Technical Standards for FM Radio Broadcasting in The Bahamas

ECS 04/2019

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1 Preliminary

1.1 Introduction

This document, the Technical Standards for FM Radio Broadcasting in The Bahamas – ECS 04/2019 ("the FM Radio Technical Standards") is issued by the Utilities Regulation and Competition Authority (URCA) pursuant to its powers under the Communications Act 2009, and comprises technical standards which must be complied with by any person issued a licence by URCA to provide FM Radio broadcasting in The Bahamas.

1.2 Definitions

For the purposes of this Technical Standards document, the following terms and definitions shall apply:

Antenna Port: means the port of an apparatus which is designed, in normal operation, to be connected to an antenna using coaxial cable;

Audio Frequency Response: means the inverse ratio of input voltages relative to the voltage at 400 Hz, expressed in dB, required to maintain a constant percentage of modulation across the audio frequency range;

Carrier Frequency Stability: means the ability of the transmitting equipment to maintain a mean test frequency;

Channel L: means left hand channel of a stereophonic signal;

Channel R: means right hand channel of a stereophonic signal;

Cabinet Radiation: means radiation from enclosure containing, equipment, excluding radiation from connected antennas or cables;

Carrier Power: means the average power supplied to the antenna port by a transmitter during one cycle taken under the condition of no modulation;

Class of Emission: means the set of characteristics of an emission, designated by standard symbols, e.g. type of modulation of the main carrier, modulating signal, type of information to be transmitted, and also, if appropriate, any additional signal characteristics;

Composite: See "Multiplex (MPX) Signal";

Coverage Area: means radio communication service area in which the transmissions are intended for direct reception by the general public;

Crosstalk (Multiplex): means the presence of an undesired signal occurring in one channel (L to R) caused by the signal in the other channel (R to L);

dBc: means the decibels relative to the un-modulated carrier power of the emission (in the cases which do not have a carrier, for example in some digital modulation schemes where the carrier is not accessible for measurement, the reference level equivalent to dBc is decibels relative to the mean power P);

FM Radio Station: means all the apparatus necessary to convert the modulating input signal to a frequency modulated carrier at the center frequency of a standard FM channel in the 88 MHz to 108 MHz frequency band, established, maintained and operated pursuant to a Individual Spectrum Licence granted by URCA;

Mean Power: means the average power supplied to the antenna port by a transmitter during an interval of time sufficiently long compared with the lowest frequency encountered in the modulation envelope taken under normal operating conditions;

Multi-Plex (MPX) Signal: means all information, including the pilot tone and any supplementary signal used to frequency modulate the VHF FM transmitter;

Necessary Bandwidth: means the width of the frequency band which is sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions for a given class of emission;

Pilot Tone: means the 19 kHz tone used to recover the stereo subcarrier in the stereo-receiver;

Radio Data System (RDS): means the signal containing information on programmes and broadcasting networks;

Signal L: corresponds to the information in the left channel of the stereophonic or monophonic signal;

Signal R: corresponds to the information in the right channel of the stereophonic signal or monophonic;

Spurious Emissions: means the emission on a frequency which is outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation

products and frequency conversion products but exclude out of band emissions;

Stereo Subcarrier: means the 38 kHz subcarrier used to carry the difference signal;

1.3 Symbols

For the purposes of the present document, the following symbols shall apply:

Ω ohms (unit of impedance)
µ mili, 10^{-3}

1.4 Abbreviations

For the purposes of this Technical Standards document, the following abbreviations shall apply:

AC	Alternating Current
AF	Audio Frequency
AM	Amplitude Modulation
dB	decibel, logarithmic ratio (tenths of a "Bel")
dBm	Db relative to one milliwatt
DC	Direct Current
EMC	Electromagnetic Compatibility
ERM	Electro-Magnetic Compatibility and Radio spectrum Matters
FM	Frequency Modulation
Hz	Hertz (cycles per second)
K	kilo, 10^{-3}
kVA	Kilovolt-Amp
LV	Low Voltage
M	Mega, 10^{-6}
MPX	Multi-PleX
R&TTE	Radio equipment and Telecommunications Terminal Equipment
RDS	Radio Data System
RF	Radio Frequency
RMS	Root Mean Square
SNR	Signal to Noise Ratio
VHF	Very High Frequency
V	Volts
W	Watt

1.5 Designators

For the purposes of this Technical Standards document, the following designators shall be used:

F3E	FM analogue sound
G	Monophonic broadcast- quality sound
N	Un-modulated carrier
F8E or F8EH	Normal FM stereo broadcast - as found on public VHF band
H	Stereophonic or quadraphonic broadcast-quality sound
F	Frequency Modulation (e.g. FM Broadcast Radio)

1.6 Main Transmitter

A broadcasting transmitter with radiated power output as authorized and which is primarily used to provide the service for which the undertaking is licensed.

