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Spectrum Management

Technical Bulletin

Cable Compatible 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 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 1* 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 currently 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 or frequency counter (50 - 1000 MHz)

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

Method

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

(2) Ensure that the receiver is operating normally and that the AFT (or AFC) if provided, is disabled.

(3) The receiver 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).

(4) The above measurements are repeated for an adequate number of channels to ensure that the measurements are significant.

Limits

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

"133 (*a*) when the apparatus is adjusted to receive signals from a broadcasting receiving undertaking, it shall be equipped and have characteristics as follows:

(ii) the fine tuning control or automatic frequency control shall provide sufficient adjustment of the apparatus over a range of frequencies to ensure

(A) for the very high frequency channels, 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, reception of input signals whose visual carrier frequencies are offset by up to -1.31 MHz from their nominal visual carrier frequencies."

Noise Figure

The method described herein presents revised excerpts from FCC OST Bulletin 50 - *Measurement of UHF Noise Figures of TV Receivers* as applicable to cable compatible television receiver noise figure measurements.

Equipment Required

Solid state 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 receiver to be tested and the equipment associated with the measurements of noise figures are placed in a shielded room or other environment with levels of radio frequency energy low enough to minimize effects on the measurements.

(2) Before testing, the television receiver and noise figure test equipment are subjected to a warm-up period of sufficient time for stabilization of factors which could affect the measurements. The supply for line-operated receivers is required to be 120V ± 5 %, 60 Hz or as specified; that for battery-operated receivers is the voltage specified.

(3) The TV receiver noise figure is preferably measured by coaxially connecting an automatic noise figure indicating system to the tuner output. If this connection is not feasible the noise output is obtained through the use of a small loop, or other suitable probe, coupled to one of the intermediate frequency amplifier stages. The stage chosen is that which yields the adequate noise output without disturbing shielding or other circuit elements. In the event that this, too, is not a workable approach, an appropriate low capacitance probe is used instead of the loop. A low noise preamplifier is used between the noise output from the receiver and the input of the indicating instrument in order to obtain a sufficient level, if necessary.

(4) A solid state noise source is connected to the receiver's 75 ohm input (via a suitable matching netword if required). Particular care is taken that the signal path from the receiver's external input to its tuner is not disturbed.

(5) Automatic gain control bias, preceding the noise output measurement point, is maintained at the level existing when there is no input signal with the receiver's 75 ohm input terminated in its nominal impedance. The receiver is otherwise operated so that the noise figure data are actually those inherent to it.

(6) An automatic noise figure indicator should be used in conjunction with the noise source (companion units) to determine the noise figure of the elevision receiver. The center frequency of the television receiver's nominal intermediate frequency band at the measurement point is used as the center frequency of the automatic noise figure indicator to which the receiver's noise output is connected.

(7) 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 midband and superband.

(8) It must be ascertained that the noise figure contribution of the IF amplifier following the measurement point does not exceed 0.25 dB. This can be done by application of the equation:

$$\Delta F = 10 \log \left[1 + F_2 - 1 \right]$$

$$F_1 G_1$$

where ΔF = noise figure contribution of the IF amplifier following the measurement point in dB,

F_2 = noise figure of that IF amplifier as a power ratio,

F_1 = noise figure from receiver antenna input terminals to measurement point as a power ratio, and

G_1 = gain of circuit from receiver antenna input terminals to measurement point as a power gain.

Factor values in this equation may be calculated design characteristics or measured values. Resulting ΔF values exceeding 0.25 dB must be added to the value obtained at the measurement point for data submitted for certification. If ΔF does not exceed 0.25 dB, it may be neglected in the submitted noise figure data.

(9) Noise figure data in dB are to be reported as read from the noise figure indicating instrument. The only permissible correction factor is the impedance transformation loss. The required ΔF contribution must be given if they are part of the final submitted noise figure values.

(10) The above measurements are repeated for an adequate number of channels to ensure that the measurements are significant.

Limits

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

"132 (*a*) the noise figure for the radio apparatus shall,

(i) for channel numbers 2 to 13, not exceed 10 dB, and

(ii) for channel numbers 14 to 69,

(A) if manufactured in or imported into Canada on or before October 1, 1981, not exceed 18 dB,

(B) if manufactured in or imported into Canada after October 1, 1981, and before October 2, 1984, not exceed 14 dB, or

(C) if manufactured in or imported into Canada after October 1, 1984, not exceed 12 dB,"

"133 (*a*) when the apparatus is adjusted to receive signals from a broadcasting receiving undertaking, it shall be equipped and have characteristics as follows:

(iii) the noise figure for any channel shall not exceed 10 dB except that, where the circuitry or configuration of the apparatus involves a double conversion of input signals, the noise figure may exceed 10 dB but shall not exceed 13 dB.

(*b*) when the apparatus is adjusted to receive signals from a broadcasting transmitting undertaking it shall conform to the requirements set out in section 132 except that the noise figure for channel numbers 2 to 13 shall not exceed 10 dB unless the circuitry or configuration of the apparatus involves a double conversion of input signals in which case the noise figure may exceed 10 dB but shall not exceed 13 dB."

