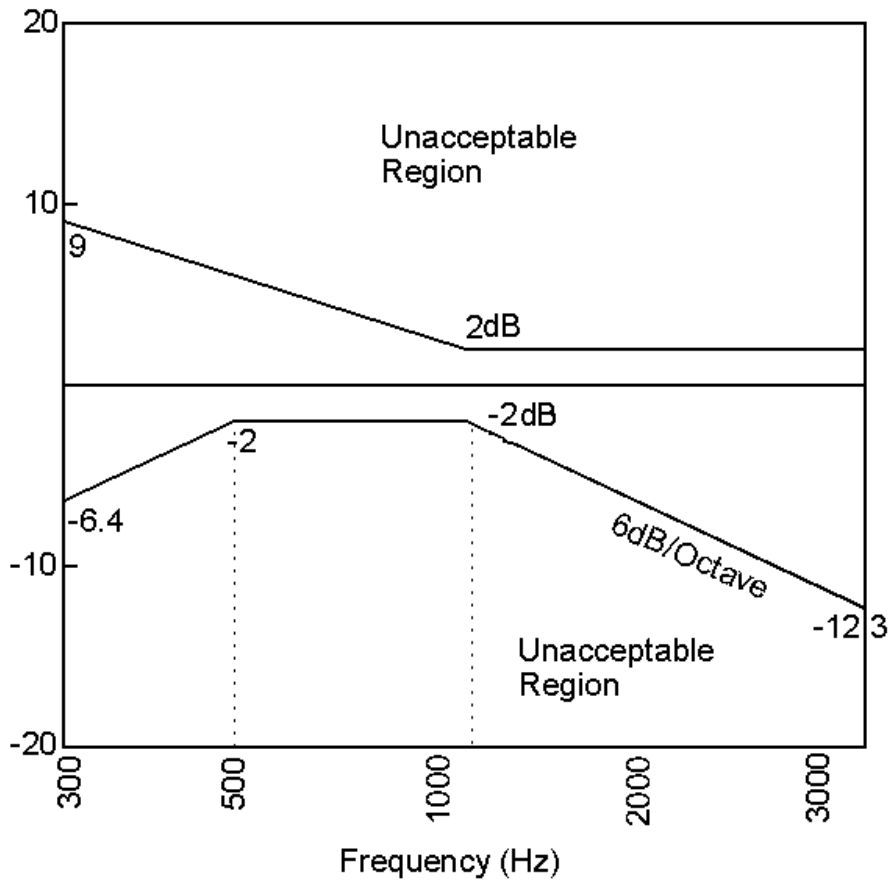


Figure 4.3

Magnetic Field Intensity Frequency Response for Receivers with an Axial Field that is Less than -19 dB but Greater than -22 dB Relative to 1 A/m Using an Integrator (See Section 4.1.4 and Figure 3.0)