1.7 Auxiliary Transmitters

(a) Alternate Transmitter

A broadcasting transmitter with the same radiated power and electrical characteristics as the main transmitter and which is used alternately with the main transmitter to provide the service for which the undertaking is licensed.

(b) Standby Transmitter

A broadcasting transmitter which is used to maintain continuity of service in the event of main or alternate transmitter failure. This transmitter may also be used during specified periods while maintenance is being carried out on the main transmitter.

(c) Emergency Transmitter

An unplanned broadcasting transmitter installation used to provide continuity of service necessitated by unforeseen circumstances beyond the control of the licensee. The operation of such systems shall normally be limited to a duration of two (2) weeks, however a longer period may be authorized when warranted due to extraordinary circumstances.

2 General

2.1 The standards contained herein are issued by URCA for FM radio broadcasting and are

the minimum requirements for the design and operation of FM radio stations in The Bahamas.

2.2 URCA may conduct such tests, technical investigations and field trials as may be necessary or appropriate in order to determine whether a FM radio station meets the standards set out in this document.

2.3 URCA may require technical adjustments be made to the FM radio broadcast equipment operated by any licensee to resolve any harmful interference which may occur to other FM radio broadcast station(s), having determined the source of the harmful interference and the most effective and efficient method of resolution.

2.4 A licensee shall not, without URCA's prior written approval, make changes to the technical and/or physical operating parameters of a FM radio broadcast station.

2.5 The use of an FM radio broadcast frequency (88 MHz -108 MHz, for program rebroadcast is prohibited.

3 Labeling

3.1 All FM radio broadcasting equipment[1] must display:

(a) The manufacturer's name or brand name;
(b) The model identification number;
(c) The serial number; and,
(d) The Country of Origin of the equipment.

3.2 The identification label containing the above information must be displayed prominently and affixed permanently to the equipment so that the information can be seen throughout the life of the equipment.

4. Effective Radiated Power (ERP)

4.1 ERP is determined by subtracting system losses and adding system gains to the actual electrical power output of a transmitter.

[1] FM radio broadcasting equipment which has been certified for operation in ITU Region 2 by an International Standards Body (e.g. FCC).

4.2 Transmitters shall be authorized for power levels which will provide the minimum internationally accepted field strength of 70 dBuV/m (3.16mV/m) at the limit of coverage area, but shall not exceed the prescribed ERP established for each island territory in Table 1 below:

Table 1

	ISLAND	MAXIMUM EFFECTIVE RADIATED POWER[2]
1	Abaco	10,000-watts
2	Acklins	10,000-watts
3	Andros - North (Morgan's Bluff to Behring Point)	10,000-watts
4	Andros - South (Moxey Town to Mars Bay)	5,000-watts
5	Berry Islands	5,000-watts
6	Bimini Islands	1,000watts
7	Cat Island	10,000-watts
8	Crooked Island	10,000-watts
9	Exuma	10,000-watts
10	Eleuthera	10,000-watts
11	Grand Bahama	10,000-watts
12	Inagua	5,000-watts
13	Long Island	10,000-watts
14	Mayaguana	10,000-watts
15	New Providence	5,000-watts
16	Ragged Island	2,000-watts
19	Rum Cay	1,000-watts
18	San Salvador	2,000-watts

5 Minimum Distance Separation between Transmitters

5.1 The transmitters for FM radio broadcast stations broadcasting on the same

[2] Determined by applying prediction coverage overlay for each island.

frequency/channel shall be separated by a minimum distance of 61 Miles/100 km. Other factors shall also be considered in order to avoid harmful interference between such stations (such as the station ERP, coverage area and design radiation patterns).

5.2 The physical spacing set out in 5.1 above shall not apply to stations installed and operating prior to the date of these FM Radio Technical Standards.

6 Transmitter Location

6.1 Location of the transmitter must be determined on the basis that the ERP power and antenna height above average terrain (HAAT) employed, provides a minimum signal level of 70 dB above 1 uV/m (dBu) or 3.16 mV/m over the coverage area. The transmitter location must ensure that the 1mV/m contour encompasses the population center that is being served.

7 Transmitting Equipment

7.1 The transmitting equipment comprised in an FM Radio Station shall produce F3EGN emission for monophonic operation and F8EHF emission for stereophonic operation. The transmitting equipment shall be capable of operating with a frequency deviation of ±75 kHz, which is equivalent to 100% modulation.

