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GUIDELINES FOR TECHNICAL ACCEPTANCE OF RADIOTELEPHONE TRANSMITTERS AND RECEIVERS USING AMPLITUDE COMPANDORED SINGLE SIDEBAND (ACSB) IN THE FREQUENCY RANGE 27.41 TO 470 MEGAHERTZ

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TELECOMMUNICATION REGULATORY SERVICE

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GUIDELINES FOR TECHNICAL ACCEPTANCE OF RADIOTELEPHONE TRANSMITTERS AND RECEIVERS USING AMPLITUDE COMPANDORED SINGLE SIDEBAND (ACSB) IN THE FREQUENCY RANGE 27.41 TO 470 MEGAHERTZ

1.0 INTENT

1.1 This document prescribes the minimum requirements for the technical-acceptance certification of radiotelephone transmitters and receivers using amplitude compandored single sideband (ACSB) techniques in the frequency range 27.41 MHz to 470 MHz.

1.2 Transmitters and receivers certified as technically acceptable under Radio Standards Procedure 100 using these guidelines may be considered technically suitable for licensing pursuant to the Radio Regulations made under the Radio Act.

2.0 GENERAL

2.1 Anyone seeking technical acceptance certification of radio equipment using these guidelines shall satisfy the Department at his own expense that the equipment actually meets the requirements of these guidelines.

2.2 Notwithstanding the fact that a particular radio equipment has been certified as technically acceptable using the requirements of these guidelines, the Department reserves the right to require that adjustments be made to that equipment if it causes interference within the meaning of the Radio Act.

2.3 These guidelines include minimum technical requirements for certification of amplitude-compandored single sideband (ACSB) equipment. Certain users may wish to specify additional requirements to meet specific applications using ACSB equipment. Also, equipment utilizing in-band signalling or low data rate in-band information transfer as additional features to voice transmission will be considered under these guidelines for technical acceptance.

The transmission characteristics for various types of ACSB equipment are not necessarily identical and therefore may not necessarily be compatible. The Department does not, by means of these guidelines, endorse any particular transmission characteristics. However, the tests and methods of measurement included in these guidelines have been based on a specific set of transmission characteristics as specified below. Other variations of these characteristics are also acceptable, and the methods of measurement for any test and minimum performance standard in these guidelines may require appropriate modification in these cases. All equipment submitted for technical acceptance certification must comply with the minimum requirements under paragraphs 7.1, 7.3, 9.7, 9.8, 9.9 and 9.10 contained herein. If the methods of measurement require change, the applicant will be required to prove to the satisfaction of the Department that the methods of tests employed ensure that such minimum requirements are met.

SPECIFIC TRANSMISSION CHARACTERISTICS USED FOR GUIDELINES

a) Upper Sideband transmission
b) Pilot tone at 3.1 kHz above the suppressed carrier
c) 12 dB pre-emphasis
d) 12 dB de-emphasis
e) 4:1 compression
f) 4:1 expansion
g) Pilot pumping

Examples - 1. To test an equipment which does not use a pilot tone as specified above or as stated in paragraph 4.4, an appropriate two-tone test modulation should be used for standard test modulation. The applicant shall provide full details and descriptions to substantiate the choice of tone frequencies used.

2. To test an equipment which uses 6 dB pre-emphasis, the appropriate curve shall be used in place of figure 2.

2.4 The Department reserves the right to revise these Guidelines.

3.0 RELATED DOCUMENTS

3.1 RADIO STANDARDS PROCEDURE 100: Procedure to obtain technical-acceptance certification of equipment.

4.0 EQUIPMENT REQUIREMENTS

4.1 EQUIPMENT IDENTIFICATION: The serial number of the transmitter, the name, the type of unit, the manufacturer's name, the country of manufacture, the technical acceptance number, as well as any other information required to identify the equipment shall be stamped on each transmitter chassis or on a nameplate permanently fastened to the chassis. The transmitter power output rating shall also be included, unless it appears on the nameplate of the overall equipment assembly of which the transmitter forms a part.

4.2 TRANSMITTER POWER OUTPUT CONTROLS: Operator controls shall not permit operation at power levels greater than that permitted by the licence.

4.3 SIDEBAND EMITTED: Only the upper sideband shall be emitted.

4.4 PILOT FREQUENCY: The transmitted RF shall contain a pilot frequency at the upper edge of the sideband, outside the audio band.

4.5 PRE-EMPHASIS: The transmitter modulating frequencies shall be subject to pre-emphasis. The receiver shall contain suitable de-emphasis.

4.6 COMPANDING: The transmitter modulating frequencies shall be subject to compression. The receiver shall contain suitable expansion.

4.7 PUMPING: The level of the pilot frequency may decrease as the transmitter power increases.

5.0 STANDARD TEST CONDITIONS AND DEFINITIONS

5.1 GENERAL: Standard test conditions are those conditions under which the equipment shall be operated while it is being tested for minimum requirements. These conditions apply, unless otherwise specified.

5.1.1 STANDARD OPERATING CONDITIONS:

5.1.2 GENERAL: Except as specified below, the equipment shall be operated in accordance with the manufacturer's published instructions and in the case or cabinet supplied, where this is essential to the performance of the equipment.

5.1.3 RECEIVER: For all tests the receiver external control shall be unsquelched to the maximum extent.

5.1.4 Associated Equipment: Associated equipment shall be that normally used with the transmitter and/or receiver. Standard test conditions shall apply also to any necessary associated equipment.

5.2 STANDARD TEST VOLTAGE: Standard Test Voltage shall be within $\pm$ 2% of the value stated by the manufacturer to be the normal working voltage. It shall be measured at the point of power connection to the equipment. For equipment powered by a battery, the test voltage shall be as provided by the type of battery or batteries normally supplied with the equipment. When an external power supply is used in lieu of the equipment battery during any testing, the voltge shall be set to $\pm$2% of the nominal battery voltage. A low impedance, dynamically regulated, laboratory type power supply shall be used for such testing.