Co-Channel Immunity

Equipment Required

Field strength meter

Adjustable dipole with frequency measuring ruler

RF amplifier

RF attenuator

Spectrum analyser (50 - 250 MHz)

VHF multichannel antennas (2)

Multichannel RF generator (VHF channels 2 - 13) (optional)

Method

(1) A VHF multichannel receive antenna is placed in an environment permitting reception of off-air broadcast signals.

(2) The signal from the antenna is input to a broadband RF amplifier.

(3) The amplifier output signal is connected to the second VHF multichannel antenna in order to permit re-radiation of the broadcast signal.

(4) Utilizing a field strength meter and adjustable dipole, a 100 mV/m field is located at a distance of 5 - 10 meters from the re-radiation antenna. The antenna positions may have to be varied in order to prevent possible oscillations between re-radiation and pick-up antennas. The required field may be achieved by adjustment fo the amplifier output level. (The F.S.M. reading is converted to mV/m by using the antenna correction factor for the corresponding frequency of the channel under investigation.)

(5) The receiver under test is placed in the 100 mV/m field such that the antenna panel occupies the field. (The receiver must not block the antenna panel from the transmitted signal.)

(6) The feed from the multichannel RF generator or local cable system is connected to the spectrum analyser (via a suitable matching network if required).

(7) The spectrum analyser is tuned to the frequency of interest and the amount of attenuation required to produce levels of -20 dBmV and 0 dBmV determined.

(8) Ensure that the receiver is operating normally and that all customer switches and controls are adjusted for cable reception and normal viewing for the channel of interest.

(9) The signal feed is then connected to the receiver's 75 ohm input by means of a coaxial cable whose length equals an odd multiple of $\lambda/2$ for the channel under test.

(10) With an input signal level of -20 dBmV, an attempt should be made to identify the non-coincident sync interference. This will enable the tester to concentrate on the video interference only. (If observation of the non-coincident sync information is preferable, the input signal level may be adjusted to -37 dBmV.

(11) The input signal level is then increased to 0 dBmV and the receiver's picture display observed for any evidence of co-channel synchronous interference (-17 dBmV for non-synchronous interference).

(12) The above measurements are repeated for an adequate number of channels to ensure that the measurements are significant.

Limits

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

"133 (*a*) when the apparatus is adjusted to receive signals from a broadcasting receiving undertaking, it shall be equipped and have characteristics as follows:

(iv) the apparatus shall be so shielded that there is no noticeable evidence of interference when

(A) the apparatus is in the field of a co-channel synchronous television signal having a measured field strength of 100 millivolts per metre, and

(B) the signal level of the desired input signal is adjusted to 1 millivolt (0 dBmV) at the input terminals of the apparatus."

Signal Overload

Equipment Required

Spectrum analyser (50 - 1000 MHz)

RF attenuator

RF amplifier

Multichannel RF generator or signal available from local cable system (minimum capability of VHF channels 2 - 13, and three adjacent mid band channels).

Method

(1) The feed from the multichannel RF generator or local cable system is connected to the spectrum analyser (via a suitable matching network if required).

(2) The spectrum analyser is tuned to channel 2 and the input signal amplified (if required) to produce a level of 14 dBmV at the frequency of interest.

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

(4) Ensure that the receiver is operating normally and that all customer switches and controls are adjusted for cable reception and normal viewing.

(5) The receiver's picture display is then observed for any evidence of overload.

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

Limits

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

"133 (*a*) when the apparatus is adjusted to receive signals from a broadcasting receiving undertaking, it shall be equipped and have characteristics as follows:

(vi) there shall be no overloading of the apparatus at any signal level below 5 millivolts (14 dBmV)."

Image Rejection

Equipment Required

VHF signal generator

Oscilloscope or Spectrum analyser (optional)

RF attenuator

Method

(1) The feed from the VHF signal generator is connected to the receiver's 75 ohm input via the RF attenuator.

(2) The signal input level is reduced so as to operate the AGC in a maximum gain mode.

(3) The IF level is then measured at the IF detector point.

(4) The VHF signal generator is then adjusted to the image frequency and fine tuned to maximize signal at the IF detector point.

(5) The generator output level is adjusted so as to match the IF detector point amplitude level measured in (3) above.

(6) The image rejection is then determined from the difference in the generator output levels of (2) and (5) above.

(7) The above procedure is applied to all channels whose image frequency falls below 300 MHz.

Limits

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

"133 (*a*) when the apparatus is adjusted to receive signals from a broadcasting receiving undertaking, it shall be equipped and have characteristics as follows:

(vii) the image rejection shall be at least 60 dB for any image frequency below 300 MHz."

Internally Generated Interference

Equipment Required

Spectrum analyser (5 - 1000 MHz)

Method

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

(2) Ensure that the receiver is operating normally and that all customer switches and controls are adjusted for cable reception and normal viewing.

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

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

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

Limits

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

"133 (*a*) when the apparatus is adjusted to receive signals from a broadcasting receiving undertaking, it shall be equipped and have characteristics as follows:

(viii) the level of any local oscillator signal and of any signal of an undesired or spurious nature, generated within the apparatus and arriving at the cable input terminals of the apparatus,

(A) in the frequency range above 5 MHz and below 54 MHz, shall not exceed -50 dBmV,

(B) in the frequency range from 54 MHz to 300 MHz, shall not exceed -26 dBmV, and

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