7.2 Emissions shall not exceed 100% modulation (±75 kHz deviation) except for the following conditions:

(i) FM multiplex sub-carrier using any modulation may operate if the multiplexed sub- carrier and its sidebands are maintained within the range 20 kHz to 99 kHz; and,

(ii) Total peak modulation may be increased 0.5% for each 1.0% sub-carrier injection modulation.

7.3 The transmitting equipment shall be capable of operation in accordance with these standards on any channel in the specified carrier frequency range without change in construction other than changing frequency-determining components.

7.4 The AC voltage input shall be at a frequency of 60 Hz. Voltage, Frequency and maximum kVA requirement shall be indicated on the transmitting equipment as established by the manufacturer.

7.5 The transmitting equipment, if rated above 10 kVA, shall present a balanced load to the AC mains such that the current in each phase shall be 10% of the average of all three currents.

7.6 Operating power and mode tolerances

The transmitter output power of an FM Radio Station which is authorized for output power more than 10 watts must be maintained as near to practicable to the authorized transmitter output power and may not be less than 90% or more than 105% of the authorized power.

7.7 Operating carrier frequency tolerance

The carrier frequency of an FM Radio Station with an authorized power greater than 10 watts shall not deviate more than ±2000 Hz (±2 KHz) from the authorized carrier.

8. RF Carrier Performance

8.1 The transmitter shall deliver continuously into a test load at its antenna port, the transmitter's rated output power in accordance with the manufacturer's specified conditions of operation.

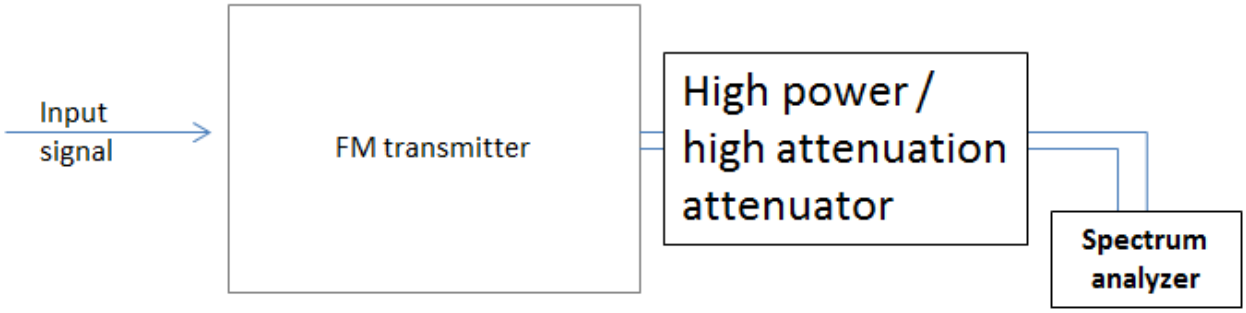
8.2 Method of measurement

(i) Test frequencies:
   a) the lowest operating frequency of the transmitter;
   b) the highest operating frequency of the transmitter; and
   c) a frequency mid-way between "a" and "b" above.

(ii) Test arrangement steps (see also **Error! Reference source not found.** below):
   a) connect the transmitter to the Spectrum analyser via a "high power/high attenuation" attenuator;

b) alternative 1: a cascade set of attenuators may be used or a high attenuation couple device and a test load.

Figure 1



8.3 The standard rating of power output for the transmitting equipment shall be as specified by the individual manufacturer. The transmitting equipment shall be capable of being adjusted to deliver the power output when the AC input voltage varies by 5% from the rated value.

9 Carrier Frequency Stability

9.1 The frequency of the carrier shall remain within ± 1000 Hz of the mean test frequency.

10 Spurious Emission

10.1 A spurious emission from any part of the FM Radio Station transmitter installation, other than the antenna and its transmission line, shall not have an effect greater than what occurs if the antenna system were supplied with the maximum permitted power at that spurious emission frequency.