5.3 WARM-UP PERIOD: The equipment may have a 15 minute warm-up period under standby conditions prior to all tests, except where otherwise specified.

5.4 STANDARD ATMOSPHERIC CONDITIONS: Tests shall be conducted under ambient conditions of atmospheric pressure and humidity at a temperature of 25°C ± 5°C.

5.5 SUPPRESSED CARRIER FREQUENCY (F_s): Is that radio frequency which results in a frequency of zero Hertz when the single sideband signal is demodulated. In the AM technique the upper and lower sidebands are located symmetrically about the carrier frequency. Therefore when the signal is demodulated the carrier frequency will be the origin i.e. zero Hertz.

5.6 ASSIGNED FREQUENCY (F_a): Is 1.8 KHz above the suppressed carrier frequency.

5.7 PILOT FREQUENCY (F_p): Is defined as equal to the suppressed carier frequency plus an audio frequency at the upper edge, but outside the audio passband of the transceiver.

5.8 STANDARD MODULATING FREQUENCY: Shall be 1000 Hertz, with proper coupling and matching to the receiver input.

5.9 STANDARD TEST FREQUENCY (F_t): Is that radio frequency which results in a frequency of 1000 Hz when the ACSB signal is demodulated. It is equal to the suppressed carrier frequency plus 1000 Hertz.

5.10 STANDARD ANTENNA INPUT/OUTPUT TERMINATION: Shall be 50 ohms resistive. If the termination is other than 50 ohms resistive, the manufacturer shall supply a suitable impedance matching network to change the impedance to 50 ohms resistive. Full specifications of this netowrk shall be supplied by the manufacturer.

5.11 STANDARD AUDIO OUTPUT TERMINATION: The standard audio output termination of the receiver shall be specified by the manufacturer or equipment certification applicant.

5.12 RECEIVER STANDARD INPUT SIGNAL SOURCES: shall be 50 ohms resistive.

5.13 INTERCONNECTION OF SIGNAL GENERATORS FOR MULTIPLE SINGLE TESTS: When it is necessary to couple two or more signal generators to a reciever, a combining network shall be used such that each signal generator shall see a matched load when the output of the network is matched to the nominal input impedance of the receiver. Account shall be taken of losses in the combining and/or matching networks to establish the signal levels delivered to the receiver. The effect of intermodulation products and noise generated within the signal generators and combining networks shall not affect the measurement accuracy.

5.14 PEAK ENVELOPE POWER (PEP): Is the average power delivered by the transmitter during one radio frequency cycle at the highest crest of the modulation envelope. For a two frequency situation involving the standard test frequency and the pilot frequency, if the former has a level of P_t dBW and the latter P_p dBW, then

$PEP = 20 \log_{10} ([V_t + V_p]/\sqrt{Z_o})$

where RMS Voltages V_t and V_p are defined by

$P_t = 10 \log_{10} (V_t^2/Z_o)$

$P_p = 10 \log_{10} (V_p^2/Z_o)$

and Z_o = 50 ohms resistive

Values of PEP can be derived from Pt and Pp using the appropriate value of Δ tabulated below.

Values of Δ as a function of $|P_t - P_p|$

$\|P_t-P_p\|$ (in dB)	Δ (in dB)	$\|P_t-P_p\|$ (in dB)	Δ (in dB)
0	6.0	10	2.4
1	5.5	11	2.2
2	5.1	12	1.9
3	4.6	13	1.8
4	4.2	14	1.6
5	3.9	15	1.4
6	3.5	16	1.3
7	3.2	17	1.1
8	2.9	18	1.0
9	2.6	19	0.9

From $|P_t - P_p|$ read off value of Δ

for: $P_t \geq P_p$, $PEP = P_t + \Delta$

for: $P_p > P_t$, $PEP = P_p + \Delta$

5.15 STANDARD TEST FREQUENCY TO PILOT RATIO: Is the ratio in dB of the standard test frequency to the pilot frequency at the transmitter output terminals when the transmitter is operating at rated PEP.

5.16 STANDARD TWO FREQUENCY TEST SIGNAL: Is a radio signal containing both the standard test frequency and the pilot frequency with their relative levels given by the standard test frequency to pilot ratio. The level of this signal shall be defined in terms of the level of the pilot frequency.

5.17 DUTY CYCLE: Transmitter rated duty cycle shall be designated by the manufacturer as either continuous, semi-continuous, or intermittent, in accordance with one of the following test conditions:

a) Continuous - Transmitter operated continuously for 24 hours

b) Semi-continuous - Transmitter operated continuously for eight hours.

c) Intermittent - Transmitter operated under a cycle of one minute "on" (Transmit) and four minutes "off" (stand by) for a period of eight hours followed by three test cycles of five minutes "on", fifteen minutes "off".

6.0 ENVIRONMENTAL TEST CONDITIONS

6.1 TOLERANCES - Environmental test conditions shall be maintained within the following tolerances:

a) Temperature: ±3°C

b) Voltage: ±2%

c) Stabilization - For the purpose of these tests the test sample temperature shall be considered stabilized when it has been exposed to a controlled temperature for a period of at least two hours.

6.2 ENVIRONMENTAL TEST CONDITION RANGES

(a) Self contained equipment.
Temperature: -10°C to +40°C

(b) Equipment, including portable, intended for use with external power supplies.
Temperature: -30°C to +60°C.
Voltage: ±10% of standard test voltage.

6.2.1 Equipment with Self-Contained Batteries

(a) During environmental tests it shall be permissible to substitute an external voltage source. In these cases the batteries may be disconnected, but not removed.

(b) When tested with an external power supply, the equipment shall be operated under the conditions applicable to externally powered equipment.

7.0 TRANSMITTER TESTS UNDER STANDARD TEST CONDITONS

7.1 RATED PEAK ENVELOPE POWER

7.1.1 Definition: The rated peak envelope power (PEP) of the transmitter is the peak power delivered to the standard antenna output termination during operation at the rated duty cycle and under those conditions of operation consistent with the intermodulation distortion product limitations specified in paragraph 7.1.2 below.

