# TECHNALOGIX
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# TXF-50: 50-WATT FM TRANSMITTER
# TEST REPORT

Technalogix TXF-50 (S/N: 02261197)

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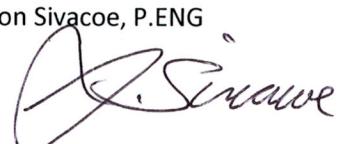
Date:              August 28, 2014

# Contents

# 1. Equipment List

| Equipment | Manufacturer | Model Number | Serial Number | Last Calibration |
|---|---|---|---|---|
| Network Analyzer | Agilent | 8753ET | MY42000269 | 19-Sep-2013 |
| Spectrum Analyzer | Tektronix | Tek492 | B042695 | 8-Apr-2014 |
| FM Modulation Analyzer | Innovonics | Model 531 | 2414 | Mar-2013 |
| Modulation Meter | QEI | 691 | 691511 | 16-Oct-2013 |
| THD Multimeter | Keithley | 2015 | 0893126 | 15-Jan-2014 |
| HIghpass Filter | MiniCircuits | NHP-200 | | Note 1 |
| Antenna | Aaronia AG | Bicolog 5070 | 78477 | Jan-2014 |
| RF Wattmeter | Coaxial Dynamics | 81060A | 1099 | 5-Mar-2014 |
| RF Load | Termaline | 8892D300 | | Note 1 |
| RF Load (600W) | Bird | 8402 | 1595 | Note 1 |
| Directional Coupler | Bird | WBC1-45 | 122201685 | Note 1 |
| Variable Autotransformer | Staco Energy Prod. | 3PN1010 | 122-0003 8645 | N/A |
| Variable Autotransformer | Chuan Hsin | SRV-20 | | N/A |
| Digital Camera | Canon | PowerShot A2500 | 652160000043 | N/A |

Note 1: Checked in house against Agilent 8753ET in January 2014
N/A: No calibration required

# 2. Test Temperature

Standard temperature:  $20^oC$ +/- $5^oC$ as per BETS-6 [section 3.3]

Actual temperature:      _____20 $^oC$_____

## 3. Carrier Power

**Definition**

The power output rating of the transmitting equipment is the carrier power at which the transmitting equipment may be operated continuously into the test load.

**Requirement (FCC) - 47CFR Part 2, Subpart J, 73.1560 (b)**

(b) FM stations. Except as provided in paragraph (d) of this section, the transmitter output power of an FM station, with power output as determined by the procedures specified in §73.267, which is authorized for output power more than 10 watts must be maintained as near as practicable to the authorized transmitter output power and may not be less than 90% nor more than 105% of the authorized power. FM stations operating with authorized transmitter output power of 10 watts or less may operate at less than the authorized power, but not more than 105% of the authorized power.

**Requirement (Industry Canada) - BETS-6 [section 6.1.3]**

The transmitting equipment shall be capable of being adjusted to deliver the rated power output when the AC input voltage varies by 5% from the rated value. Adjustment of the power output of the transmitting equipment shall permit operation over a range of at least from 50% to rated power output.

**Method**

An average reading RF wattmeter is placed between the transmitter output (directly on the directional coupler's N connector on the back panel) and the 50 Ω dummy load. While observing the external wattmeter, the AC mains voltage and output power is varied to ensure that is adjustable over the proper ranges.
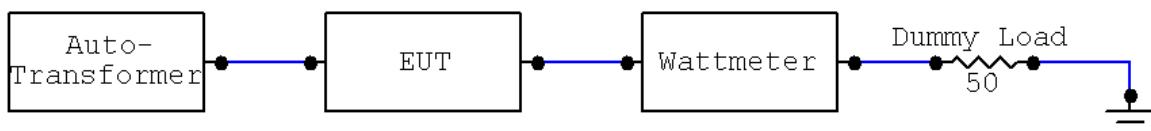


**Measurement**

Rated AC voltage ____110____ Vac.
The rated carrier output power is __50__ watts at -5% Vac.
The rated carrier output power is __50__ watts at rated Vac.
The rated carrier output power is __50__ watts at +5% Vac.

Specified RF power out _____50_____ watts.
Range of RF power out___1____ watts to___50___ watts.
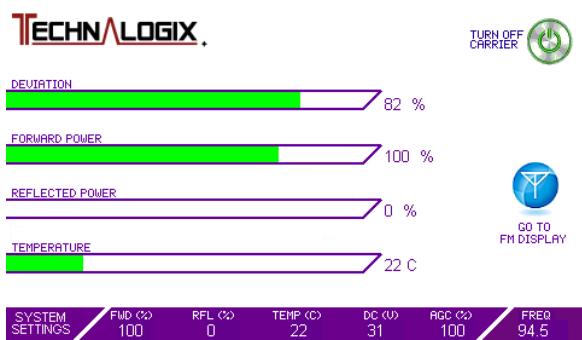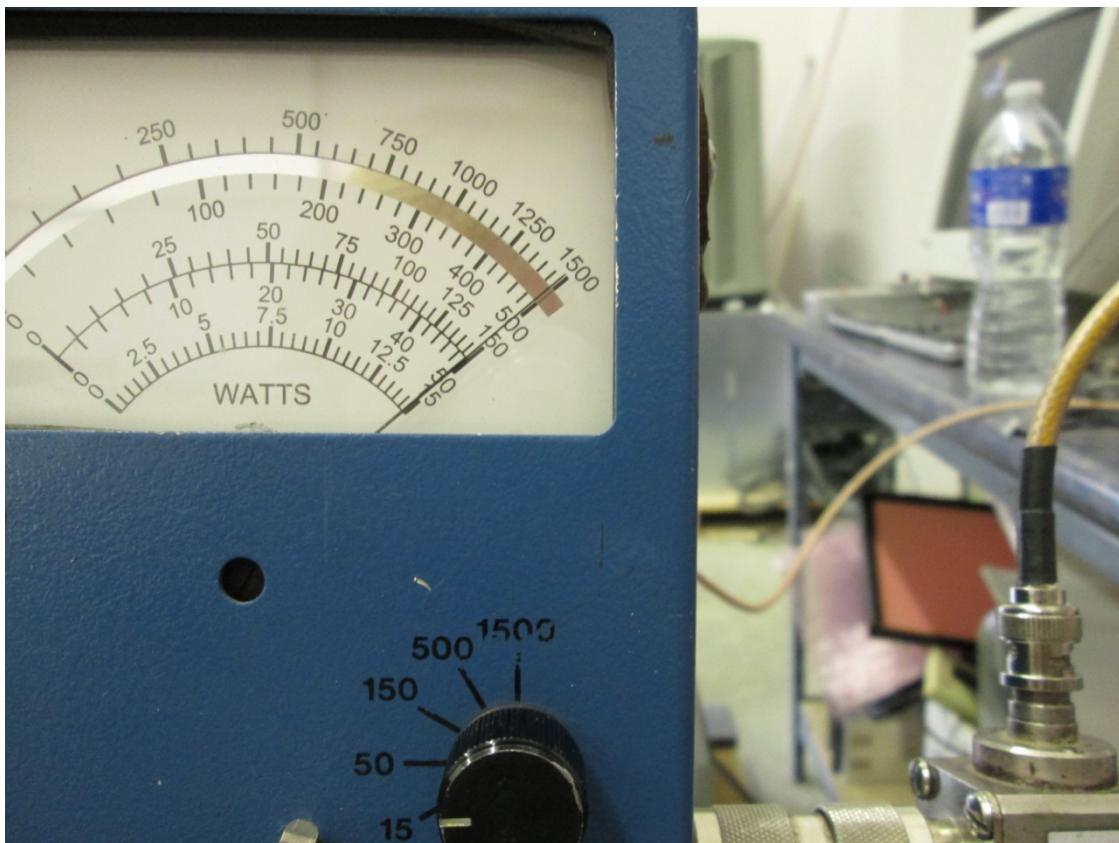
Figure 1: RF Output Level on Wattmeter and Transmitter Readout

## 4. Audio Frequency Response (Mono)

**Definition**

A curve or equivalent data showing the frequency response of the audio modulating circuit shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted. For the audio input channel, the audio amplitude frequency response of a transmitter is defined as the inverse ratio of the input voltages at specific frequencies, referenced to a 400 Hz test tone of sufficient amplitude to result in 100% modulation required to obtain a constant percentage of modulation. The input voltages at specific frequencies are within the range from 50 Hz to 15 kHz and the ratio is expressed in dB.

**Requirement (FCC) -  47CFR Part 2, Subpart J, 73.1570 (b)**

(b) Maximum modulation levels must meet the following limitations:
(2) FM stations. The total modulation must not exceed 100 percent on peaks of frequent reoccurrence referenced to 75 kHz deviation. However, stations providing subsidiary communications services using subcarriers under provisions of § 73.319 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 percent for each 1.0 percent subcarrier injection modulation.
(ii) In no event may the modulation of the carrier exceed 110 percent (82.5 kHz peak deviation).

**Requirement (Industry Canada) - BETS-6 [section A.1.3.3]**

The maximum departure of the amplitude response from the standard 75µsec pre-emphasis curve over the range of 50 Hz to 15 kHz shall not exceed ± 0.5 dB up to ± 75 kHz  deviation.

