TB-4
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Spectrum Management

Technical bulletin

Cable Converting Television Apparatus Measurement Methods

Canada

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Effective July 1, 1979, the Minister issued new regulations governing the sale of broadcasting receiving apparatus. These regulations identify limits for a number of parameters in order to ensure compatibility with the radio environment and cable TV systems. On this subject, Section 19 of the *General Radio Regulations, Part I* stipulates that:

> "Before offering for sale for use in Canada any radio apparatus of the class described in subsection 18 (*1*), the manufacturer or importer shall ensure that the apparatus or a production sample or other representative unit of that type of apparatus is tested in accordance with a procedure approved by the Minister to determine whether or not it conforms to the applicable technical requirements established by the *General Radio Regulations, Part II*."

Throughout the intervening period, the Department has reviewed and accepted test methods submitted by manufacturers on a case-by-case basis to ensure compliance with the technical requirements of the Regulations. The Department, up until now, had not formally approved any particular measurement method.

The measurement methods presented in this technical bulletin are those presently used by the Department in ascertaining compliance with the *General Radio Regulations*. This bulletin is not intended to serve as a complete engineering standard and may be subject to future revisions.

The methods described permit a certain flexibility in the measurement of parameters, available test equipment and the elimination of some of the ambiguities encountered in past reports.

It should be emphasized that the Department will accept other methods provided they are fully documented and that their results coincide with the methods described herein. Manufacturers and other interested parties are invited to submit suggestions on alternate methods to:

Director General
Spectrum Engineering
Industry Canada
300 Slater Street
Ottawa, Ontario
K1A 0C8

Manufacturers are reminded that final responsibility for compliance with Part 2 of the *General Radio Regulations* rests with them, and that the measurement methods described herein are provided as guidelines only.

Original signed by

Dr John deMercado
Director General
Telecommunication Regulatory Service

Tuning - Offset Capability

Equipment Required

Spectrum analyser of frequency counter (50 - 1000 MHz)

The minimum accuracy of the frequency measuring device shall be within 50 kHz.

Method

(1) The converter's 75 ohm input is connected to the spectrum analyser (via a suitable matching network if required).

(2) All other ports are terminated in 75 ohms.

(3) Ensure that the converter is operating normally.

(4) The converter is tuned to channel 2 and the fine tuning frequency range of the local oscillator determined. In borderline cases, a reading of increased accuracy may be obtained through the use of a frequency counter (and amplifier if required).

(5) The above measurements are repeated for all channels (or, if applicable, only the local oscillator frequency range need be determined).

Limits

The *General Radio Regulations, Part II* states the following:

"134 (1) (*a*) every converter that converts the received television broadcasting signals to a particular output channel in the very high frequency band for delivery of signals to a radio apparatus that conforms to the requirements of paragraph 131 (1) (*a*) shall be equipped with

(ii) a fine tuning control, an automatic frequency control, or an internally adjustable control for each channel received or any combination of such controls that will provide sufficient adjustment of the converter over a range of frequencies to ensure,

(A) for the very high frequency channels, the reception of input signals whose visual carrier frequencies are offset by up to ± 0.55 MHz from their nominal visual carrier frequencies, and

(B) for the mid-band channels and super-band channels, the reception of input signals whose visual carrier frequencies are offset by up to -1.31 MHz from their nominal visual carrier frequencies."

Frequency Stability

Equipment Required

Variable transformer (104 - 127 VAC)

AC voltmeter

Frequency counter

Data recorder (optional)

R.F. signal generator (not required for UHF block type converter)

The minimum accuracy of the frequency generating and measuring devices shall be within 1 part per million.

Method

(1) The converter under test is subjected to a twelve hour warm-up period (AC power provided via the variable transformer, 117 VAC suggested).

(2) The R.F. signal generator is tuned to a selected channel and the output signal level adjusted to produce a level of 14 dBmV at the frequency of interest (in the case of UHF block type converters applying only single frequency conversion, determination of local oscillator frequency stability, with no input signal present, is acceptable).

(3) The adjusted signal feed is connected to the converter's 75 ohm input and the converter tuned to the selected channel.

(4) The converter's 75 ohm output is connected to the frequency counter (via an amplifier if required).

(5) Any unused ports on the converter are terminated in 75 ohms.