7.1.2 Method of Measurement: The transmitter shall be set up to operate into a 50 ohms load (paragraph 5.10) at the appropriate duty cycle (paragraph 5.17) and adjusted for operation according to the manufacturer's instructions. The standard modulating frequency (paragraph 5.8) shall be connected to the transmitter input terminals and, while simultaneously monitoring the transmitter RF output signal on a spectrum analyser the modulating amplitude shall be increased until either one of the odd order intermodulation products of the standard test frequency and pilot frequency is 32 dB below the PEP level (See paragraph 5.14) or the transmitter PEP is equal to that specified by the manufacturer whichever comes first. The value of PEP obtained shall be recorded and the means of measurement shall be stated in the test report. No further adjustments shall be made to the transmitter or the test set-up. The transmitter shall be operated at the manufacturer's rated duty cycle for the appropriate test time (paragraph 5.17) and the RF power output shall be monitored continuously during the test period.

7.1.3 Minimum Performance Standard: Manufacturer's specification of rated PEP shall not be higher than the value measured under the conditions of paragraph 7.1.2.

7.2 CARRIER LEVEL

7.2.1 Definition: The carrier level is the ratio in dB of the power of the carrier to rated PEP at the output of the transmitter.

7.2.2 Method of Measurement: The standard modulating frequency shall be applied to the transmitter input at a level to produce rated PEP. A sample of the transmitter output signal shall be coupled to a spectrum analyser and the level of the carrier measured relative to the rated PEP, see paragraph 5.14. In this test a spurious signal is produced between the 1 KHz tone and pilot. This spurious signal, together with the 1 KHz tone can produce an intermodulation product at the carrier frequency which may falsify the reading of the suppressed carrier level. The test should be repeated with at least 2 other frequencies, e.g. 750 and 1250 Hz.

This test would be easier to perform if a push button is provided to transmit the pilot at rated PEP. In this case there would be no ambiguity with respect to the carrier.

7.2.3 Minimum Performance Standard: The level of the carrier shall be attenuated at least 45 dB relative to the rated PEP.

7.3 SPURIOUS EMISSIONS

7.3.1 Definition: Spurious emissions are emissions at any frequency outside the band necessary to ensure the adequate transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, and intermodulation products which are remote from the immediate vicinity of this band.

7.3.2 Method of Measurement: The measurement set up shall be as in paragraph 7.1.2. The level of the standard modulating frequency shall be adjusted to produce rated PEP. The level of the standard modulating frequency shall then be increased by 10 dB.

7.3.2.1 Test A: Emissions in the Frequency Range Fs-6 Khz to Fs + 10 Khz

All emissions in the frequency range F_s -6 Khz to F_s + 10 Khz shall be measured (relative to the developed PEP) and recorded.

7.3.2.2 Test B: Emissions Outside the Band of 7.3.2.1

The output frequency spectrum shall be searched from 10 kHz frequency up to 1000 Mhz. All significant spurious outputs outside the range F_s - 6 Khz to F_s + 10 Khz shall be identified, measured (relative to the developed PEP) and recorded.

7.3.3 Minimum Performance Standards

7.3.3.1 Under test A above, no emission shall be in the cross-hatched area of Figure 1.

7.3.3.2 Under Test B above, no spurious emissions shall exceed -16 dBm (25 microwatts).

7.4 HUM AND NOISE LEVEL

7.4.1 Definition: The hum and noise level of the transmitter is defined as the ratio of the level of the demodulated output under conditions of standard test modulation, to the level of the demodulated output with no modulation applied, both measured with the same bandwidth.

7.4.2 Method of Measurement: The set-up for the measurement shall be as specified in paragraph 7.1.2. The standard modulating frequency shall be increased in amplitude until rated PEP as determined in paragraph 7.1.2 is achieved. The level of the standard modulating frequency as seen on the spectrum analyzer shall be determined and recorded. The modulating signal shall then be removed and the value of the highest signal level in the band from f_s to f_s + 3 kHz, excluding the pilot signal if present, shall be determined and recorded. For the purpose of this measurement, the spectrum analyzer resolution bandwidth (IF bandwidth) shall be a nominal 300 Hz. In the presence of noise, video filtering may be used to average the noise. All spectrum analyzer settings shall be recorded. If a nominal IF bandwidth other than 300 Hz is used due to test equipment constraints, then the equipment's IF bandwidth setting closest to 300 Hz shall be utilised.

7.4.3 Minimum Performance Standard: The highest signal level with no modulation applied shall be at least 34 dB below the standard modulating frequency level as determined on the spectrum analyzer.

7.5 TRANSMITTER AUDIO FREQUENCY RESPONSE

7.5.1 Definition: The transmitter frequency response is defined in terms of the degree of closeness to which the audio frequency response of the transmitter output follows the prescribed 12 dB per octave pre-emphasis characteristic over a specified continuous modulated frequency range.

7.5.2 Method of Measurement: The measurement set-up shall be as specified in paragraph 7.1.2. The input level of the 1000 Hertz standard modulating frequency shall be adjusted until the standard test frequency, as observed on the spectrum analyser, shall be equal in amplitude to the pilot frequency. The level of the standard modulating frequency shall be measured and recorded as the reference level. The modulating frequency shall then be varied over the frequency range 300 to 2800 Hertz and its level adjusted so that at, for any given frequency, the resultant output radio frequency is equal in amplitude to the pilot frequency. The level and frequency of the modulating signal, and the amplitude ratio of the modulating signal to the reference level signal shall be recorded. A sufficient number of measurements shall be made and recorded to plot a smooth curve on Figure 2. This plot shall be contained in the test report.

7.5.3 Minimum Performance Standard: The transmitter audio frequency response, when plotted shall not lie anywhere in the hatched areas of Figure 2.