**Method**

A 400 Hz sinusoidal signal from an audio oscillator is applied to the audio input at a level for 100%, 50%, and 25% modulation. With pre-emphasis on, apply sample from the output to the input of a modulation monitor. The audio oscillator's output level at 400 Hz is adjusted to achieve a ± 75 kHz deviation (level is recorded and used as reference). The audio oscillator level is adjusted at 50, 100, 200, 400, 1000, 2500, 5000, 7500, 10000, 12500, and 15000 Hz to retain the ± 75 kHz deviation and the change in audio oscillator level compared to the reference is recorded. Tests completed on two separate frequencies, each near the band edges.
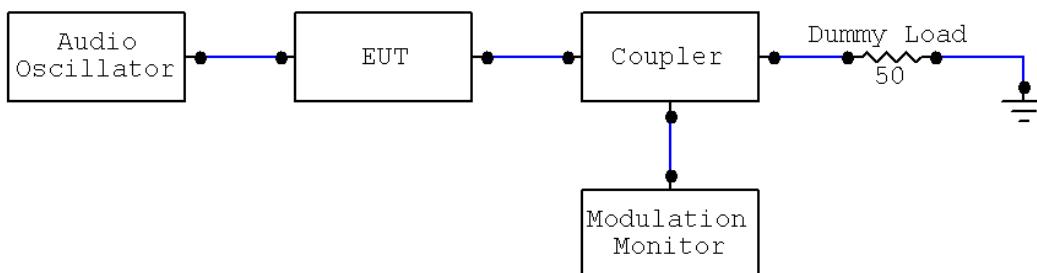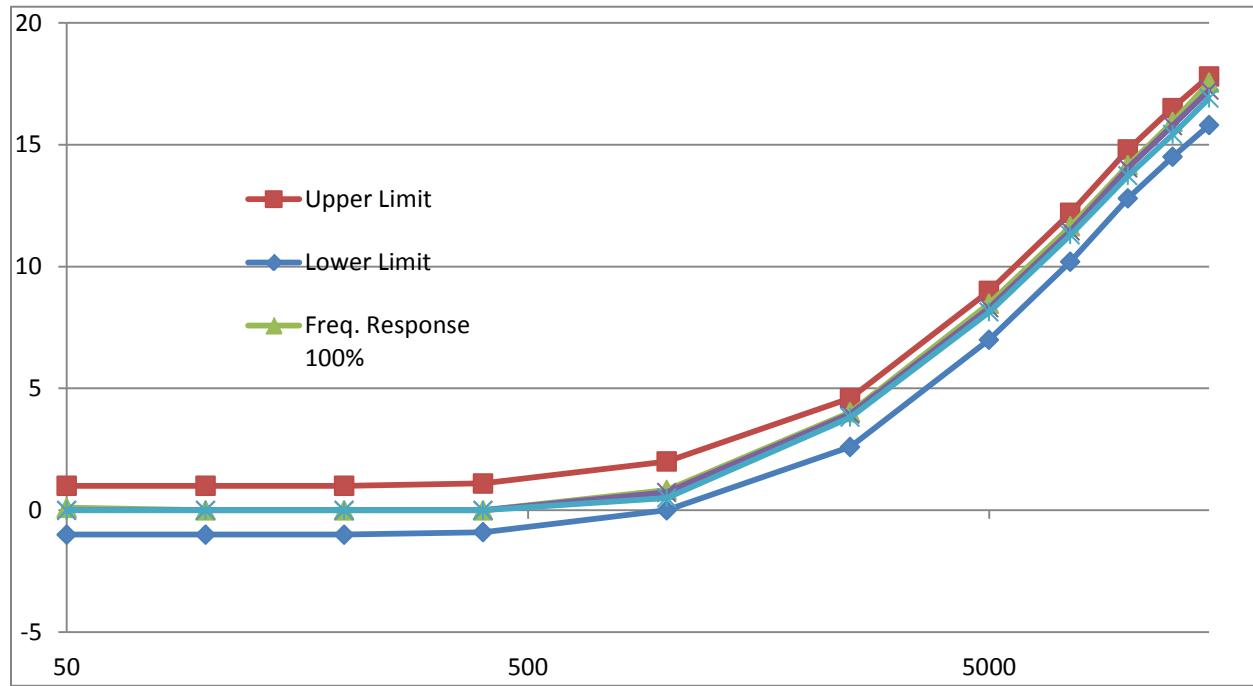
Figure 2: Audio Frequency Response (Mono) with 88.0MHz Carrier (25, 50, 100% Modulation)
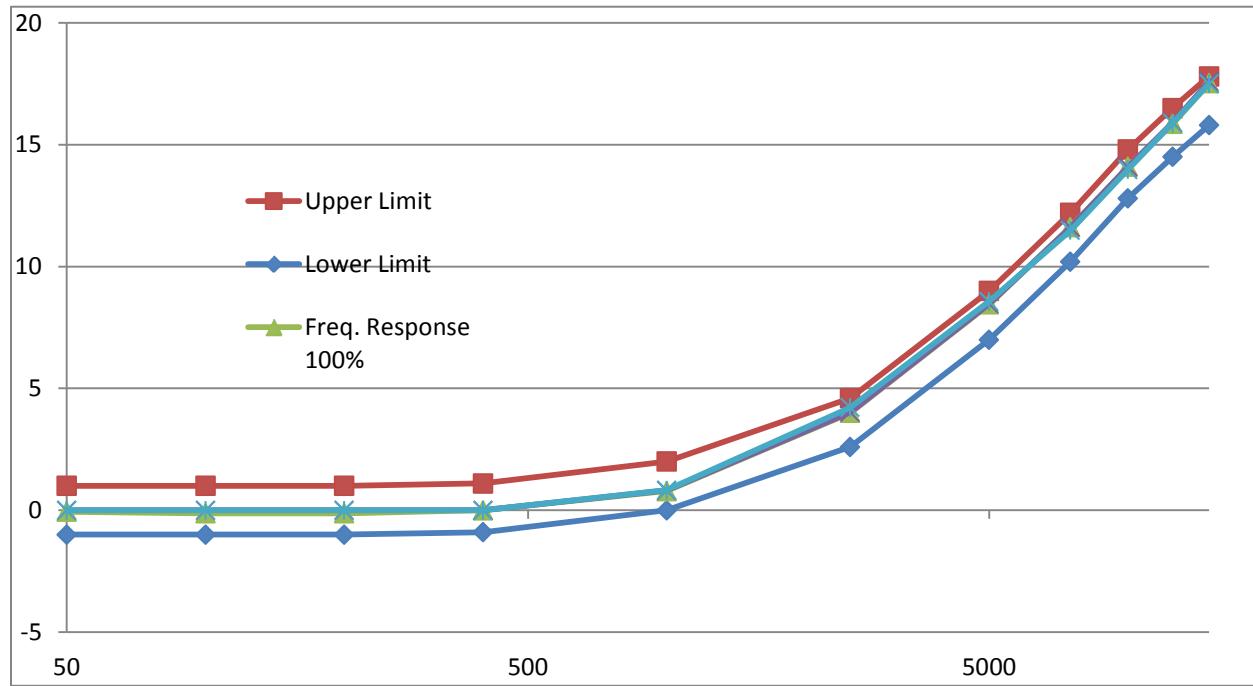
Figure 3: Audio Frequency Response (Mono) with 108.0MHz Carrier (25, 50, 100% Modulation)

# 5. Occupied Bandwidth

**Definition**

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable:

(e) Transmitters for use in the Radio Broadcast Services:

(3) FM broadcast transmitter not used for multiplex operation—when modulated 85 percent by a 15 kHz input signal.

(4) FM broadcast transmitters for multiplex operation under Subsidiary Communication Authorization (SCA)--when carrier is modulated 70 percent by a 15 kHz main channel input signal, and modulated an additional 15 percent simultaneously by a 67 kHz subcarrier (unmodulated).

(5) FM broadcast transmitter for stereophonic operation--when modulated by a 15 kHz input signal to the main channel, a 15 kHz input signal to the stereophonic subchannel, and the pilot subcarrier simultaneously. The input signals to the main channel and stereophonic subchannel each shall produce 38 percent modulation of the carrier. The pilot subcarrier should produce 9 percent modulation of the carrier.

**Requirement (FCC) - 47CFR Part 2, Subpart J, 73.317 (b-d)**

(b) Any emission appearing on a frequency removed from the carrier by between 120 kHz and 240 kHz inclusive must be attenuated at least 25 dB below the level of the unmodulated carrier. Compliance with this requirement will be deemed to show the occupied bandwidth to be 240 kHz or less.

(c) Any emission appearing on a frequency removed from the carrier by more than 240 kHz and up to and including 600 kHz must be attenuated at least 35 dB below the level of the unmodulated carrier.

(d) Any emission appearing on a frequency removed from the carrier by more than 600 kHz must be attenuated at least 43 + 10 Log[10](Power, in watts) dB below the level of the unmodulated carrier, or 80 dB, whichever is the lesser attenuation.