(6) Connection of a data recorder to the frequency counter is recommended for analysis of frequency deviations.

(7) The variable transformer is varied at ½ hour intervals over a 3 hour continuous period and the frequency deviation determined (a suggested variation pattern is 117 - 104 - 127 - 117 - 104 - 127 VAC).

Limits

The *General Radio Regulations, Part II* states the following:

"134 (1) (*c*) (*i*) the frequency stability obtained with any line voltage in the range from 104 to 127 volts and measured, after twelve hours of warm-up operation, over a period of three hours shall be such that the visual carrier frequency of signals received via any input channel, converted and delivered to a radio apparatus that conforms to the requirements of paragraph 131 (1) (*a*) via an output channel will,

(A) if the converter is equipped with a fine tuning control, be maintained within 450 kHz of the nominal carrier frequency for the output channel, or

(B) if the converter is not equipped with a fine tuning control, be maintained within 250 kHz of the nominal carrier frequency for the output channel."

Gain Characteristics

Equipment Required

Frequency generator or Sweep generator

Spectrum analyser

Method

(1) Ensure that the converter is operating normally.

(2) The feed from the frequency generator is connected to the spectrum analyser (via suitable matching network, if required).

(3) The frequency generator output level is adjusted to produce a level of 14 dBmV over the frequency range of interest.

(4) The adjusted signal feed is connected to the converter's 75 ohm input and the converter tuned to channel 2.

(5) The converter's 75 ohm output is connected to the spectrum analyser tuned to cover the output channel frequency range (via a suitable matching network if required).

(6) Any other ports on the converter are terminated in 75 ohms.

(7) The output signal level is measured and the gain characteristics determined.

(8) The above procedure is repeated for an adequate number of channels to ensure that measurement are representative.

Limits

The *General Radio Regulations, Part II* states the following:

"134 (1) (*c*) (ii) the gain characteristics shall be such that,

(A) for a converter having automatic gain control circuitry, the output signal levels are not less than 1 millivolt (0 dBmV) and not more than 5 millivolts (14 dBmV), or

(B) for a converter not having automatic gain control circuitry, the conversion gain is not less than 0 dB nor more than 7 dB."

Noise Figure

Equipment Required

Noise source (with power supply)

Automatic noise figure indicator or high sensitivity tuneable voltmeter (selection dependent on sensitivity required)

The measuring devices shall have a bandwidth of at least 1 MHz.

Method

(1) The converter to be tested and the equipment associated with the measurements of noise figure are placed in a shielded room or other environment with levels of radio frequency energy low enough to minimize effects on the measurements.

(2) Ensure that the converter is operating normally.

(3) Before testing, the converter and noise figure test equipment are subjected to a warm-up period of sufficient time for the stabilization of factors which could affect the measurements.

(4) The noise source is connected to the converter's 75 ohm input (via an applicable matching network if required).

(5) The converter's 75 ohm output is connected to the automatic noise figure indicator or high sensitivity tuneable voltmeter (via a suitable matching network if required). If necessary, a low noise preamplifier may be used between the output from the converter and the input of the indicating instrument in order to obtain sufficient level.

(6) Any other ports are terminated in 75 ohms.

(7) The center frequency of the converter's nominal output frequency band is used as the center frequency of the noise indicating instrument to which the converter's output is connected.

(8) Local oscillator frequencies are adjusted to within ± 0.55 MHz of the desired oscillator frequencies for VHF and within the 0 to -1.31 MHz range for mid-band and super-band.

(9) Noise figure data in dB for each measured channel are to be reported as read from the noise figure indicating instrument. The only permissible correction factors are the impedance transformation loss and noise contribution of the preamplifier when used.

Limits

The *General Radio Regulations, Part II* states the following:

"134 (1) (*c*) (iii) the noise figure for any channel shall not exceed 13 dB."

Shielding Effectiveness

Equipment Required

R.F. signal generator (1.6 - 300 MHz)

R.F. power amplifier system

Field strength meter and pick-up sensor/antenna

Spectrum analyser (1.6 - 300 MHz)

Broadband antenna or parallel plate antenna system ("Jacky Cell"); dependent on applicable frequency.

Method

(1) The signal from the R.F. signal generator is fed to the R.F. power amplifier.