7.6 AUTOMATIC LEVEL CONTROL

7.6.1 Definition: The automatic level control is the ability of the equipment to ensure that the transmitted power does not substantially exceed the rated PEP.

7.6.2 Method of Measurement: The measurement set-up shall be as in paragraph 7.1.2. The level of the standard modulating frequency shall be adjusted to produce rated PEP. Its level shall then be increased by 10 dB. The developed PEP shall be noted and recorded.

7.6.3 Minimum Performance Standards: The developed PEP shall not exceed the rated PEP by more than 1 dB.

7.7 COMPRESSION FACTOR

7.7.1 Definition: Compression is used to reduce the dynamic range of the speech signal, allowing it to be transmitted undistorted through a noisy channel; by using compandoring techniques the capture effect is similar to that found in FM reception. Compandoring is performed in the transmitter by audio amplitude compression shaping of speech to bring up the amplitude of weak sounds of words and bring down the amplitude of the strong sounds of words. The reverse occurs in the compandored receiver unit where the original audio is recovered by expansion.

7.7.2 Method of Measurement:

Step 1: The standard modulating signal shall be applied to the transmitter input until rated PEP as determined in paragraph 7.1.2 is achieved. The modulating signal shall then be reduced until the transmitter PEP is reduced by 1 dB from the previous level. A sample of the transmitter output signal shall be coupled to a spectrum analyser and the level of the standard test frequency (F_t) and the level of the Pilot frequency (F_p) shall be measured relative to the rated PEP (paragraph 5.14) and their values, expressed in decibels recorded. These levels will be respectively called the standard test frequency level at reduced PEP and the Pilot frequency level at reduced PEP.

Step 2: The level of the standard modulating signal shall then be decreased by 12 decibels. The level of the standard test frequency and the level of the Pilot Frequency shall be measured relative to the rated PEP (paragraph 5.14) and the value of each, expressed in decibels, recorded. These levels will be respectively called the standard test frequency level at -12dB and the Pilot Frequency level at - 12dB.

Step 3: The Audio Compression factor is given by the following ratio: 12 divided by the difference between the level of the standard test frequency at reduced PEP and the level of the standard test frequency at - 12dB, and shall be recorded.

7.7.3 Minimum Performance Standards:

The compression factor shall be 4 $\pm$ 1. If there is difficulty meeting this requirement, repeat the test as in paragraph 7.7.2 by taking the output up to rated PEP and then reduce the output by 2 dB vice 1 dB.

7.8 PILOT FREQUENCY LEVELS (Pumping Action)

7.8.1 Definition: The pumping action is defined by the amount of change in the pilot levels at the output of the transmitter when the standard modulating signal, applied to the input of the transmitter, is varied from zero (no modulation) to a level that produces rated PEP.

7.8.2 Method of Measurement

The standard modulating signal shall be applied to the transmitter input until rated PEP as determined in paragraph 7.1.2 is achieved. A sample of the transmitter output signal shall be coupled to a spectrum analyser and the level of the standard test frequency (F_t) and the level of the Pilot frequency (F_p) shall be measured relative to the rated PEP (paragraph 5.14) and their values, expressed in decibels recorded. These levels will be respectively called the standard test frequency level at rated PEP and the Pilot frequency level at rated PEP. The level of the standard modulating signal is then decreased to zero (no modulation). The level of the Pilot frequency at the transmitter output shall then be measured relative to the rated PEP (paragraph 5.14) and its value, expressed in decibels, recorded.

7.8.3 Minimum Performance Standard:

a) The pilot frequency level, when no modulation is applied to the input of the transmitter, shall be between 3 and 10 dB below the rated PEP.

b) The pilot frequency level at rated PEP shall be more than 12 dB below the rated PEP.

7.9 STANDARD TEST FREQUENCY TO PILOT RATIO

7.9.1 Definition: The standard test frequency to pilot ratio is the level ratio in dB of the standard test frequency to the pilot frequency at the transmitter output terminals when the transmitter is delivering rated PEP.

7.9.2 Method of Measurement: The measurement set-up described in Paragraph 7.8.2 was used to find the pilot frequency level at rated PEP and the standard test frequency level at rated PEP. Their ratio, expressed in decibels with reference to the pilot frequency level at rated PEP, shall be recorded.

Reference level: The test frequency to pilot relative level measured under paragraph 7.9.2 is the standard test frequency to pilot ratio that shall be used in subsequent sections of the receiver performance specification.

8.0 TRANSMITTER TESTS UNDER ENVIRONMENTAL CONDITIONS

8.1 Operational Performance

8.1.1 Definition: Operational Performance denotes the ability of the transmitter to operate with no more than a specified amount of degradation in performance under the specified extremes of temperature and supply voltage.

8.1.2 Methods of Measurement

8.1.2.1 Standard Test Voltage, +25°C: The transmitter shall be placed in an environmental test chamber and allowed to stand inoperative until its temperature has stabilized at 25°C (paragraph 6.1). At the end of the temperature stabilization period, standard test voltage shall be applied to the transmitter and fifteeen minutes allowed for warmup. The transmitter shall then be operated by applying the standard modulating frequency to the transmitter input at a level to produce an output RF level of 6 dB below the rated PEP. The output level, standard test frequency and the pilot frequency shall be measured at one-minute intervals over one-hour period for transmitters with a continuous or semi-continuous duty cycle rating. For transmitters with intermittent duty cycle rating the frequencies shall be measured at one-minute intervals during three cycles of five minutes "on" and fifteen minutes "off".