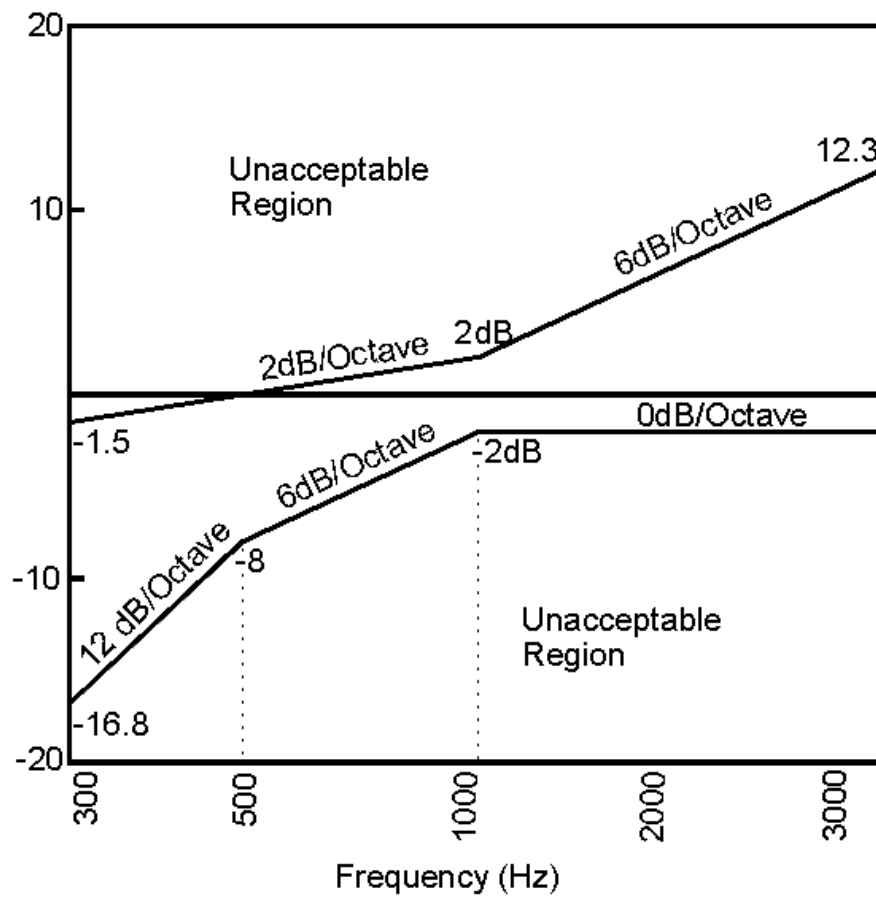


Figure 4.4

Magnetic Field Intensity Frequency Response for Receivers with an Axial Field that is Less than -19 dB but Greater than -22 dB Relative to 1 A/m Without Using an Integrator (See Section 4.1.4 and Figure 3.0)

4.2 Method of Measurement

4.2.1 Analogue Telephones

- (1) Arrange the DC feed circuit so that the total resistance between its tip and ring terminals is 1650 ohms and the battery voltage is 48 volts DC.
- (2) Connect the terminal equipment (TE) to the test circuit as shown in Figure 3.0.
- (3) With the TE off hook, set the signal source frequency to 1 kHz and adjust its level to -10 dBV. Average the selective level meter to pass 1 kHz.
- (4) With reference to the definitions contained in CS-03 Part IV, locate the reference axis, position the probe in an axial orientation on the receiver of the handset and move the probe across the surface of the receiver to find the measurement axis. Record the voltage measured.

- Note:**
- (a) It will be necessary to convert the measured voltage into magnetic field strength. This conversion will require a knowledge of the probe's sensitivity as established through calibration.
 - (b) For the purpose of repeating these measurements, it is useful to note the measurement axis location.
 - (c) The measurement axis is normally considered as that location within the prescribed distance from the reference axis where the maximum field intensity is observed. However, the measurement axis may be selected as a location within the prescribed distance from the reference axis that is to the optimum advantage to satisfy the axial and radial requirements. Once a measurement axis is established, it is used as a basis for all measurements.

- (5) With the probe in an axial orientation and located at the measurement axis, set the signal source to sweep the band of frequencies from 300 Hz to 3300 Hz. Arrange the selective voltmeter to track the signal source frequency. Record the measurement results, taking into account the variation in sensitivity that occurs with changing frequency. Plot the frequency response relative to 1 kHz.
- (6) Set the signal source as in step (3). Position the probe in a radial orientation at 16 mm from the measurement axis. Move the probe in a radial direction, away from measurement axis. Record the maximum voltage observed.
- (7) Repeat step (6) to obtain a total of four measurements, each separated by 90 degrees around the circumference of the receiver.