**Method**

The transmitting equipment is operated into the standard test load at rated power. The carrier is modulated with the standard test input signal at 100% modulation. All emissions found in the above frequency requirements are measured.
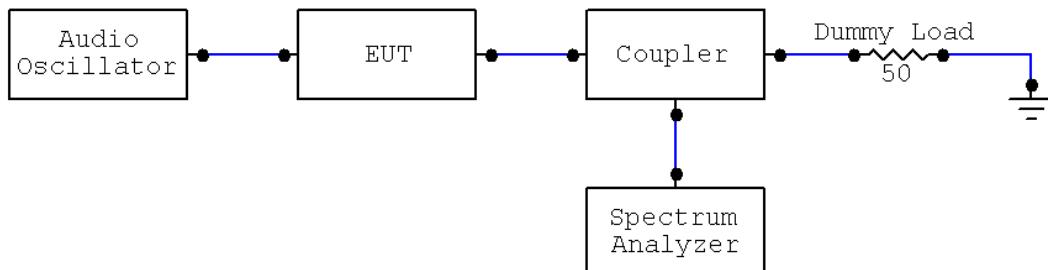
88.0 MHz Occupied BW:
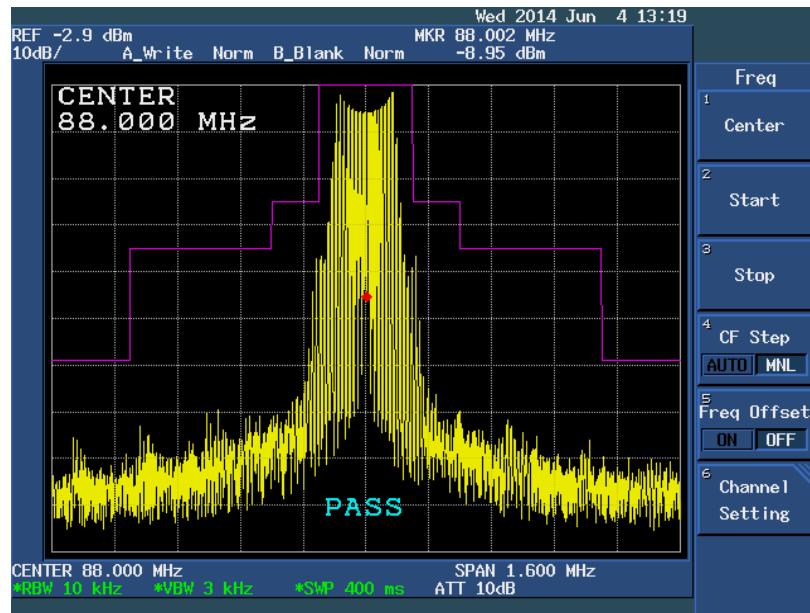


108.0 MHz Occupied BW:
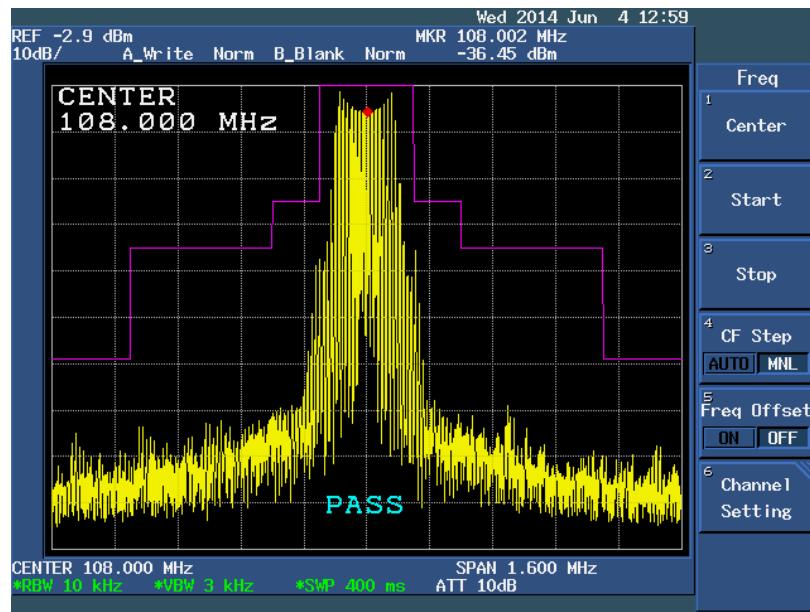


Figure 8: Occupied Bandwidth for Low and High Frequency Carriers

# 6. Spurious Emissions at Antenna Terminals

**Definition**

Spurious emissions are unwanted emissions occurring at the output terminals of the transmitting equipment, at frequencies other than those of the IMD products. The RF powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna.

**Requirement (FCC) - 47CFR Part 2, Subpart J, 73.317 (d)**

(d) Any emission appearing on a frequency removed from the carrier by more than 600 kHz must be attenuated at least 43 + 10 Log[10](Power, in watts) dB below the level of the modulated carrier, or 80 dB, whichever is the lesser attenuation.

**Requirement (Industry Canada) – BETS6 [section 6.3.3]**

Frequencies above 600 kHz from the carrier frequency, all spurious emissions must be better than either minus(43 + 10logP) or -80dB, whichever is stronger.

**Method**

Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.
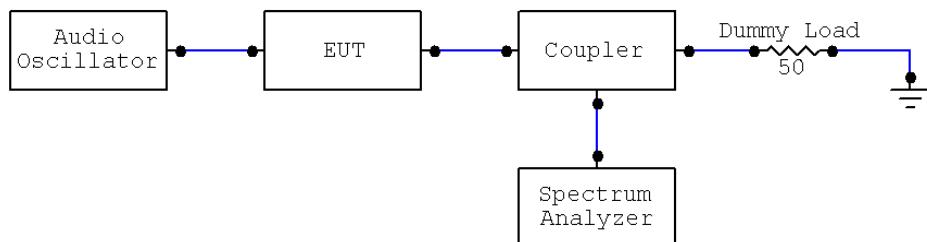


**Measurement**

| Frequency Range | SPURIOUS (dBc) | |
| --- | --- | --- |
| | f = 88.0 MHz | f = 108.0 MHz |
| f ≥ 600 kHz | -82 | -80 |

| Frequency Range | HARMONICS (dBc) | |
| --- | --- | --- |
| | f = 88.0 MHz | f = 108.0 MHz |
| 2$^{nd}$ Harmonic | >-85 | >-90 |
| 3$^{rd}$ Harmonic | >-89 | >-92 |

Fundamental
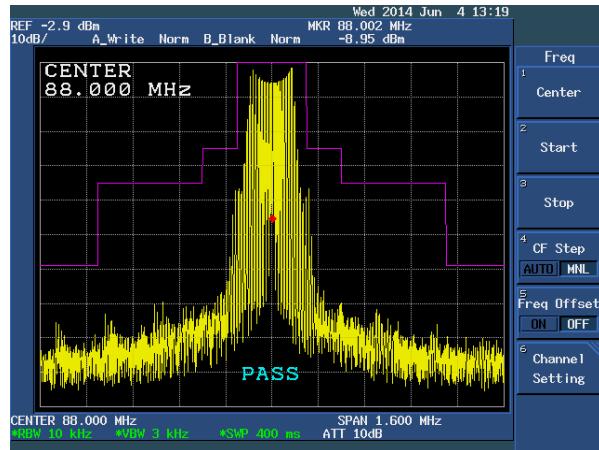


Second Harmonic
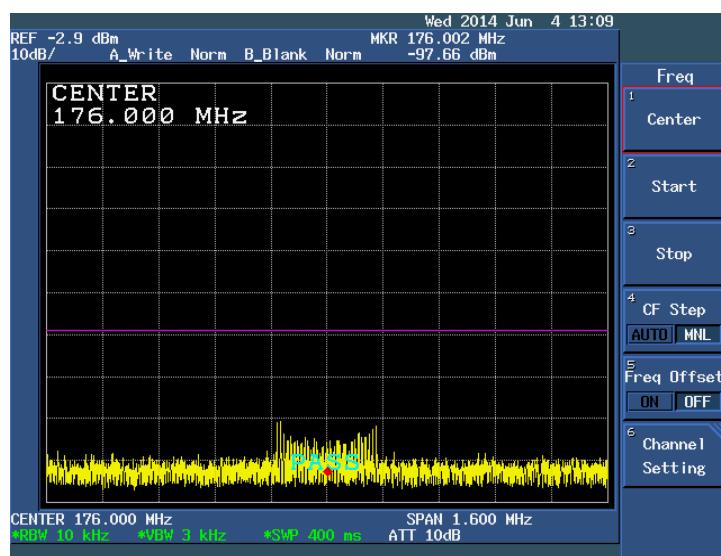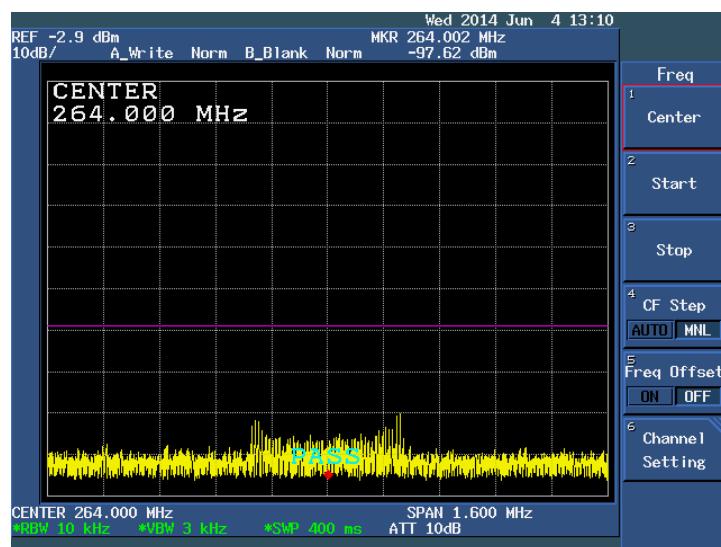