8.1.2.2 Measurement under Temperature and Voltage Extremes

a) Low Temperature, Low Voltage - The transmitter shall be placed in an environmental test chamber at -10°C for self contained equipment and -30°C for other equipment as defined in paragraph 6.2. It shall be allowed to stand inoperative until its temperature has stabilized (paragraph 6.1) The transmitter shall then have primary power applied and allowed a fifteen minute warmup under stand-by conditions. Following this warmup period, the transmitter shall be operated (as in paragraph 8.1.2.1) with the primary voltage decreased to 90% of standard test voltage, and its output frequencies shall be measured and recorded during a five minute period. The R.F. power output shall be monitored during a one-minute period, and the measured values recorded.

b) Low temperature, High Voltage - This test shall follow immediately after test 8.1.2.2(a). The transmitter shall be operated as above with its primary voltage increased to 110% of standard test voltage. The output frequencies shall be measured during a five-minute period and the R.F. power output shall be monitored during a one-minute period and the measured value recorded.

c) High temperature, Low Voltage - The environmental test chamber shall be set to +40°C for self contained equipment and +60°C for other equipment as defined in paragraph 6.2. The transmitter shall be operated as above, in the chamber, at the appropriate duty cycle during the complete stabilization period (paragraph 6.1). At the end of the stabilization period, the primary voltage shall be decreased to 90% of standard test voltage. The frequencies shall be measured during a five-minute period and the R.F. power output monitored during a one-minute period and the measured values recorded.

d) High Temperature, High Voltage - This test shall follow immediately after test (c). The transmitter shall be operated with primary voltage increased to 110% of standard test voltage. The frequencies shall be measured during a five-minute period and the

R.F. power output monitored during a one-minute period and the measured values recorded.

8.1.3 Minimum Performance Standards Under Environmental Conditions

8.1.3.1 a) The measured standard test frequency shall not depart from that value specified in paragraph 5.9 by more than ±600 Hz.

b) The change in the difference between the measured standard test frequency and the measured pilot frequency shall lie in the range of ±20 Hz.

c) The RF output level shall not degrade to more than 9 dB below the rated PEP.

9.0 RECEIVER PERFORMANCE UNDER STANDARD TEST CONDITIONS

9.1 REFERENCE AUDIO OUTPUT POWER

9.1.1 Definition: The reference audio output power of the receiver is the audio output power it shall deliver to the standard output termination without exceeding a specified level of distortion when responding to a specified RF signal input.

9.1.2 Method of Measurement: The standard two-frequency test signal shall be applied to the antenna input of the receiver. The pilot level of the standard two-frequency test signal shall be set to -50 dBm (by definition the standard test frequency level shall be set accordingly to the standard test frequency to pilot ratio as determined under paragraph 7.9.2). The standard test frequency shall be adjusted to produce a receiver audio output signal frequency of 1000 Hz. The audio level control of the receiver shall be adjusted so that the receiver delivers the maximum audio power output without exceeding 10% distortion, or the manufacturer's specified maximum power level, whichever is less. The audio output power shall be measured and recorded.

Reference level: The audio output power measured under paragraph 9.1.2 is the reference audio output power that shall be used in subsequent sections of this specification.

9.2 SENSITIVITY

9.2.1 Definition: The sensitivity of a receiver is the minimum pilot level of the standard two-frequency test signal at the receiver input which shall produce a (signal + noise + distortion) to (noise + distortion) ratio (SINAD) of 12 dB and at least 50% of reference audio power output.

9.2.2 Method of Measurement: The set-up for the measurement shall be as in paragraph 9.1.2. With the audio level control adjusted for reference audio power, the standard two-frequency test signal will be equally attenuated (maintaining the standard test frequency to pilot ratio) to the minimum level which shall simultaneously satisfy both conditions of a 12 dB SINAD and at least 50% of reference audio output power without re-adjustment of the audio level control. In the event that 50% of reference audio power is not attainable at a SINAD of 12 dB, the attenuation of the standard two frequency test signal shall be reduced to obtain the 50% value. The SINAD and the level of the pilot frequency of the standard two-frequency test signal shall be measured and recorded.

9.2.3 Minimum Performance Standard: The pilot frequency level at the input of the receiver shall be not more than -110 dBm.

9.3 AUTOMATIC FREQUENCY CONTROL LIMITS

9.3.1 Definition: The automatic frequency control limits are the upper and lower frequency limits relative to the pilot frequency within which the automatic frequency control is operative.

9.3.2 Method of Measurements: The set-up for the measurement shall be as in paragraph 9.1.2. The audio level control shall be adjusted for reference audio power level output. The pilot frequency of the standard two-frequency test signal shall be the reference frequency. While maintaining the same frequency difference between the two frequencies of the standard two-frequency test signal, both frequencies of the test signal shall be slowly decreased (in frequency) until the reference audio output power falls by at least 20 dB and remains at this level for at least 10 seconds. The frequency difference between this frequency and the reference frequency shall be the lower AFC limit and shall be recorded. The procedure shall be repeated to find the upper AFC limit.

9.3.3 Minimum Performance Standards: The AFC limit shall be not greater than twice the limits for the measured standard test frequency of paragraph 8.1.3.1(a), viz ±1200 Hz.

9.4 AUTOMATIC GAIN CONTROL

9.4.1 Definition: The automatic gain control characteristic is the change in audio output power as the radio frequency input level is varied over a specific range.

9.4.2 Method of Measurement: The set-up for the measurement shall be as specified in paragraph 9.1.2 with the level of the pilot frequency set at -10 dBm. The receiver audio level control shall be adjusted so that the receiver audio output does not exceed 10% distortion when the RF input is adjusted as described below. The standard two-tone test frequency level, as defined by the level of the pilot frequency, shall be varied from -110 dBm to + 0 dBm, and the audio output power shall be measured and recorded.

9.4.3 Minimum Performance Standards: The audio power shall not vary more than 10 dB for input signals from -90 dBm to -10 dBm and not more than 20 dB for input signals from -110 dBm to + 0 dBm.

9.5 RECEIVER AUDIO FREQUENCY RESPONSE

9.5.1 Definition: The audio frequency response is defined in terms of the degree of closeness to which the frequency deviation of the audio output follows the prescribed 12 dB per octave de-emphasis characteristics over a specified continuous frequency range.