4.2.2 Digital Telephones

- (1) For digital telephones, an appropriate input test level that produces an equivalent acoustic level to analogue sets (nominal +0 dBPa), with the receive volume control set to its nominal gain level, needs to first be determined. The acoustic output of the handset is measured instead of the magnetic output to determine the input test level.
- (2) Place the telephone receiver in the Type 3.3 artificial ear, using the high leak condition specified in TIA-810-B, and connect the telephone set to the circuit interface as shown in Figure 5.0. Alternatively, the Type 1 artificial ear may be used if a seal can be achieved between the handset and the artificial ear without the use of sealing putty or similar materials.
- (3) Apply a 1000 Hz input signal from a sinewave generator and measure the microphone output signal using an AC voltmeter. Determine the sound pressure produced in the artificial ear, taking into account the microphone sensitivity (in dBV/Pa), the gain (if any) of the microphone amplifier, the gain or loss of the bandpass filter, and the reading of the AC voltmeter (in dBV). Adjust the input level to produce +0 dBPa at 1000 Hz. Record the input level required to produce +0 dBPa at 1000 Hz, as this is the input level determined for the magnetic field measurement.
- (4) Connect the terminal equipment (TE) to the test circuit as shown in Figure 3.0.
- (5) With the TE off hook, set the signal source frequency to 1 kHz and adjust its level to the input level determined in step (3). Average the selective level meter to pass 1 kHz.
- (6) With reference to the definitions contained in CS-03 Part IV, locate the reference axis, position the probe in an axial orientation on the receiver of the handset and move the probe across the surface of the receiver to find the measurement axis. Record the voltage measured.

Note: (a) It will be necessary to convert the measured voltage into magnetic field strength. This conversion will require a knowledge of the probe's sensitivity as established through calibration.

(b) For the purpose of repeating these measurements, it is useful to note the measurement axis location.

(c) The measurement axis is normally considered as that location within the prescribed distance from the reference axis where the maximum field intensity is observed. However, the measurement axis may be selected as a location within the prescribed distance from the reference axis that is to the optimum advantage to satisfy the axial and radial requirements. Once a measurement axis is established, it is used as a basis for all measurements.
- (7) With the probe in an axial orientation and located at the measurement axis, set the signal source to sweep the band of frequencies from 300 Hz to 3300 Hz. Arrange the selective voltmeter to track the signal source frequency. Record the measurement results, taking into account the variation in sensitivity that occurs with changing frequency. Plot the frequency response relative to 1 kHz.

- (8) Set the signal source as in step (5). Position the probe in a radial orientation at 16 mm from the measurement axis. Move the probe in a radial direction away from measurement axis. Record the maximum voltage observed.
- (9) Repeat step (8) to obtain a total of four measurements, each separated by 90 degrees around the circumference of the receiver.

5. Telephone Receive Volume Control

5.1 Requirements

An analogue, digital or IP-based telephone set shall be equipped with a receive volume control that provides, through the receiver in the handset of the telephone, 12 dB of gain (minimum) and up to 18 dB of gain (maximum.) The 18 dB of receive gain may be exceeded provided that:

- (1) the amplified receive capacity automatically resets to the measured (nominal) level when the telephone is caused to pass through a proper on-hook transition in order to minimize the likelihood of damage to individuals with normal hearing; or
- (2) the maximum gain of 18 dB in the handset of the telephone may be exceeded, without automatic volume reset, using an override switch located on the equipment in such a way as to not be accessible to accidental engagement. Clear labelling near the override switch and a caution note printed in the user manual shall be required to observe safe operating practices. This switch shall also enable a bright indicator light, prominently displayed on the front of the telephone, with an accompanied printed notification of high amplification present at the handset receiver. A printed warning message in braille shall be supplied for visually impaired persons. The message shall be capable of securely attaching to the back of the handset to indicate that a high-volume setting may be engaged.

The unamplified receiver level shall comply within the defined limits and be evaluated using a Receiver Objective Loudness Rating (ROLR), as required by ANSI/EIA/TIA-470-B-1998 for analogue telephones, or Receiver Loudness Rating (RLR) ANSI/EIA/TIA-579-1998 for digital and IP-based telephone sets. No variation in loop conditions is required for digital and IP-based telephones since the receive level of these telephones is independent of loop length.

Loop conditions for analogue telephones are defined as follows:

- (1) zero loop of 26 AWG non-loaded cables or equivalent (52.5 Vdc, 400 ohms), with a nominal ROLR value of +46 dB, within a permissible range of +41 dB to +51 dB;
- (2) medium loop, 2.7 km, of 26 AWG non-loaded cables or equivalent (52.5 Vdc, 1200 ohms), with a nominal ROLR value of +48 dB, within a permissible range of +43 dB to +53 dB;
- (3) maximum loop, 4.6 km, of 26 AWG non-loaded cables or equivalent (42.5 Vdc, 1740 ohms), with a nominal ROLR value of +50 dB, within a permissible range of +45 dB to +55 dB.