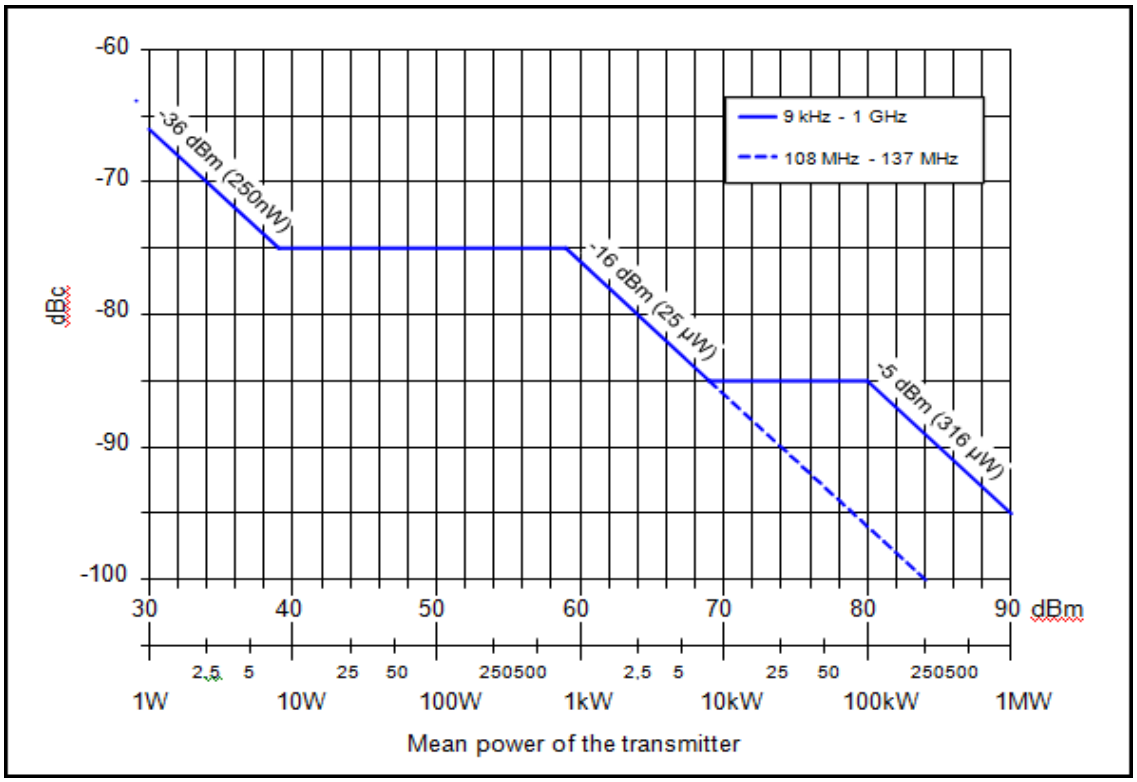
10.2 The spurious emissions of the FM Radio Station transmitter shall not exceed the values set out in Table 2 below, and illustrated in Figure 2 below.

Table 2

Spurious Emission	Maximum Value
Between 120 kHz and 240kHz from the carrier frequency.	-25 dB*
More than 240 kHz and up to and including 600 kHz from the carrier frequency.	-35 dB*
More than 600 kHz from the carrier frequency whichever is the stronger.	-(43 +10 log P)* or –80 dB*

* Referred to the power level of the un-modulated carrier.