Third Harmonic



Figure 9: Spurious Emissions with 88.0MHz Carrier

Fundamental
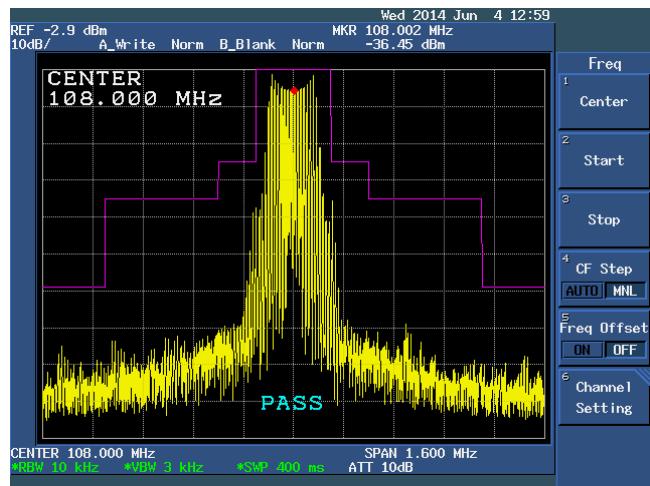


Second Harmonic
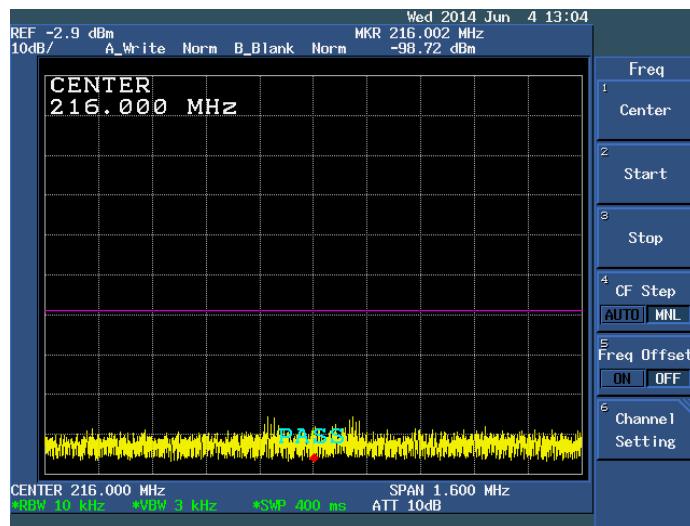


Third Harmonic
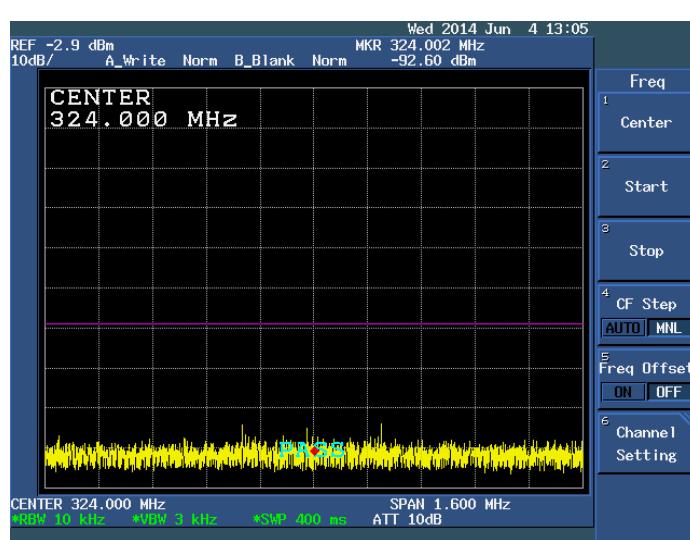


Figure 10: Spurious Emissions with 108.0MHz Carrier

## 7.  Cabinet Radiation

**Definition**

Cabinet radiation is any emission from the transmitting equipment housing or enclosure from sources other than a normal output port.

**Requirement (Industry Canada) – BETS-6 [section 6.4.3]**

Emissions at any frequency shall be at least 54 dB below the calculated field strength reference level. Any radiation weaker than 70dB below the reference level need not be recorded.

**Method**

The transmitting equipment shall be operated at rated power and at a suitable frequency. A receiving antenna shall be connected to a calibrated field strength meter or frequency selective voltmeter. The free space path loss, cable loss, and antenna gain characteristics are obtained at the fundamental frequency and at each of the harmonics of the center frequency in order to assess the level of signal radiated from the cabinet. Radiation from the cabinet is measured at a distance of 10 meters in four different physical rotation angles: 0, 90, 180, and 270 degrees (0 degrees being the front of the cabinet). All spectral components above the noise floor referenced to average power radiated from the cabinet are recorded. Alternatively, suitable radiation measurement equipment may be used, providing the noise floor of the equipment is not higher than the signal to be measured. Using the free space formula below, calculate the reference field strength:

$E = 7 \sqrt{P/r}$ volts per meter    (P is the rated output power in watts and r is distance in meters)
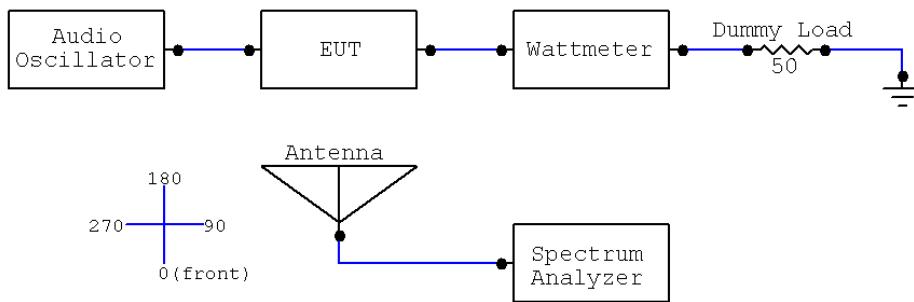
## Measurement

### 88.0 MHz:

| Location | Distance | Measured Power (dBm) | | | E Reference | | Measured Field | | | Antenna Gain (dBi) | | | Cable Loss (dB) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | V/m | dBu | 1st | 2nd | 3rd | 1st | 2nd | 3rd | 1st | 2nd | 3rd |
| Front | 3.0 m | -60.5 | -73.5 | -57.2 | 16.5 | 144.3 | 76.9 | 52.4 | 62.6 | -19.39 | -7.89 | -1.71 | 0.15 | 0.19 | 0.22 |
| Left | 3.0 m | -55.6 | -77.7 | -63.5 | 16.5 | 144.3 | 81.8 | 48.2 | 56.3 | -19.39 | -7.89 | -1.71 | 0.15 | 0.19 | 0.22 |
| Right | 3.0 m | -55.7 | -72.7 | -60.5 | 16.5 | 144.3 | 81.7 | 53.2 | 59.3 | -19.39 | -7.89 | -1.71 | 0.15 | 0.19 | 0.22 |
| Back | 3.0 m | -48.6 | -70.6 | -59.8 | 16.5 | 144.3 | 88.8 | 55.3 | 60.0 | -19.39 | -7.89 | -1.71 | 0.15 | 0.19 | 0.22 |

| Location | Difference ( > 54 dB) | | |
|---|---|---|---|
| | 1st | 2nd | 3rd |
| Front | 67.4 | 91.9 | 81.7 |
| Left | 62.5 | 96.1 | 88 |
| Right | 62.6 | 91.1 | 85.0 |
| Back | 55.5 | 89.0 | 84.3 |

### 108.0 MHz:

| Location | Distance | Measured Power (dBm) | | | E Reference | | Measured Field | | | Antenna Gain (dBi) | | | Cable Loss (dB) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | V/m | dBu | 1st | 2nd | 3rd | 1st | 2nd | 3rd | 1st | 2nd | 3rd |
| Front | 3.0 m | -58.9 | -74.1 | -73.2 | 16.5 | 144.3 | 74.1 | 49.5 | 43.3 | -16.7 | -7.28 | -0.22 | 0.17 | 0.20 | 0.24 |
| Left | 3.0 m | -57.8 | -72.1 | -70.2 | 16.5 | 144.3 | 75.2 | 51.5 | 46.3 | -16.7 | -7.28 | -0.22 | 0.17 | 0.20 | 0.24 |
| Right | 3.0 m | -61.1 | -73.5 | -70.4 | 16.5 | 144.3 | 71.9 | 50.1 | 46.1 | -16.7 | -7.28 | -0.22 | 0.17 | 0.20 | 0.24 |
| Back | 3.0 m | -55.6 | -72.2 | -69.9 | 16.5 | 144.3 | 77.4 | 51.4 | 46.6 | -16.7 | -7.28 | -0.22 | 0.17 | 0.20 | 0.24 |

| Location | Difference ( > 54 dB) | | |
|---|---|---|---|
| | 1st | 2nd | 3rd |
| Front | 70.3 | 94.9 | 101.0 |
| Left | 69.2 | 92.9 | 98.0 |
| Right | 72.5 | 94.3 | 98.2 |
| Back | 67.0 | 93.0 | 97.7 |

## 8. Carrier Frequency Stability

**Definition**

Carrier frequency stability is the ability of the transmitting equipment to maintain a mean test frequency.

**Requirement (FCC) – 74CFR Part 2, Subpart J, 2.1055 and 73.1545**

(b) FM stations. (1) The departure of the carrier or center frequency of an FM station with an authorized transmitter output power more than 10 watts may not exceed +/-2,000 Hz from the assigned frequency.
(2) The departure of the carrier or center frequency of an FM station with an authorized transmitter output power of 10 watts or less may not exceed +/-3,000 Hz from the assigned frequency.

**Requirement (Industry Canada) – BETS6 [section 6.2.3]**

The frequency of the carrier shall remain within +/- 1,000 Hz of the mean test frequency.