For digital telephone sets, the nominal ROLR value is +48.5 dB, within a permissible range of +43.5 to +53.5 dB.

Gain at the receiver is evaluated by comparing additional loudness rating measurement(s) for any given volume control setting(s), provided that no clipping of the signal has occurred.

Note: (a) Although the receive volume control requirement is described in terms of ROLR in IEEE 661-1979 (R1998), current industry standards TIA-470.110-C and TIA-810-B have shifted to measuring receive loudness in terms of Receive Loudness Rating (RLR) as defined by ITU-T Recommendation p.79. Annex G of TIA-470.110-C provides the following relationship between these two loudness rating measures:

$$\text{ROLR (IEEE 661)} = \text{RLR (ITU-T p. 79)} + 51 \text{ dB}$$

(b) The receive gain measurements apply to telephone sets that are fully operational. They do not apply during AC power failure if a telephone set is designed to operate with AC-adapter powering.

5.2 Method of Measurement

5.2.1 Analogue Telephones

- (1) With the volume control in the unamplified or off setting, place the telephone receiver in the Type 3.3 artificial ear using the high leak condition specified in ANSI/TIA-470.110-C, and connect the telephone set to the circuit interface as shown in Figure 5.0. Alternatively, the Type 1 artificial ear may be used if a seal can be achieved between the handset and the artificial ear without the use of sealing putty or similar materials.
- (2) Configure the artificial line and battery for zero loop conditions.
- (3) Using a signal source, sweep the frequency range logarithmically from 200 to 4000 Hz. The sweep rate is to be such that one complete transverse of the 200 to 4000 Hz band requires approximately 8 to 10 seconds. The generator output is to be adjusted to an open circuit voltage of 0.316 volts (i.e. -10 dB relative to 1 volt) from a 900 ohm source. The electric source and the measurement circuit should have the capability of operating linearly up to a level of approximately 1 volt.
- (4) The ROLR of the telephone under test is to be determined by first measuring the receive frequency response according to IEEE 269-2002. The ROLR is then calculated from the measured frequency response as specified in IEEE 661-1998. Perform an ROLR measurement and record the unamplified receive level. Verify that the measured ROLR is within the permissible range at zero loop.
- (5) Place the volume control to its maximum setting. Perform an ROLR measurement and record the maximum receive level.
- (6) Calculate the gain by subtracting the maximum ROLR value from the unamplified ROLR value.

(7) If the calculated gain is greater than 18 dB, place the telephone in the on-hook mode, go off hook and verify that the volume resets to the unamplified measured (nominal) level, or check for an override switch with the appropriate visual indicator and printed messages, accompanied by a warning message in braille.

(8) Repeat steps (3) to (7) for 2.7 km and 4.6 km loop lengths.

5.2.2 Digital Telephones

(1) With the volume control in the unamplified or off setting, place the telephone receiver in the Type 3.3 artificial ear using the high leak condition specified in TIA-810-B, and connect the telephone set to the circuit interface as shown in Figure 5.0. Alternatively, the Type 1 artificial ear may be used if a seal can be achieved between the handset and the artificial ear without the use of sealing putty or similar materials.

(2) Configure the Encoder/Decoder to be capable of encoding or decoding signals with zero loss.

(3) Using a signal source, sweep the frequency range logarithmically from 200 to 4000 Hz. The sweep rate is to be such that one complete transverse of the 200 to 4000 Hz band requires approximately 8 to 10 seconds. The signal source is to be adjusted to produce an equivalent acoustic level to analogue sets (nominal +0 dBPa) with the receive volume control set to its nominal gain. The electric source and the measurement circuit should have the capability of operating linearly up to a level of approximately 1 volt. When testing digital telephones (e.g. VoIP telephones), because of the packet delay (generally ranging from 100 ms to 300 ms) in the digital network, the test signal from the signal source should be long enough for the measuring amplifier and the level recorder to capture the maximum readings at each of the measuring frequencies.