(2) The amplifier output signal is connected to either a broadband antenna or parallel plate antenna system (dependent on frequency) for the purpose of generating a uniform field of 100 mV/m over a specific area (the parallel plate antenna system is recommended due to its generation of a relatively uniform field in an enclosed area, as well as requiring a lesser amplifier power output).

(3) Utilizing a field strength meter and pick-up sensor/antenna, a 100 mV/m field is located. The required field may be achieved by adjustment of the amplifier output level (if applicable, the F.S.M. reading is converted to mV/m by using the antenna correction factor for the frequency of the channel under investigation).

(4) The converter under test is placed in the 100 mV/m uniform field on a non-metallic platform, such that the converter is centered in the generated field space.

(5) The converter's 75 ohm output is connected to the spectrum analyser (via a suitable matching network if required).

(6) Any other ports on the converter are terminated in 75 ohms.

(7) The converter under test shall be checked over the entire frequency range for which it is intended to be tuned. The number of test frequencies shall be sufficient to ensure that the maximum level of interference is measured at the output of the converter in the frequency range from 1.6 to 300 MHz. Test frequencies selected should include the video carrier fundamental frequencies for the full range of VHF, mid-band and super-band channels. Converter output signals should be measured at the fundamental of both the input frequency and the converted output channel.

Limits

The *General Radio Regulations, Part II* (amended) states the following:

"134 (1) (*c*) (iv) when the converter is exposed to a radiation field having a measured field strength of 100 mV/m at any frequency in the range from 1.6 MHz to 300 MHz, the shielding shall be sufficient to ensure that no voltage attributable to the field exceeds 10 microvolts (-40 dBmV) as measured at the output terminals of the converter."

Internally Generated Interference

(At input port with no input signals present)

Equipment Required

Spectrum analyser (5 - 1000 MHz)

Sensitivity: -99 dBm (-50 dBmV)

Method

(1) The converter under test and the equipment associated with the measurements are placed in an environment with levels of radio frequency energy sufficiently low so as to preclude any effects on the measurements.

(2) Ensure that the converter is operating normally.

(3) The converter's 75 ohm input is connected to the spectrum analyser (via a suitable matching network if required).

(4) All other ports on the converter are terminated in 75 ohms.

(5) The converter is tuned to channel 2 and the spectrum searched for any internally generated signals.

(6) The above measurements are repeated for all channels.

Limits

The *General Radio Regulations, Part II* states the following:

"134 (1) (*c*) (vi) with no input signal present, the level of any local oscillator signal and of any signal of an undesired or spurious nature generated within the converter and arriving at the cable input terminals of the converter,

(A) in the frequency range above 5 MHz and below 30 MHz, shall not exceed -50 dBmV.

(B) in the frequency range from 30 MHz to below 54 MHz, shall not exceed - 35 dBmV.

(C) in the frequency range from 54 MHz to 300 MHz, shall not exceed -31 dBmV, and

(D) in the frequency range above 300 MHz and below 1000 MHz, shall not exceed -10 dBmV.

Internally Generated Interference

(At input port with input signals present)

Equipment Required

Power divider (75 ohms)

Spectrum analyser (5 - 300 MHz)

R.F. attenuator

Multichannel R.F. generator (minimum capability: VHF channels 2 - 13, and any three adjacent mid-band channels)

Method

(1) The converter under test and the equipment associated with the measurements are placed in an environment with levels of radio frequency energy sufficiently low so as to preclude any effects on the measurements.

(2) Ensure that the converter is operating normally.

(3) The converter's 75 ohm input is connected to the spectrum analyser via the output ports of a power divider (using a suitable matching network if required).

(4) All other ports on the converter are terminated in 75 ohms.

(5) The feed from the multichannel R.F. generator (unmodulated TV signals, vision and sound carriers only) is connected to the power divider input via an R.F. attenuator.

(6) The generator/attenuator signal level is adjusted to produce a level of 14 dBmV at the converter input port.

(7) The converter is tuned to channel 2 and, using the spectrum analyser, the spectrum is searched for any internally generated signals.

(8) The above measurements are repeated for all channels.

Limits

The *General Radio Regulations, Part II* states the following:

"134 (1) (*c*) (vii) with input signals present, any spurious signal generated within the converter and appearing at the input terminals shall be at least 25 dB below input signal levels."