**Method**

After a warm up period of at least one hour at rated AC input voltage, the frequency of the carrier is measured at one-minute intervals during a period of fifteen minutes. From these measurements, the mean test frequency is determined. The operating frequencies are measured at ambient temperatures from +0°C and +50°C at the following three values of power supply voltage for each of these temperatures; 85%, 100%, and 115% of nominal AC supply voltage. Repeat for low and high frequencies within the FM band.
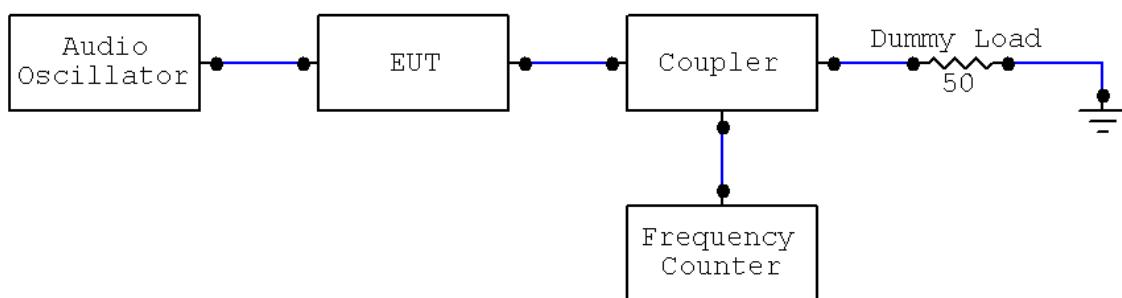
**Measurement**

Mean carrier frequency at 88.0 MHz is ___87.999 552___ MHz

| TEMPERATURE (˚C) | AC VOLTAGE | CARRIER FREQUENCY (MHz) | DEVIATION (Hz) FROM MEAN |
|---|---|---|---|
| 0 | 85% | 87.999 707 | +155 |
| | 100% | 87.999 710 | +158 |
| | 115% | 87.999 714 | +162 |
| 5 | 85% | 87.999 679 | +127 |
| | 100% | 87.999 685 | +131 |
| | 115% | 87.999 689 | +135 |
| 10 | 85% | 87.999 658 | +106 |
| | 100% | 87.999 661 | +109 |
| | 115% | 87.999 666 | +114 |
| 20 | 85% | 87.999 555 | +3 |
| | 100% | 87.999 558 | +6 |
| | 115% | 87.999 563 | +11 |
| 30 | 85% | 87.999 820 | +268 |
| | 100% | 87.999 827 | +275 |
| | 115% | 87.999 833 | +281 |
| 40 | 85% | 87.999 899 | +347 |
| | 100% | 87.999 906 | +354 |
| | 115% | 87.999 911 | +359 |
| 45 | 85% | 87.999 996 | +444 |
| | 100% | 87.999 998 | +446 |
| | 115% | 88.000 003 | +451 |
| 50 | 85% | 87.999 998 | +446 |
| | 100% | 88.000 002 | +450 |
| | 115% | 88.000 006 | +454 |

Mean carrier frequency at 108.0 MHz is ___107.999 442___ MHz

| TEMPERATURE (˚C) | AC VOLTAGE | CARRIER FREQUENCY (MHz) | DEVIATION (Hz) FROM MEAN |
|---|---|---|---|
| 0 | 85% | 107.999 889 | +447 |
| | 100% | 107.999 894 | +452 |
| | 115% | 107.999 899 | +457 |
| 5 | 85% | 107.999 782 | +340 |
| | 100% | 107.999 787 | +345 |
| | 115% | 107.999 786 | +344 |
| 10 | 85% | 107.999 550 | +108 |
| | 100% | 107.999 554 | +112 |
| | 115% | 107.999 556 | +114 |
| 20 | 85% | 107.999 433 | -9 |
| | 100% | 107.999 438 | -4 |
| | 115% | 107.999 441 | -1 |
| 30 | 85% | 107.999 508 | +66 |
| | 100% | 107.999 514 | +72 |
| | 115% | 107.999 519 | +77 |
| 40 | 85% | 107.999 731 | +289 |
| | 100% | 107.999 737 | +295 |
| | 115% | 107.999 741 | +299 |
| 45 | 85% | 107.999 802 | +360 |
| | 100% | 107.999 806 | +364 |
| | 115% | 107.999 809 | +367 |
| 50 | 85% | 107.999 954 | +512 |
| | 100% | 107.999 958 | +516 |
| | 115% | 107.999 966 | +524 |

## 9. Audio Frequency Harmonic Distortion (Mono)

**Definition**

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

**Requirement (Industry Canada) – BETS-6 [section A.1.4.3]**

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

**Method**

The demodulated output of the transmitter is 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 100% modulation are taken at a sufficient number of frequencies in each range of frequencies to plot a distortion versus frequency curve. Alternatively, a VM700 waveform measurement set (or equivalent) may be used. Repeat for low, mid, and high frequencies within the FM band.
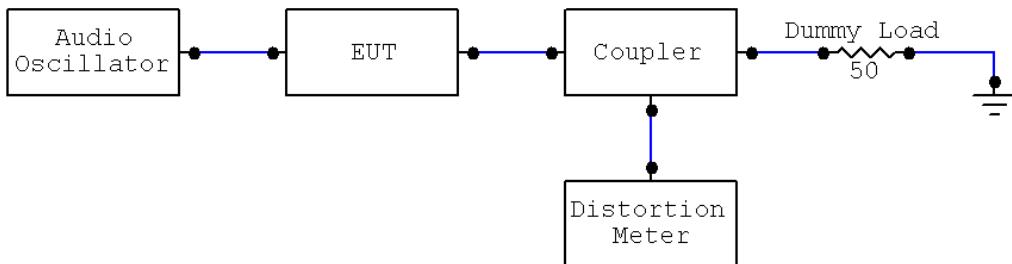


**Measurement**

Carrier Frequency at 88.0 MHz

| Frequency (Hz) | THD (%) |
|---|---|
| 50 | 0.38 |
| 100 | 0.34 |
| 200 | 0.34 |
| 400 | 0.36 |

| Frequency (Hz) | THD (%) |
|---|---|
| 1,000 | 0.36 |
| 2,500 | 0.38 |
| 5,000 | 0.40 |
| 7,500 | 0.43 |

| Frequency (Hz) | THD (%) |
|---|---|
| 10,000 | 0.48 |
| 12,500 | 0.53 |
| 15,000 | 0.63 |

Carrier Frequency at 108.0 MHz

| Frequency (Hz) | THD (%) |
|---|---|
| 50 | 0.19 |
| 100 | 0.20 |
| 200 | 0.21 |
| 400 | 0.21 |

| Frequency (Hz) | THD (%) |
|---|---|
| 1,000 | 0.24 |
| 2,500 | 0.29 |
| 5,000 | 0.34 |
| 7,500 | 0.38 |

| Frequency (Hz) | THD (%) |
|---|---|
| 10,000 | 0.41 |
| 12,500 | 0.57 |
| 15,000 | 0.61 |
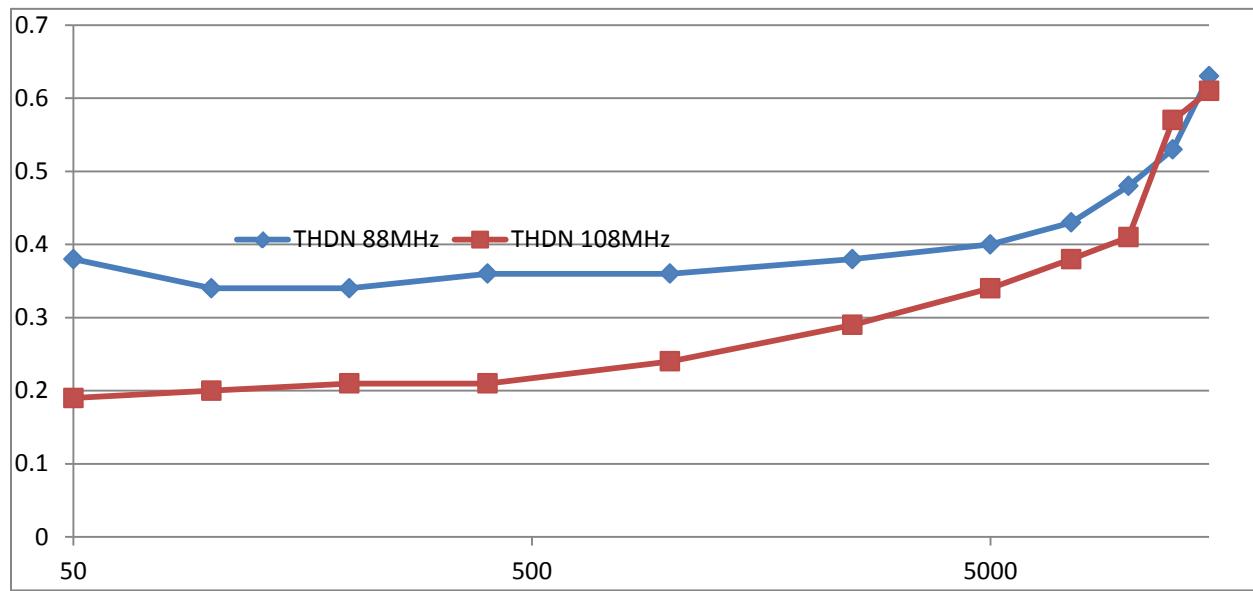
Figure 11: Audio Harmonic Distortion at 88.0 and 108.0MHz Carrier (Mono)

## 10.    Audio Input Level for 100% Modulation and Impedance

**Definition**

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.

**Requirement (Industry Canada) – BETS-6 [section A.1.2.3]**

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

**Method**

The standard test signal shall be adjusted to produce 100% modulation and this level shall be recorded.