Figure 2

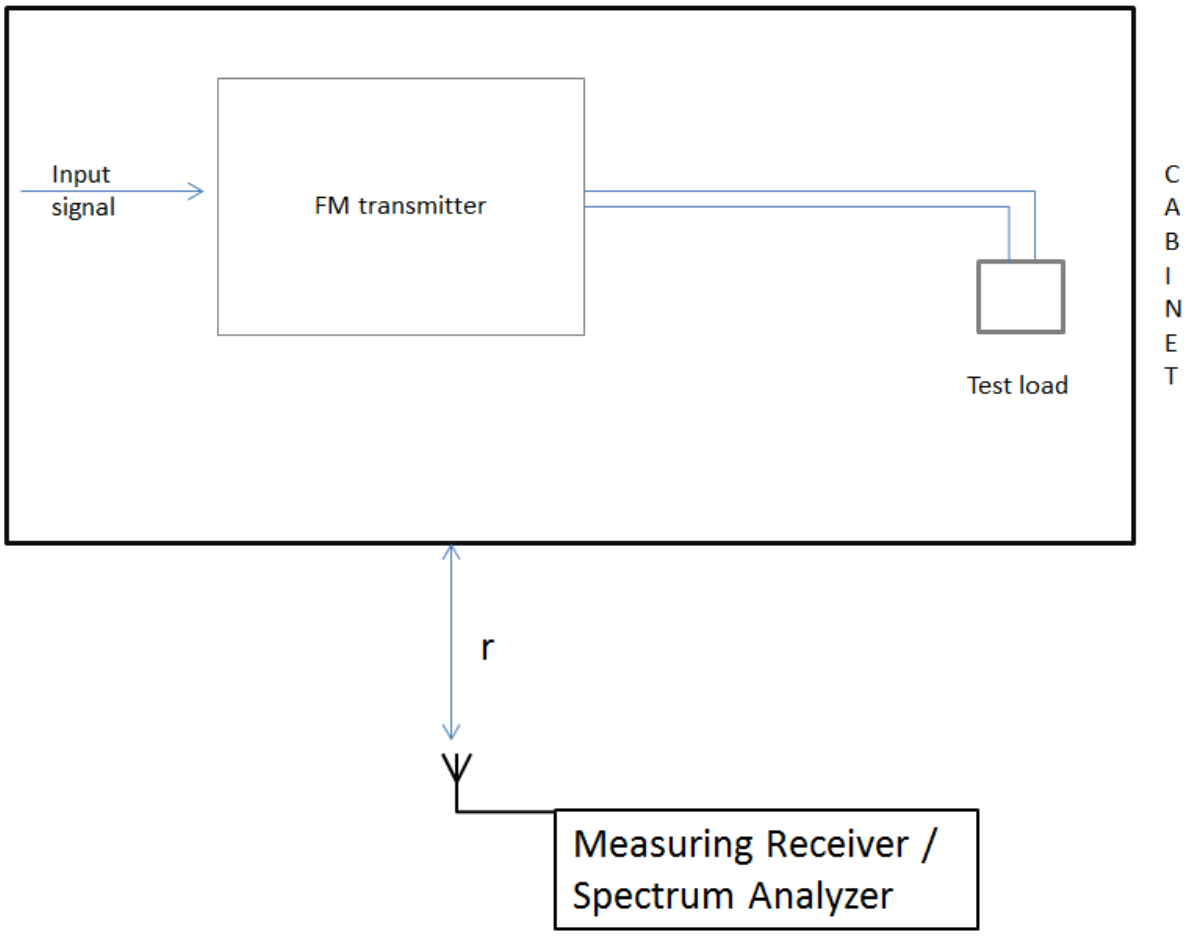


11 Cabinet Radiation

11.1 Cabinet radiation emissions at any frequency shall be at least 54 dB below the calculated field strength reference level.

11.2 The test arrangement for cabinet radiation is shown in Figure 3 below:

Figure 3



11.4 <u>Test Methodology</u>

The transmitting equipment shall be operated at rated power output and at a suitable frequency. A receiving antenna, located alternately at a known distance between three and ten meters from at least three sides of the transmitting equipment (i.e. front, back,

left or right hand side), shall be connected to a calibrated field strength meter or frequency-selective voltmeter. Field strength measurements shall be made and the results recorded for all emissions (including the fundamental and harmonics of the carrier frequency) up to the third harmonic of the carrier frequency. For the measurement, the receiving antenna shall be rotated in all three planes and the maximum received field shall be noted (allowance shall be made for antenna factor and transmission line loss of the measuring equipment). Using the free space formula below, calculate the reference field strength.

12 Receiver-generated Intermodulation Interference

12.1 Receiver-generated intermodulation interference can take place in the vicinity of an FM station and the severity of the interference potential depends on the broadcasting radio environment. Licensees operating FM Radio Stations shall be required to use their reasonable endeavours to situate transmitters in locations which will minimize the population within the 115 dBµV/m contours of the transmitter site. URCA reserves the right to request changes to the antenna site, to the antenna height, or to the antenna itself, or to the radiated power to reduce the population within these high signal level contours.

12.2 The restrictions in this section 12 shall not apply to existing FM Radio Stations, however all applicants for a licence for a new FM Radio Station or licensees proposing changes to an existing FM Radio Station which have the potential to impact the population level within the 115 dBµV/m contours of the transmitter site shall, together with their application submit an estimate of the population within the calculated 115 dBµV/m contour of the transmitter.

The location of the contours shall be determined using the appropriate F(50,50) field strength curves and shown on a suitable map, prepared in accordance with Section 12.3 below.

13 FM Stereophonic Sound Transmission and Multiplex Operation

13.1 An FM Radio Station shall not use the band 19 kHz ± 20 Hz, except as the stereophonic pilot frequency in a transmission system meeting the following criteria (see also Figure 4 below):

(i) the modulating signal for the main channel shall consist of the Left and Right (L+R) signals;

(ii) the stereophonic subcarrier shall be the second harmonic of the pilot subcarrier (38 kHz);

(iii) for L-R channel, double sideband, suppressed carrier amplitude modulation of the stereophonic subcarrier at 38 kHz shall be used; The band frequencies from 23 to 53 kHz containing the stereophonic subcarrier and its associated sidebands;

(iv) the pre-emphasis characteristic of the L-R channel shall be identical with those of the L-R channel with respect to phase and amplitude at all frequencies;

(v) the stereophonic subcarrier at 38 KHz shall be suppressed to a level at least 40 dB below the total modulation of the carrier;