9.5.2 Method of Measurement: The set-up for the measurement shall be as specified in paragraph 9.1.2, with the pilot tone frequency level set to -50 dBm. The receiver audio level control shall be adjusted so that the receiver audio output does not exceed 10% distortion when the RF frequency is changed as described below. This audio power level shall be the reference level at 1000 Hz. The level control shall remain at this position throughout the measurements. The generator producing the 1000 Hz signal of the standard two-frequency test signal shall then be adjusted to vary its frequency, but not its level, over the range 300 Hz to 2800 Hz in 100 Hz steps. At each frequency setting the receiver audio power shall be measured and its ratio, expressed in dB with reference to the reference level shall be recorded and plotted on Figure 2. This plot shall be retained in the test report.

9.5.3 Minimum Performance Standard: The audio frequency response, when plotted, shall not be anywhere in the hatched area of Figure 2.

9.6 EXPANSION FACTOR

9.6.1 Definition: This test verifies that the receiver has an expansion factor equivalent to the compression factor found in paragraph 7.7.

9.6.2 Method of Measurement: The standard two-frequency test signal shall be applied to the antenna input of the receiver. The pilot level of the test signal shall be set to -50 dBm. The audio level control of the receiver shall be adjusted so that the receiver delivers the reference audio output power (P1). The level of the pilot frequency shall then be increased by 3 dB, and, the level of the standard test frequency shall be decreased by 3 dB. The corresponding audio output power (P2) shall then be measured and recorded, and the ratio: $10\text{Log}_{10}(P1/P2)$ shall also be recorded.

The audio expansion factor is given by the following ratio:

[10Log_{10} (P1/P2)] divided by 3.

9.6.3 Mimimum Performance Standard: The ratio shall be equivalent to the compression factor.

9.7 TWO SIGNAL SELECTIVITY AND DESENSITIZATION CHARACTERISTICS

9.7.1 Definition: The two-signal selectivity and desensitization characteristics of a receiver are a measure of its ability to process a desired signal without exceeding a specified degradation of output in the presence of an undesired signal on a nearby frequency.

9.7.2 Method of Measurement: The output of three unmodulated R.F. signal generators shall be equally coupled to the input of the receiver through an impedance matching network which shall present a correct impedance match to the receiver input circuit and to the R.F. signal generators. With the output level of generator number 3 set at zero, generator number 1 and number 2 shall be adjusted as in para 9.2.2 above to produce 12 dB SINAD at the receiver output. Generator number 3 shall then be adjusted to a sufficient number of settings over the frequency range F_a + 5 kHz to plot a curve. At each frequency setting, the output level of generator number 3 shall be increased until the receiver SINAD ratio is reduced to 6 dB, or until the audio output power of the receiver is degraded by 3 dB, whichever occurs first. The corresponding output level of signal generator No. 3 shall be measured and recorded, and its ratio, expressed in decibels with reference to the output level of the standard test frequency shall also be recorded.

9.7.3 Minimum Performance Standard: The two-signal selectivity curve shall not lie anywhere in the cross-hatched areas of Figure 3.

9.8 SPURIOUS RESPONSE ATTENUATION

9.8.1 Definition: Spurious response attenuation is the ratio of the response to any undesired signal to its response at its resonant frequency.

9.8.2 Method of Measurement: The method of measurement described in section 9.7.2 shall be used. Signal generator 3 shall be unmodulated. A careful search shall be made for spurious responses by slowly tuning the frequency of the input signal (3) source over the frequency range from the lowest intermediate frequency of the receiver to 1000 megahertz, excluding the frequency band $F_a \pm 5$ kHz. Subharmonics of the resonant frequency of the receiver are also to be excluded in the search for spurious emissions. All spurious responses shall be identified by frequency and recorded. At each spurious response, signal generator No. 3 output level shall be increased until the SINAD is reduced to 6 decibels, or until the total audio output power of the receiver is reduced by 3 decibels, whichever event occurs first. The corresponding output levels of signal generators No. 3 shall be measured and recorded and their ratios, expressed in decibels with reference to the output level of the standard test frequency shall be recorded.

9.8.3 Mimimum Performance Standard: All spurious responses shall be attenuated by at least 70 dB.

9.9 INTERMODULATION SPURIOUS RESPONSE ATTENTUATION

9.9.1 Definition: Intermodulation spurious response attenuation of a receiver is its measured ability to process a desired standard-modulated signal at its resonant frequency, without exceeding a specified degradation of output in the presence of two undesired signals, at frequencies which are so separated from the desired signal and from one another that nth order mixing in the non-linear elements of the receiver may generate spectral components which are within the pass band of the receiver. This standard is concerned only with third order mixing of frequencies which are separated from the desired frequency and from one another by integral multiples of the standard channel spacing.

9.9.2 Method of Measurement: The procedure outlined below shall be followed:

Step 1: With the output of the receiver terminated in the standard output termination, 4 equivalent standard signal generators shall be equally coupled to the receiver input (see paragraph 5.10).

Step 2: With the output levels of signal generators No. 3 and No. 4 adjusted to zero, signal generators No. 1 and 2 shall be adjusted as described in Section 9.2.2 to produce 12 dB SINAD at the receiver output.

Step 3: Signal generator No. 3 shall then be adjusted to a frequency in the adjacent channel above the assigned frequency that would produce a 1.8 kHz audio output on that channel (i.e. frequency of the suppressed carrier of the assigned channel (F_s) + 1.8 kHz + the channel spacing 5 kHz), and signal generator No. 4 shall be adjusted to the next higher channel on a similar frequency (i.e. F_s + 1.8 kHz + 10 kHz).

Step 4: The output level of signal generators No. 3 and No. 4 shall be maintained equal and increased simultaneously until the SINAD is reduced to 6 decibels, or until the total audio output power of the receiver is reduced by 3 decibels, whichever event occurs first. The frequency of signal generator No. 4 shall be re-adjusted to produce a maximum degradation of SINAD before the required final output levels of signal generators No. 3 and No. 4 are established, measured, and recorded. The ratio of the output level of signal generator No. 3 (or No. 4) expressed in decibels with reference to the output level of the standard test frequency, is the intermodulation spurious response attenuation for the particular combination of undesired input signals used.