(4) The ROLR of the telephone under test is to be determined by first measuring the receive frequency response according to IEEE 269-2002. The ROLR is then calculated from the measured frequency response as specified in IEEE 661-1998.

(5) Place the volume control to its maximum setting. Perform an ROLR measurement and record the maximum receive level.

(6) Calculate the gain by subtracting the maximum ROLR value from the unamplified ROLR value.

(7) If the calculated gain is greater than 18 dB, place the telephone in the on-hook mode, go off hook and verify that the volume resets to the unamplified measured (nominal) level, or check for an override switch with the appropriate visual indicator and printed messages, accompanied by a warning message in braille.

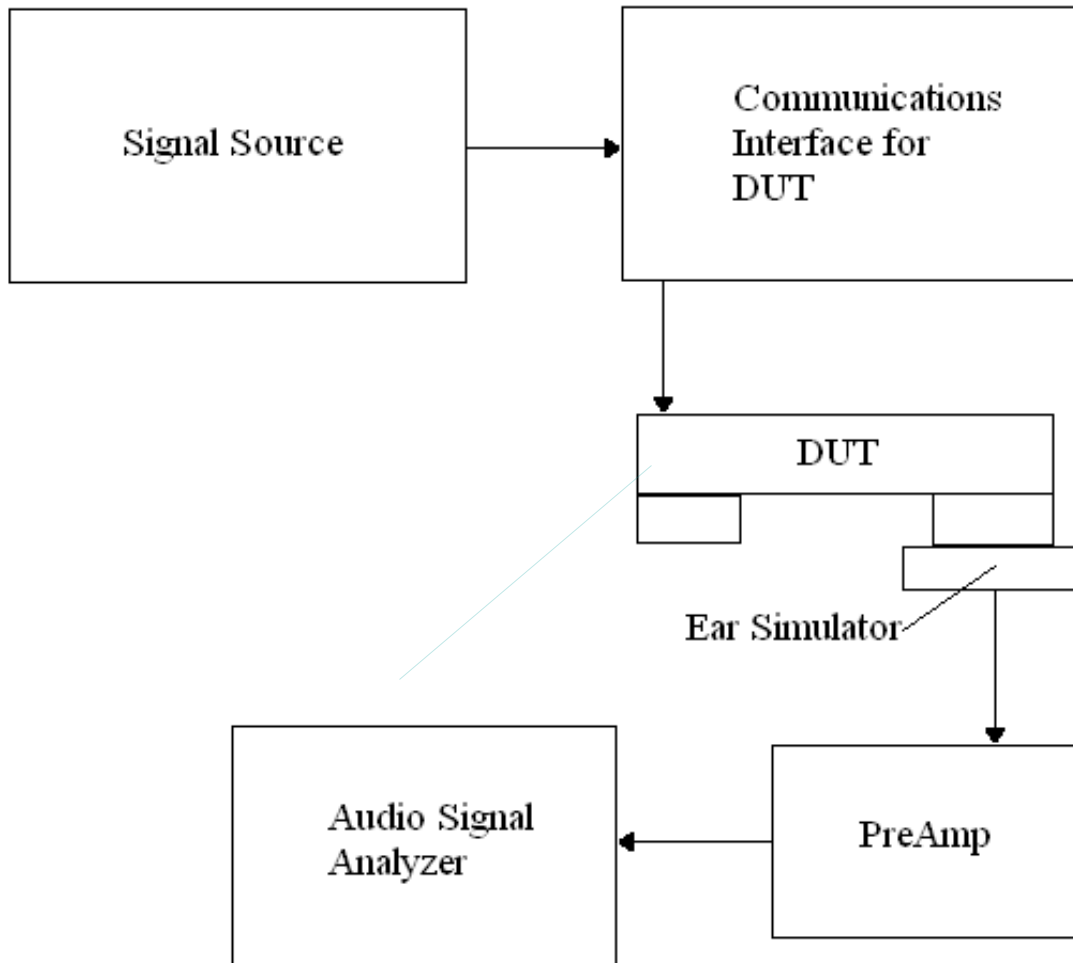


Figure 5.0

Receive Volume Control Measurement (ROLR)