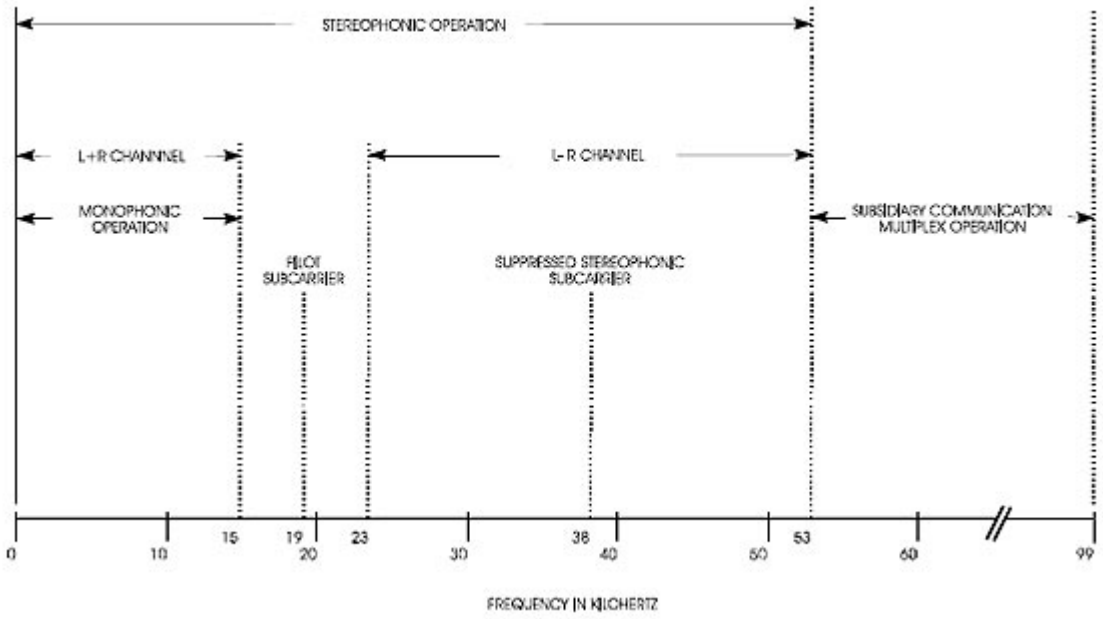
(vi) the stereophonic subcarrier shall be capable of accepting audio frequencies from 50 to 15,000 Hz;

(vii) the modulating signal for the required subcarrier shall be equal to the difference of the Left and Right signal;

(viii) applicable modulating levels:

- the sum of the sidebands resulting from amplitude modulation of the stereophonic subcarrier shall not cause a peak deviation of the carrier in excess of 45% of the total modulation when only left (or right) signal exists in the L-R channel;
- when only a left (or right) signal exists in the L + R channel, the deviation of the main carrier shall not exceed 45% of the total modulation;
- the pilot subcarrier at 19 kHz ± 20 kHz shall frequency modulate the main carrier between the limits of 8 and 10 percent for monophonic operation;
- when a signal exists in only one channel of a stereophonic sound transmission having more than one stereophonic subcarrier in the baseband, the modulation of the carrier by audio components within the audio baseband range of 23 kHz to 99 kHz shall not exceed 53% with total modulation not to exceed 90%. A station not transmitting stereo with a method above shall limit the main carrier deviation caused by any modulating signals occupying the band 19 kHz ± 20 kHz to 125 Hz.

Figure 4



13.2 Subsidiary Communications Multiplex Operation channel (SCMO)

13.2.1 Any form of modulation may be used on any multiplex subcarrier.

13.2.2 More than one multiplex subcarrier may be used. During periods of no program transmission, the multiplex subcarrier and its significant sidebands shall be within the frequency range of 20 to 99 kHz. During monophonic or stereophonic program transmission, the multiplex subcarrier and its significant sidebands shall be within the frequency range of 53 to 99 kHz.

13.2.3 During periods of no program transmissions, the modulation of the carrier by the arithmetic sum of all subcarriers above 76 kHz may not exceed 10%, and modulation of the carrier by the arithmetic sum of all subcarriers may not exceed 30% referenced to ± 75 kHz deviation. During monophonic or stereophonic program transmissions, the modulation of the carrier by the arithmetic sum of all multiplex subcarriers above 76 kHz may not exceed 10%, and modulation of the carrier by the arithmetic sum of all multiplex subcarriers may not exceed 20% referenced to ± 75 kHz deviation.

13.2.4 Without subsidiary communications, the total modulation of the FM carrier by the sum of all baseband signals may not exceed 100% (75 kHz peak deviation). When subsidiary communications services are provided, using subcarrier concurrently with the broadcasting of stereophonic or monophonic programs, the peak modulation deviation may be increased as follows:

With more than one subcarrier, the total peak modulation may be increased by 0.5% for each 1.0% subcarrier injection modulation; and

Under no circumstances may the modulation of the FM carrier exceed 110% (82.5 kHz peak deviation).