Step 5: The above procedure (Steps 2-4) shall be repeated with signal generators No. 3 and No. 4 adjusted to frequencies which are both above and below the suppressed carrier frequency of the receiver, as indicated in the following table:

SIGNAL GENERATOR FREQUENCIES				
TEST NO.	S.G. NO. 1 & NO. 2	TEST NO.	S.G. NO. 3	S.G. NO. 4
1 & 2	Para. 9.2.2.		F_s + 1.8 kHz	F_s + 1.8 kHz
		1	+ 5 kHz	+ 10 kHz
		2	- 5 kHz	- 10 kHz
3 & 4	Para. 9.2.2.		F_s + 1.8 kHz	F_s + 1.8 kHz
		3	+ 10 kHz	+ 20 kHz
		4	- 10 kHz	- 20 kHz

Step 6: All measurements shall be recorded and reported.

9.9.3 Minimum Performance Standard: All intermodulation spurious responses shall be attenuated by at least 60 dB.

9.10 ANTENNA CONDUCTED RECEIVER SPURIOUS EMISSIONS:

9.10.1 Defintion: Antenna conducted receiver spurious emissions are radio frequency output voltages generated within the receiver, which appear at the antenna terminals.

9.10.2 Method of Measurement: The receiver antenna terminals shall be terminated in, or impedance matched to, a spectrum analyzer or frequency selective voltmeter whose nominal input impedance is 50 ohms resistive. Depending on the number of channels available, the receiver shall be operated in the normal receiver mode on at least three channels, one near the mid-point and the others approximately 10% inside the upper and lower extremities of the band over which the receiver is designed to operate. At each frequency of operation the output shall be searched by carefully tuning the spectrum analyzer or frequency selective voltmeter over the range from the lowest intermediate frequency (IF) generated in the receiver, to three times its operating frequency, or to 1000 megahertz, whichever is higher. All detected outputs shall be investigated and those within 20 dB of the permissible level shall be identified by frequency, measured and recorded. If the receiver incorporates a scanning mode of operation, the above procedure shall be repeated with the receiver operating in the scanning mode.

9.10.3 Minimum Performance Standard: Radio frequency output power at the antenna terminals at any discrete frequency shall not exceed -57 dBm (2000 picowatts) (316 microvolts across 50 ohms).

Note: The radio frequency output power for Hand-Held Radio Units with self contained batteries shall not exceed -53 dBm (5000 picowatts) (500 microvolts across 50 ohms).

9.11 RECEIVER LOCK RANGE

9.11.1 Definition: The lock-in range is defined as the frequency range over which a received signal at the 12 dB SINAD sensitivity level can be locked onto by the receiver.

9.11.2 Method of Measurement: The set-up for the measurement shall be as in paragraph 9.1.2 except that the test frequency to pilot ratio shall be maintained at 10 dB. The audio level control for the receiver shall be adjusted for reference audio power. Throughout the rest of this test, the standard two-frequency test signal will be equally attenuated (maintaining the test frequency to pilot ratio of 10 dB) and the frequency difference between the two frequencies of the standard test signal shall be maintained.

The RF output level of the composite signal shall be fully attenuated and then slowly increased until the receiver locks and both a 12 dB minimum SINAD and 50% of the reference audio output power are obtained. The RF signal level shall be recorded.

In order to ensure that the upper limit of the lock-in range exceeds the upper limit of the minimum performance standard in 9.11.3, both frequencies shall be increased to the minimum upper limit with the RF output fully attenuated. The RF output level shall be slowly increased until the receiver locks and both a 12 dB minimum SINAD and 50% of the reference audio output power are obtained. The RF signal level should not exceed the level previously recorded in this test.

A similar test shall be performed to check the lower limit of the minimum performance standard.

9.11.3 Minimum Performance Standard: The lock-in range shall be ±500 Hz minimum.

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FIGURE 1

SPURIOUS EMISSION LIMITS CLOSE TO NECESSARY BAND (B_n)