R.F. Emission

Equipment Required

Field Strength meter (30 - 1000 MHz)

Tuneable dipole antenna (30 - 1000 MHz)

Method

(1) The converter under test and the equipment associated with the measurements are placed in an environment with levels of radio frequency energy sufficiently low so as to preclude any effects on the measurements.

(2) Ensure that the converter is operating normally.

(3) Tests must be conducted in a suitable environment such as that specified in Supplement to Standard 51 IRE 17.S1* *Practical Considerations in measuring VHF receiver oscillator radiation* September 11, 1952 published as part of IEEE Standard 187 - 1951; Standards on Radio Receivers *Open Field Method of Measurement of Spurious Radiation from Frequency Modulation and Television Broadcast Receivers*.

(4) The converter shall be positioned at a height of 1 metre above ground.

(5) The power-line cord from the converter is completely uncoiled and plugged into a receptacle located on the vertical axis directly below the converter.

(6) All ports on the converter are terminated in 75 ohms.

(7) The tuneable dipole antenna is positioned and adjusted as designated by the limits of the frequency range under test.

(8) The location of the field strength meter and operator shall be such as to preclude any effects on the measurements. (A power switch at this location to permit momentary converter turn off may prove helpful in verifying that the correct signal is being detected and that no interference is present).

(9) The converter under test is checked over the frequency range to which it is intended to be tuned. The number of test frequencies shall be adequate to insure measurement of maximum radiation within this range.

(10) The converter under test and the dipole antenna are rotated until maximum signal at the field strength meter is obtained for each measurement set.

(11) The above tests are performed for the field strength meter antenna aligned for both horizontal and vertical polarization configurations.

Limits

The *General Radio Regulations, Part II* states the following:

"134 (1) (*c*) (viii) the field strength of any emission emanating from the converter shall not exceed

(A) 20 μV/m at a distance of 10 metres in the frequency range above 5 MHz and below 54 MHz;

(B) 20 μV/m at a distance of 3 metres in the frequency range from 54 MHz to below 108 MHz;

(C) 10 μV/m at a distance of 3 metres in the frequency range from 108 MHz to below 174 MHz;

(D) 20 μV/m at a distance of 3 metres in the frequency range from 174 MHz to below 216 MHz;

(E) 20 μV/m at a distance of 10 metres in the frequency range from 216 MHz to below 300 MHz; and

(F) 220 μV/m at a distance of 10 metres in the frequency range from 300 MHz to 1000 MHz."

Internally Generated Interference

(Spurious signals within the pass-band of any output channel)

Equipment Required

Multichannel R.F. generator (minimum capability: VHF channels 2 - 13, and three adjacent mid-band channels)

Two spectrum analysers (5 - 300 MHz) (second spectrum analyser optional)

R.F. attenuator

Power divider (75 ohms) (optional; requirement dependent on availability of second spectrum analyser)

Method

(1) The converter under test and the equipment associated with the measurements are placed in an environment with levels of radio frequency energy sufficiently low so as to preclude any effects on the measurements.

(2) Ensure that the converter is operating normally.

(3) In order to monitor the input signal to the converter, a power divider and spectrum analyser may be connected to the multichannel R.F. generator (unmodulated TV signals, vision and sound carriers only) with a suitable matching network if required.

(4) The feed from the multichannel R.F. generator (via power divider if applicable) is connected to the converter's 75 ohm input.

(5) The converter's 75 ohm output is connected to a spectrum analyser (via a suitable matching network if required).

(6) Any other ports on the converter are terminated in 75 ohms.

(7) The generator/attenuator signal level is adjusted to produce a level of 14 dBmV at the converter input port.

(8) The converter is tuned to channel 2 and using the spectrum analyser, the spectrum of the converter output signals is searched for any spurious signals within the 6 MHz pass-band of the output channel.

(9) The above procedure is repeated for all available channels.

Limits

The *General Radio Regulations, Part II* states the following:

"134 (1) (*c*) (ix) Any level of any spurious signal produced by the converter and falling within the pass-band of any output channel shall not, in the worst case, be less than 50 dB below the signal level of the output visual carrier, as measured separately for each input channel where signals at the same level in the range, from 1 millivolt (0 dBmV) to 5 millivolts (14 dBmV), are supplied to all inputs except the one under test."