13.3 All FM radio broadcast stations, regardless of the stereophonic transmission, shall not exceed the maximum modulation limits of 100 % on peaks on frequency recurrence to 75 kHz deviation. Stations providing subsidiary communications services using subcarrier standards concurrently with the broadcasting of stereophonic or monophonic programs may increase the peak modulation deviation as follows:

(i) the total peak modulation may be increased 0.5% for each percent subcarrier injection modulation; and

(ii) the modulation shall not exceed 110 per cent (82.5 kHz peak deviation).

14 Stereophonic Separation

14.1 The stereophonic separation between channels shall be 30 dB or better.

14.2 Method of Measurement

Modulate the carrier to a level of 90% with a standard test signal applied to the L channel only. Measure the demodulated output of the L and R channels and determine the separation at frequencies of 100, 400, 1,000, 2,500, 5,000, 7,500 and 10,000 Hz. Repeat the above with a test signal applied to the R channel only.

15 Frequency Stability of Subcarrier

15.1 The pilot subcarrier frequency shall be 19,000 Hz ± 2 Hz and any multiplex subcarrier shall be within 500 Hz of the operating frequency selected by the manufacturer as noted in the test report.

16 Stereophonic Subcarrier Suppression

16.1 The stereo subcarrier shall be at least 40 dB below the total modulation of the carrier.

16.2 Method of Measurement

Using a stereo modulation monitor or other suitable method, determine the level of the stereo subcarrier.

17 Crosstalk (Stereophonic)

17.1 Crosstalk into either channel shall be at least 40 dB below 90% modulation.

17.2 Method of Measurement

Using the standard test input signal to produce 90% modulation of the carrier by the L + R channel, measure the components of the signal appearing in the L - R channel. With 90% modulation of the carrier by the L - R channel, measure the components of the signal appearing in the L + R channel.

18 Multiplex Operation

Audio Frequency Response

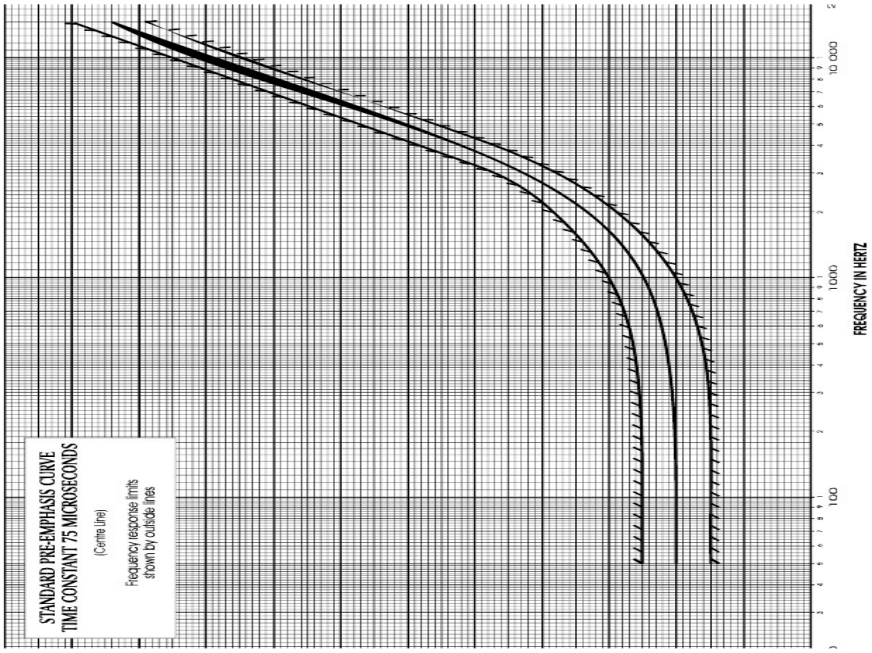
18.1 Method of Measurement

The standard test set-up shall be used. The normal 75 microsecond pre-emphasis shall be employed. The audio input to maintain a constant modulation level of 25%, 50% and 100% shall be determined at a sufficient number of points over the frequency range 50 to 15,000 Hz to enable curves to be plotted.

18.3 The audio frequency response curves shall lie on or between the dashed curves as shown

in Figure 5 below:

Figure 5



19 Audio Frequency Harmonic Distortion

19.1 The audio frequency harmonic distortion is the harmonic content of the audio signal contributed by the transmitting equipment.

19.2 The L and R channels shall meet the requirements of section 25.2 below.

20 Frequency Modulation Noise Level on Carrier

20.1 The frequency modulation noise on the carrier is the residual frequency modulation resulting from disturbances produced in the transmitting equipment itself within the band of 50 Hz to 15,000 Hz.