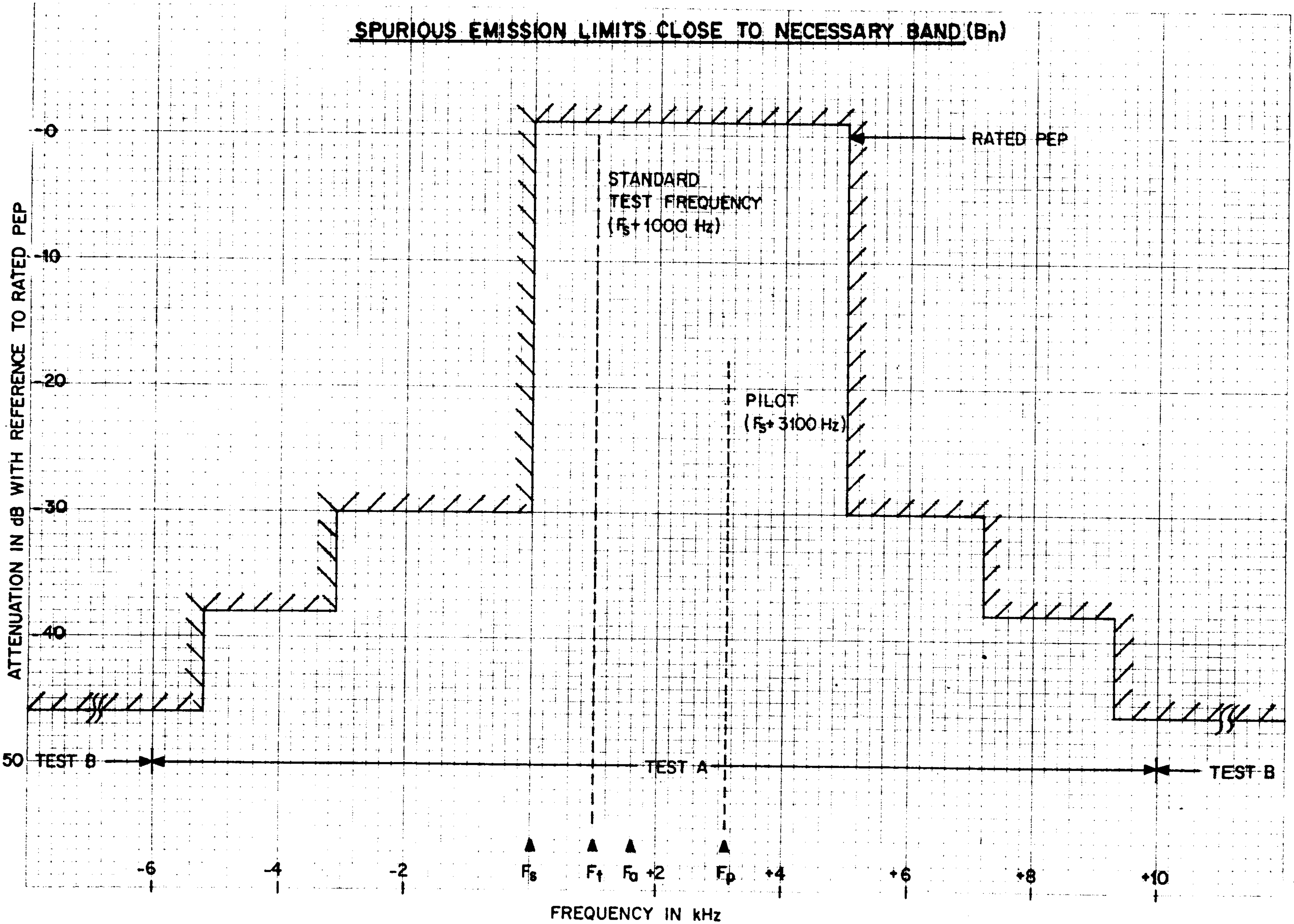

FIGURE-2

AUDIO FREQUENCY RESPONSE

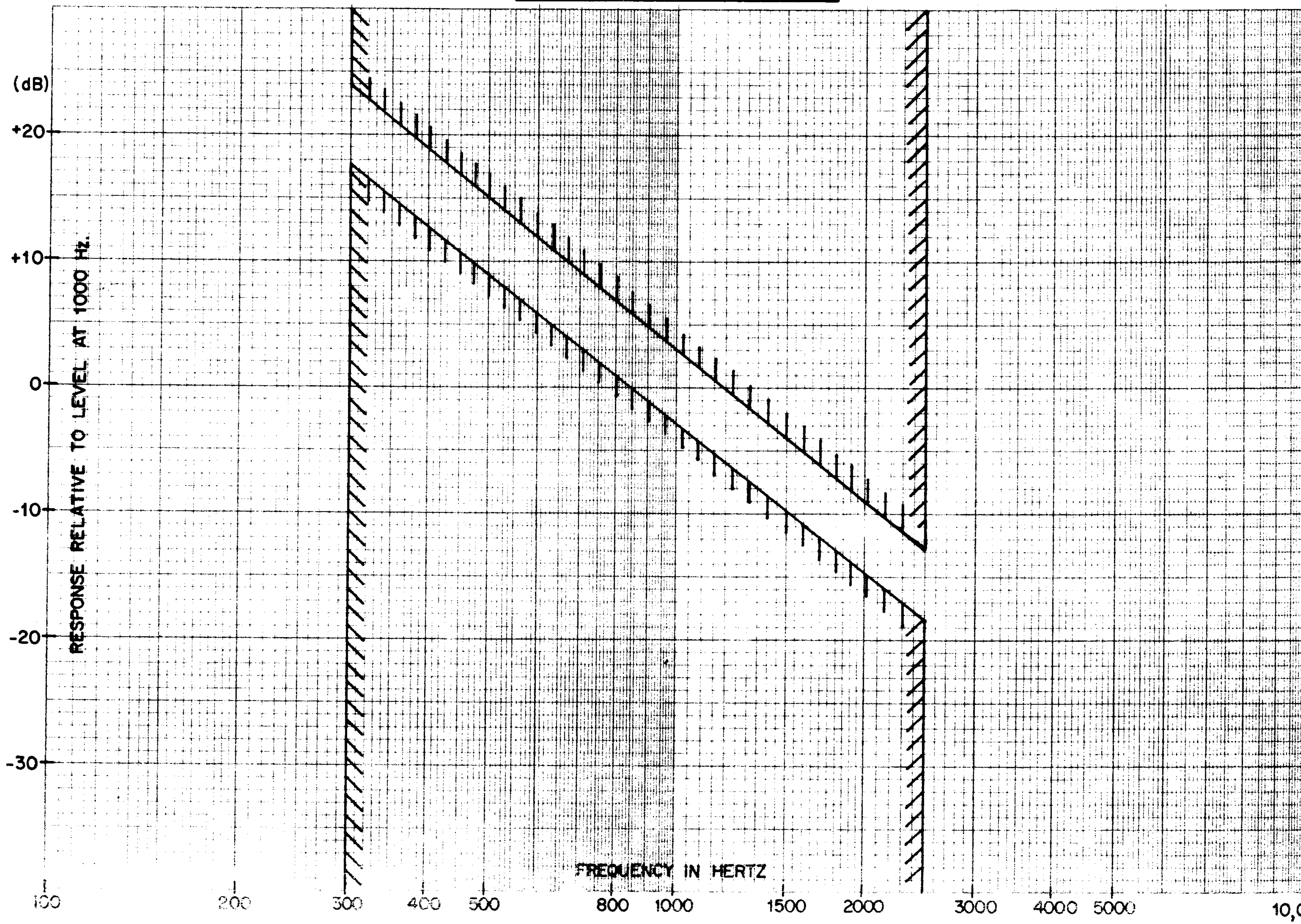

FIGURE-3

RECEIVER TWO-SIGNAL SELECTIVITY