**Measurement**

Audio input level:       8.31      dBm


Audio input impedance as per BETS-6 [section A.1.1.1]:           582     ohms

## 11. Frequency Modulation Noise on Carrier (Mono)

**Definition**

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 to 15,000 Hz.

**Requirement (Industry Canada) – BETS-6 [section A.1.5.3]**

The ratio shall be at least 60dB below 100% modulation.

**Method**

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

**Measurement**

| Carrier Frequency | Ratio ( dB ) |
|---|---|
| 88.0MHz | -62 |
| 108.0MHz | -62 |

## 12.  Amplitude Modulation Noise on Carrier (Mono)

**Definition**

The amplitude modulation noise on the carrier 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.

**Requirement (Industry Canada) – BETS-6 [section A.1.6.3]**

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

**Method**

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.

**Measurement**

| Carrier Frequency | Ratio ( dB ) |
|---|---|
| 88.0MHz | -72 |
| 108.0MHz | -72 |

# 13.      Multiplex L&R Audio Frequency Response

**Definition**

A curve or equivalent data showing the frequency response of the audio modulating circuit shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted. For the audio input channel, the audio amplitude frequency response of a transmitter is defined as the inverse ratio of the input voltages at specific frequencies, referenced to a 400 Hz test tone of sufficient amplitude to result in 100% modulation required to obtain a constant percentage of modulation. The input voltages at specific frequencies are within the range from 50 Hz to 15 kHz and the ratio is expressed in dB.

**Requirement (Industry Canada) – BETS-6 [section A.2.3.1]**

The maximum departure of the amplitude response from the standard 75µsec pre-emphasis curve over the range of 50 Hz to 15 kHz shall not exceed ± 0.5 dB up to ± 75 kHz deviation.

**Method**

Using the measurement method of A.1.3.2, except that the maximum modulation level shall be 90%, determine the frequency response curves of the L and R channels.

**Measurement**

A 400 Hz sinusoidal signal from an audio oscillator is applied to the audio input at a level for 90%, 50%, and 25% modulation. With pre-emphasis on, apply sample from the output to the input of a modulation monitor. The audio oscillator's output level at 400 Hz is adjusted to achieve a ± 75 kHz deviation (level is recorded and used as reference). The audio oscillator level is adjusted at 50, 100, 200, 400, 1000, 2500, 5000, 7500, 10000, 12500, and 15000 Hz to retain the ± 75 kHz deviation and the change in audio oscillator level compared to the reference is recorded. Tests completed on two separate frequencies, each near the band edges.
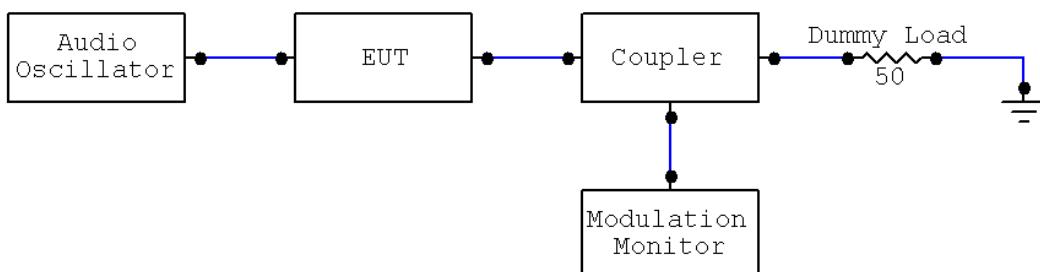
88.0 MHz (Right)
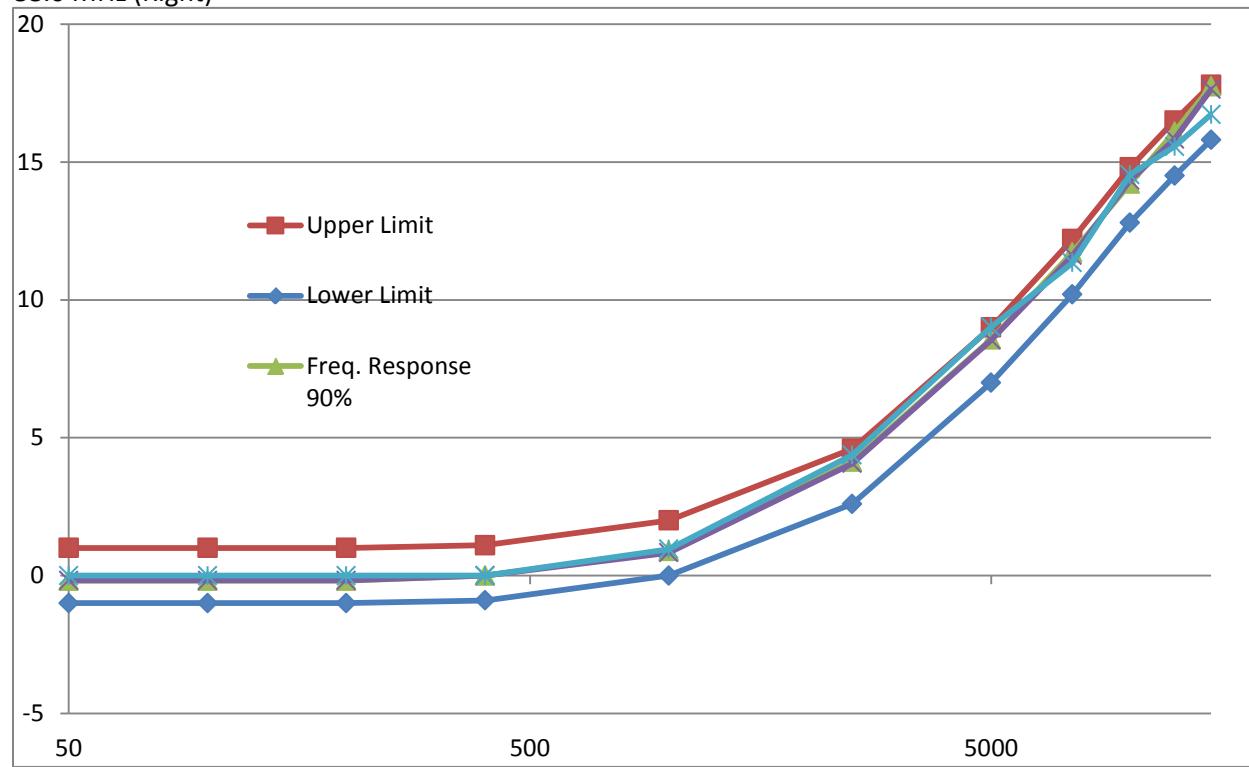


88.0 MHz (Left):
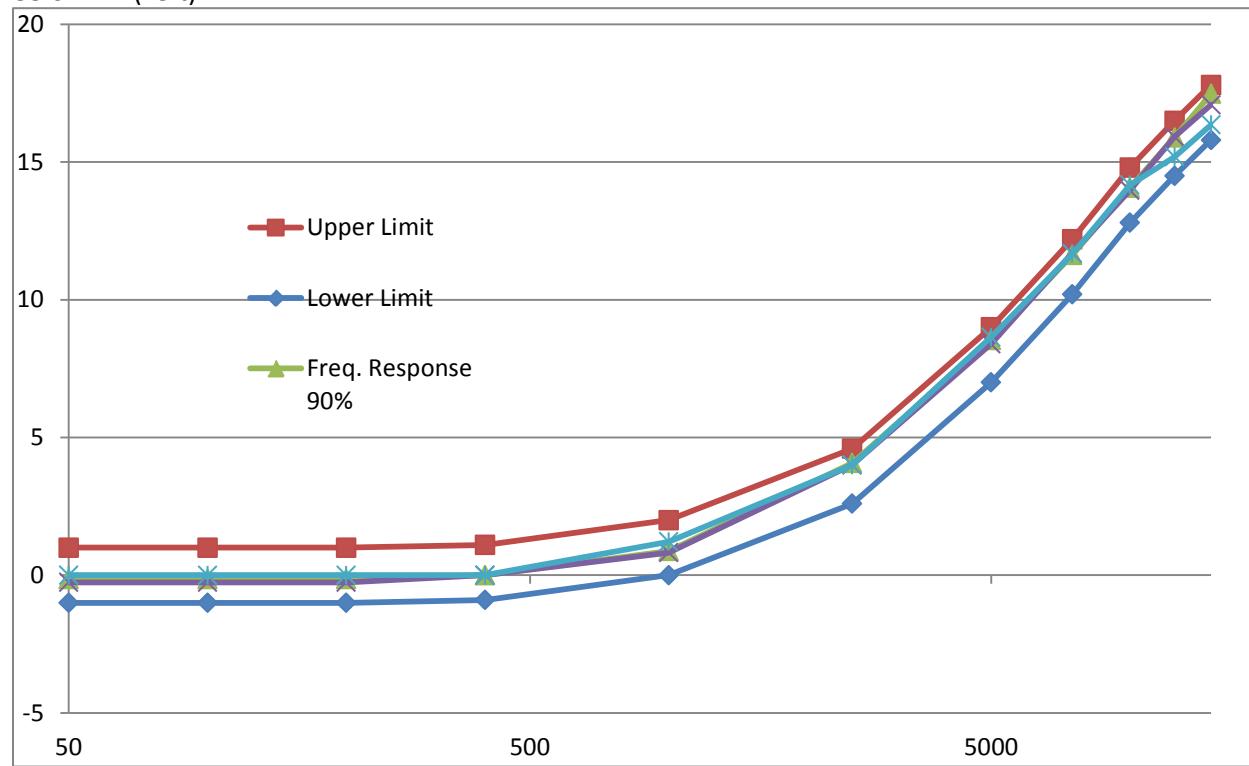


Figure 11: Multiplex L&R Audio Frequency Response with 88.0MHz Carrier (25,50,90% Modulation)