20.2 The requirements of section 26.2 below shall apply.

21 Amplitude Modulation Noise Level on Carrier

21.1 The amplitude modulation noise level of an FM carrier is the ratio of the RMS value of the amplitude modulation component (50 to 15,000 Hz) of the carrier envelope to the RMS carrier value during the absence of applied modulating voltage.

21.2 The requirements of 27.2 below shall apply.

22 Crosstalk (Multiplex)

22.1 Method of Measurement

- Modulate any multiplex subcarrier at the maximum level and at the maximum modulating frequency for which it is designed to operate. If more than one such subcarrier is provided, modulate them simultaneously. The frequency level should be recorded in the test report. With no modulation on the L + R or the L - R channels, measure the output of the L + R and the L - R channels.
- With no modulation on the multiplex subcarrier or subcarrier, apply the standard input signal to both L + R and L - R channels, measure the level of the crosstalk in the output of the multiplex sub-channel and record this level in the test report.

22.3 Crosstalk from multiplex channels into the L + R or L - R channels shall be at least 60 dB below maximum modulation level. There is no standard for crosstalk from the L + R or L - R channels into the multiplex sub-channels.

23 FM Monophonic Sound Transmission

Audio Input Impedance

23.1 The audio input level for 100% modulation is the audio input, expressed in dBm (0 dBm = 1 mW), necessary to produce a frequency deviation of ±75 kHz.

23.2 The audio input impedance shall be a nominal 600 ohm balanced to ground. Additional impedances may also be provided.

23.3 The standard test signal shall be adjusted to produce 100% modulation.

23.4 The standard audio input level for 100% modulation shall be 10 dBm, ±2 dBm = 12bBm.

24 Audio Frequency Response

24.1 The audio frequency response is the inverse ratio of input voltages relative to the voltage at 400 Hz, expressed in dB, required to maintain a constant percentage of modulation across the audio frequency range.

24.2 Method of Measurement

The standard test set-up as described in Table 2 (under Section 8.3 above) shall be used. The normal 75 microsecond pre-emphasis shall be employed. The audio input to maintain a constant modulation level of 25%, 50% and 100% shall be determined at a sufficient number of points over the frequency range 50 to 15,000 Hz to enable curves to be plotted.

25 Audio Frequency Harmonic Distortion

25.1 The audio frequency harmonic distortion is the harmonic content of the audio signal contributed by the transmitting equipment.

25.2 Method of Measurement

The standard test set-up as described in Table 2 (under Section 8.3 above) shall be used and the demodulated output fed to a wave or distortion analyzer. The normal 75 microsecond pre-emphasis shall be employed, and the demodulator shall include a 75 microsecond de-emphasis. Measurements at 90% modulation shall be taken at a sufficient number of frequencies in each range of frequencies to plot a distortion versus frequency curve.

25.3 The audio frequency distortion including all harmonics up to 30 kHz shall not exceed 1% in the range of frequencies from 50 Hz to 15,000 Hz.

26 Frequency Modulation Noise Level on Carrier

26.1 The frequency modulation noise on the carrier is the residual frequency modulation resulting from disturbances produced in the transmitting equipment itself within the band of 50 Hz to 15,000 Hz.

26.2 Method of Measurement

Using the normal 75 microsecond pre-emphasis, a sample of the RF output of the transmitting equipment shall be fed to a distortion and noise meter, via a suitable demodulator. The frequency response characteristic of the demodulator shall be within ±1 dB of the normal 75 microsecond de-emphasis curve from 50 Hz to 15,000 Hz. Readings shall be taken of the output levels with standard test modulation of 90% and without modulation, with the input terminated in 600 ohms. Their ratio shall be expressed in dB below 100% modulation (±75 kHz deviation).

26.3 The ratio shall be at least 60 dB below 90% modulation.

27 Amplitude Modulation Noise Level on Carrier

27.1 The amplitude modulation noise level of an FM carrier is the ratio of the RMS value of the amplitude modulation component (50 Hz to 15,000 Hz) of the carrier envelope to the RMS carrier value during the absence of applied modulating voltage.

27.2 Method of Measurement

Measurement of the carrier amplitude modulation noise level may be accomplished by the use of a linear peak carrier responsive AM detector coupled to the output of the transmitting equipment. Readings are made of the DC voltage and the RMS value of the AC component across the detector load resistor. The DC voltage must be multiplied by 0.707. The measurement shall be made in the absence of modulating voltage, with the audio input terminated in 600 ohms.

27.3 The ratio shall be at least 50 dB below carrier level within the band of 50 Hz to 15,000 Hz.