108.0 MHz (Right)
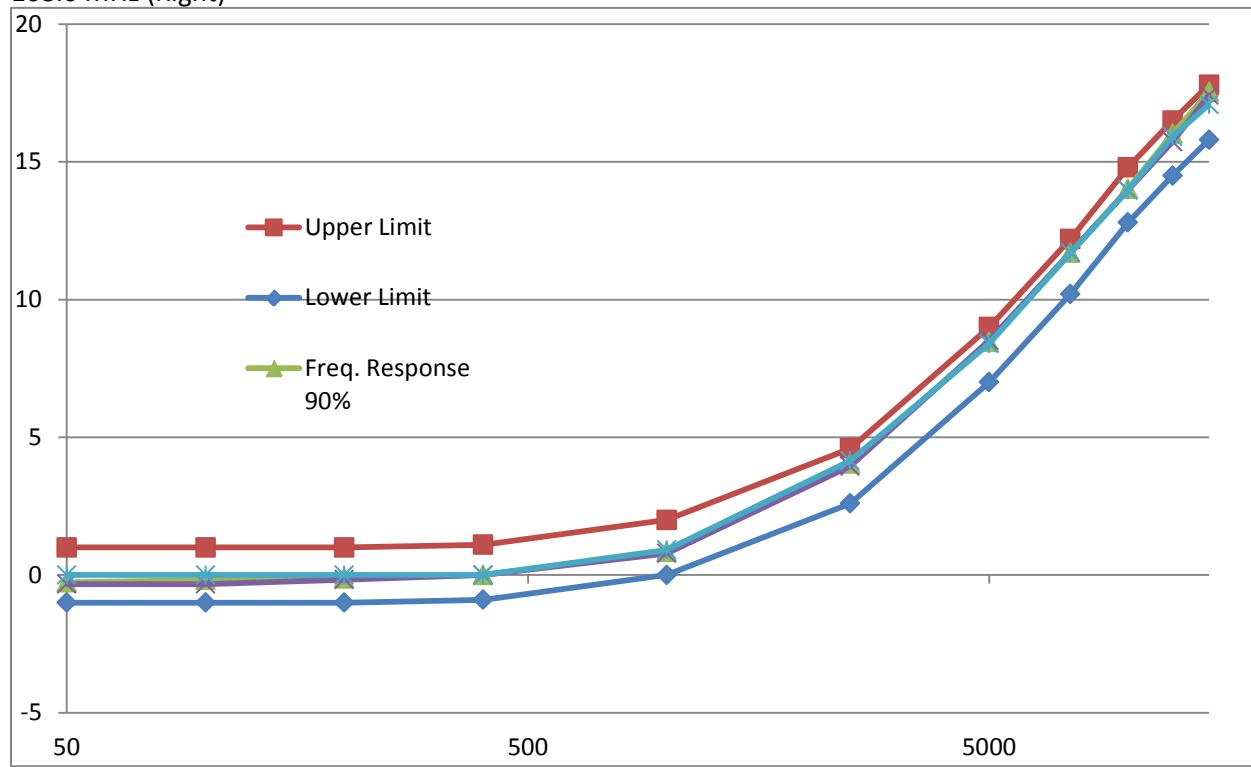


108.0 MHz (Left):
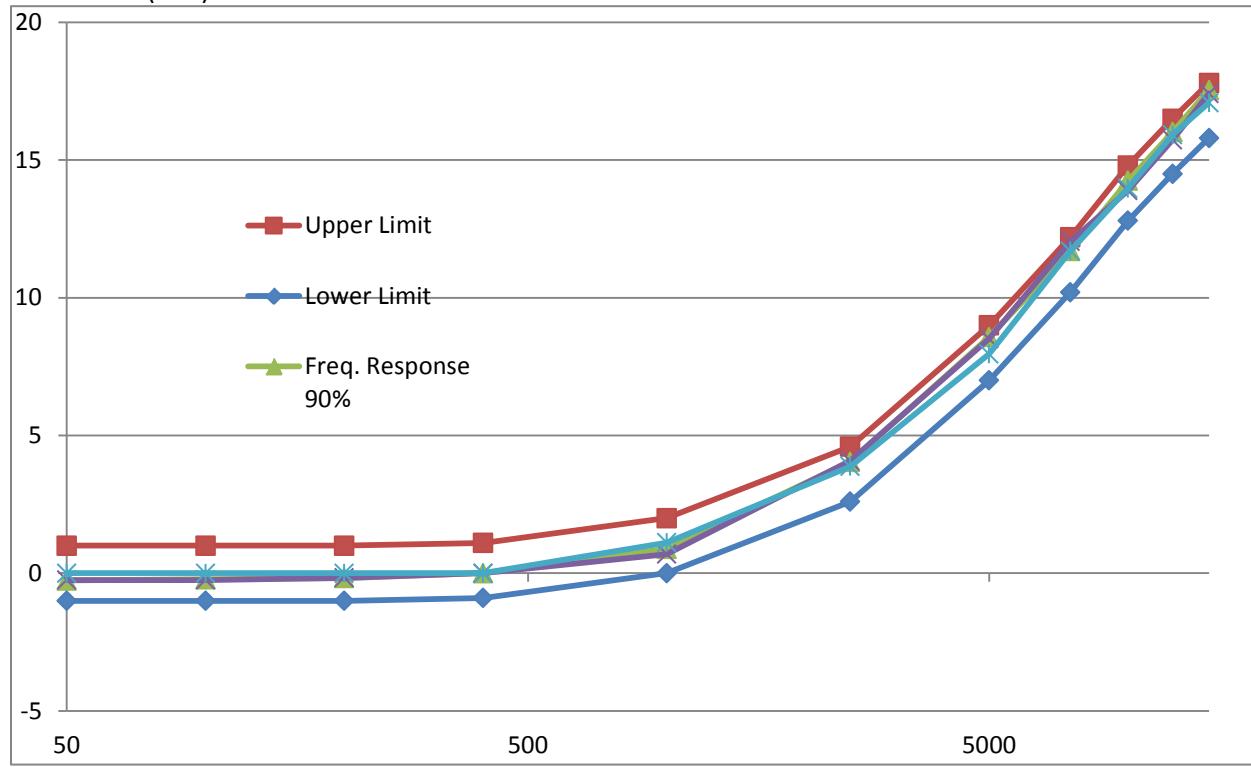


Figure 12: Multiplex L&R Audio Frequency Response with 108.0MHz Carrier (25,50,90% Modulation)

# 14.    Multiplex L&R Audio Frequency Harmonic Distortion

**Definition**

The audio frequency harmonic distortion is the harmonic content of the audio signal contributed by the transmitting equipment. It is measured here for stereo operation.

**Requirement (Industry Canada) – BETS-6 [section A.2.3.2]**

The audio frequency distortion including all harmonics up to 30 kHz shall not exceed 1% in the range of frequencies from 50 to 15,000 Hz. This measurement references the ratio to 90% for stereo operation.

**Method**

The demodulated output of the transmitter is 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 100% modulation are taken at a sufficient number of frequencies in each range of frequencies to plot a distortion versus frequency curve. Alternatively, a VM700 waveform measurement set (or equivalent) may be used. Repeat for low, mid, and high frequencies within the FM band.
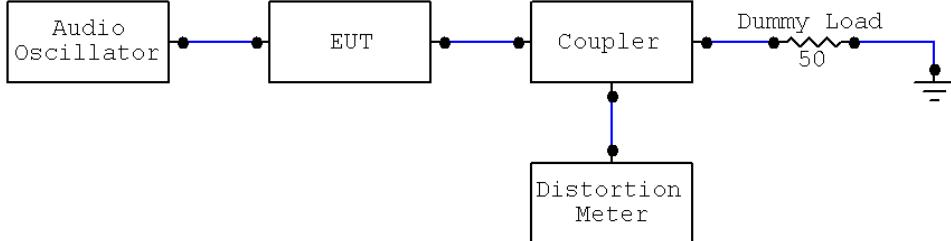


**Measurement**

Carrier Frequency at 88.0 MHz (Right):

| Frequency (Hz) | THD (%) | Frequency (Hz) | THD (%) | Frequency (Hz) | THD (%) |
|---|---|---|---|---|---|
| 50 | 0.44 | 1,000 | 0.38 | 10,000 | 0.56 |
| 100 | 0.46 | 2,500 | 0.39 | 12,500 | 0.97 |
| 200 | 0.44 | 5,000 | 0.48 | 15,000 | 1.00 |
| 400 | 0.49 | 7,500 | 0.51 | | |

Carrier Frequency at 88.0 MHz (Left):

| Frequency (Hz) | THD (%) | Frequency (Hz) | THD (%) | Frequency (Hz) | THD (%) |
|---|---|---|---|---|---|
| 50 | 0.45 | 1,000 | 0.38 | 10,000 | 0.68 |
| 100 | 0.55 | 2,500 | 0.41 | 12,500 | 1.00 |
| 200 | 0.47 | 5,000 | 0.49 | 15,000 | 1.00 |
| 400 | 0.29 | 7,500 | 0.59 | | |

Carrier Frequency at 108.0 MHz (Right):

| Frequency (Hz) | THD (%) |
|---|---|
| 50 | 0.45 |
| 100 | 0.48 |
| 200 | 0.48 |
| 400 | 0.55 |

| Frequency (Hz) | THD (%) |
|---|---|
| 1,000 | 0.45 |
| 2,500 | 0.35 |
| 5,000 | 0.47 |
| 7,500 | 0.56 |

| Frequency (Hz) | THD (%) |
|---|---|
| 10,000 | 0.61 |
| 12,500 | 0.99 |
| 15,000 | 1.00 |

Carrier Frequency at 108.0MHz (Left):

| Frequency (Hz) | THD (%) |
|---|---|
| 50 | 0.52 |
| 100 | 0.52 |
| 200 | 0.51 |
| 400 | 0.35 |

| Frequency (Hz) | THD (%) |
|---|---|
| 1,000 | 0.39 |
| 2,500 | 0.40 |
| 5,000 | 0.51 |
| 7,500 | 0.59 |

| Frequency (Hz) | THD (%) |
|---|---|
| 10,000 | 0.68 |
| 12,500 | 1.00 |
| 15,000 | 1.00 |
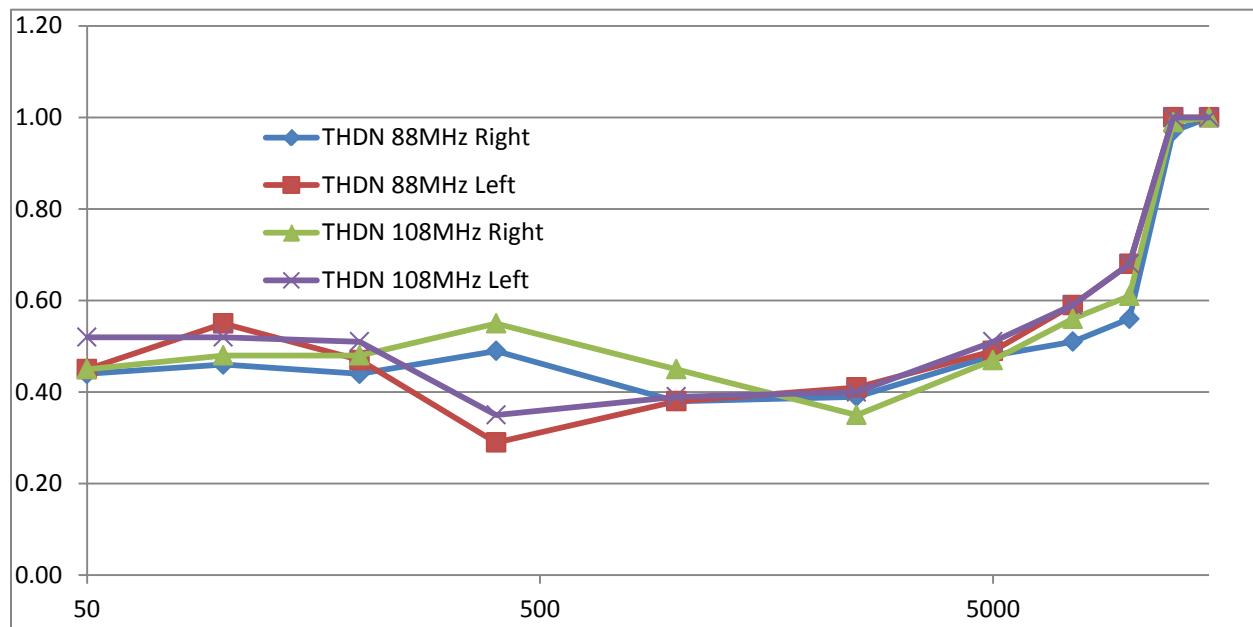


Figure 13: Audio Harmonic Distortion at 88.0 and 108.0MHz Carrier (Stereo)

## 15. Multiplex L&R Frequency Modulation Noise on Carrier

**Definition**

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 to 15,000 Hz.

**Requirement (Industry Canada) – BETS-6 [section A.2.3.3]**

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

**Method**

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

**Measurement**

| Carrier Frequency | Ratio ( dB ) |
|---|---|
| 88.0 MHz | -64 |
| 108.0 MHz | -60 |

# 16.      Multiplex L&R Amplitude Modulation Noise on Carrier

**Definition**

The amplitude modulation noise on the carrier 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.

**Requirement (Industry Canada) – BETS-6 [section A.2.3.4]**

The ratio shall be at least 50dB below carrier level within the band of 50 to 15,000 Hz, (90% modulation).

**Method**

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.

**Measurement**

| Carrier Frequency | Ratio ( dB ) |
|---|---|
| 88.0 MHz | -70 |
| 108.0 MHz | -64 |

## 17.    Stereophonic Crosstalk

**Definition**

Crosstalk is unwanted leakage or bleed of a signal from one audio channel to other channels within a device.

**Requirement (Industry Canada) – BETS-6 [section A.2.3.5]**

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

**Method**

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.

**Measurement**

*88.0 MHz:*
Crosstalk on L-R referenced to 90% modulation by L+R channel:  _____-48_____ dB

Crosstalk on L+R referenced to 90% modulation by L-R channel:  _____-47_____ dB

*108.0 MHz:*
Crosstalk on L-R referenced to 90% modulation by L+R channel:  _____-48_____ dB

Crosstalk on L+R referenced to 90% modulation by L-R channel:  _____-47_____ dB

# 18.    Stereophonic Separation

**Definition**

Stereo separation is the difference of what is being output from the left and right channels of the transmitter.

**Requirement (Industry Canada) – BETS-6 [section A.2.3.6]**

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

**Method**

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, 1000, 2500, 5000, 7500 and 10000 Hz. Repeat the above with a test signal applied to the R channel only.

**Measurement**

*88.0 MHz:*

| Signal Applied to L Channel | | Signal Applied to R Channel | |
|---|---|---|---|
| Frequency (Hz) | Separation (dB) | Frequency (Hz) | Separation (dB) |
| 100 | 31 | 100 | 31 |
| 400 | 36 | 400 | 36 |
| 1,000 | 36 | 1,000 | 34 |
| 2,500 | 35 | 2,500 | 34 |
| 5,000 | 35 | 5,000 | 35 |
| 7,500 | 36 | 7,500 | 35 |
| 10,000 | 35 | 10,000 | 35 |

*108.0 MHz:*

| Signal Applied to L Channel | | Signal Applied to R Channel | |
|---|---|---|---|
| Frequency (Hz) | Separation (dB) | Frequency (Hz) | Separation (dB) |
| 100 | 31 | 100 | 31 |
| 400 | 34 | 400 | 36 |
| 1,000 | 32 | 1,000 | 34 |
| 2,500 | 35 | 2,500 | 35 |
| 5,000 | 35 | 5,000 | 35 |
| 7,500 | 36 | 7,500 | 34 |
| 10,000 | 35 | 10,000 | 35 |

# 19.     Frequency Stability of Pilot Subcarrier

**Definition**

The pilot tone at 19 kHz indicates that there is a 38kHz stereophonic subcarrier present. The receiver uses this tone as a reference to demodulate the stereo information and it is important that the pilot subcarrier frequency remains constant.

**Requirement (Industry Canada) – BETS-6 [section A.2.3.7]**

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.

**Method**

After a warm-up period of one hour at rated AC input voltage, measure the frequency of the pilot subcarrier at one minute intervals during a period of fifteen minutes. From these measurements determine a mean pilot frequency.

**Measurement**

Mean pilot frequency: _____19,000_____ Hz
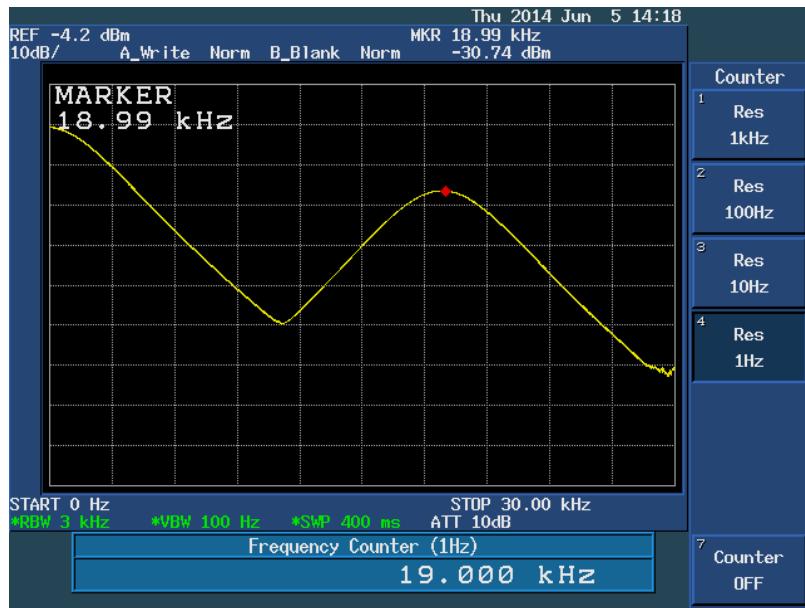


Figure 14: Pilot Subcarrier Frequency

## 20.   Stereophonic Subcarrier Suppression

**Definition**

The 38kHz subcarrier is suppressed to give a double sideband signal above the normal audio bandwidth.

**Requirement (Industry Canada) – BETS-6 [section A.2.4]**

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

**Method**

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

**Measurement**

*88.0 MHz:*
Stereo subcarrier level below total modulation of carrier:  _____-58_____ dB

*108.0 MHz:*
Stereo subcarrier level below total modulation of carrier:  _____-59_____ dB