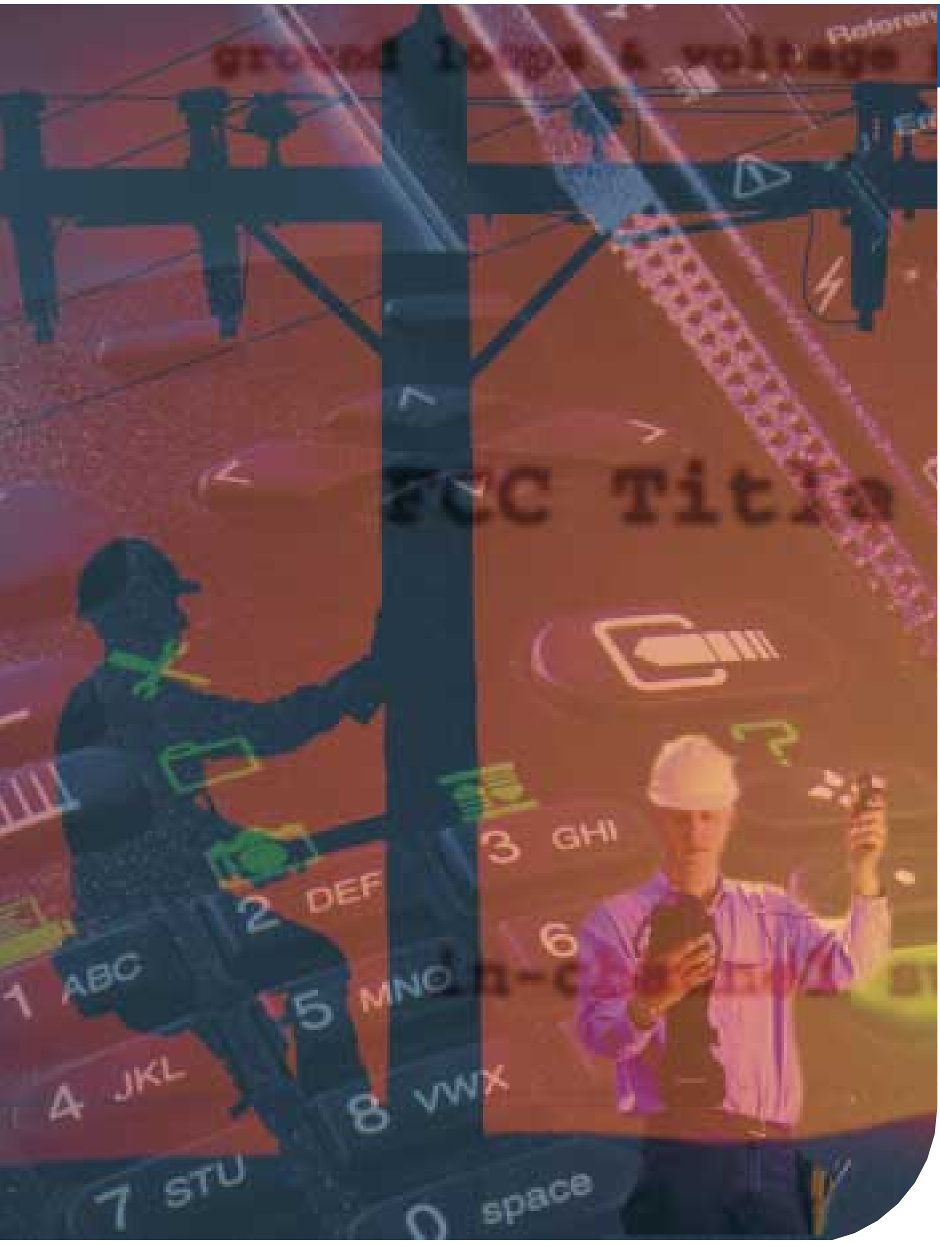
Proofing and Testing

Application Note 4



Cable Networks Application:
Using Acterna equipment to perform FCC regulated testing.

ACTERNA

FCC Title 47 Code of Federal Regulations, Subpart K, Section 76.605(a)

Records must be kept on file for 5 years and open to the FCC or the local franchiser upon request. Rule 76.614 states that leakage logs must be kept on file for 2 years for a typical CATV system, but 5 years for systems that don't fall under normal FCC regulations. This would include a system with less than 1000 subscribers. This system would not be considered a typical CATV system.

We must select 6 widely separated test points for the first 12,500 subscribers and 1 extra test point for each increment of 12,500 subscribers.

At least one third of the test points shall represent subscribers most distant from the HE.

Subsections 76.605 (a) 3, 4, and 5 require tests to be done on all NTSC channels. All other subsections require 7 channels for 400 MHz systems and 1 extra channel for every increment of 100 MHz.

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Audio/Video Tests [76.605(a)(2)]
The audio carrier will be 4.5 MHz above the video ± 5 kHz.

24-hour Variation Test [76.605(a)(3,4,5)]
Measurements shall be made every 6 hours (intervals > 5 and < 7 hours) in January or February and July or August. This represents the coldest and hottest months. So we have a 2 hour window every 6 hours, and a 2 month window every 6 months to complete these tests.

The video level for each channel at the end of a 100 foot drop will have:

- > 3 dBmV [76.605(a)(3)].
- < 8 dB variation over 24 hours & 6 months [76.605(a)(4)].
- < 3 dB of variation between adjacent channels [76.605(a)(4)].
- < 12 dB of difference between any 2 channels in a 500 MHz system and 1 dB allotted for each 100 MHz above 500 MHz. This is tilt and peak-to-valley [76.605(a)(4)].
- A maximum level is stated that doesn't overload the subscriber's receiver [76.605(a)(4)].
- The audio will always be lower than the associated video. The audio to video delta shall be between 10 and 17 dB. One exception to this rule is if a baseband converter is used, then the delta is specified for 6.5 to 17 dB [76.605(a)(5)].

n-Channel Sweeping [76.605(a)(6)]
If you want to perform an In-Channel Response (ICR) test, there are two scenarios to choose from:

1. Use your existing sweep transmitter or
2. Obtain a function generator that will sweep, at a line rate (approx. 20ms to 50ms), from 250 kHz to 6 MHz.

Adjust the output level to meet the requirements of the modulator's video input (~ 1 Vp-p).

Note: *As of 12-30-99, In-Channel Response testing must be done after the customer premise equipment, which means after the set-up box. The FCC rule is ± 2 dB of flatness.*

Create a new channel plan for each channel that you will be doing the test on. This is done on the Stealth Transmitter (Tx) or on the field unit if using a function generator.

When building this channel plan, create ten (10) scrambled channels, 500 kHz apart, starting approximately .75 MHz above the lower boundary of the cable channel continuing 5 MHz above.

After you have created the channel plan, select the appropriate mode from the "Sweep Receiver" menu. Select the "Stealth" mode if using the Tx or the "Sweepless" mode if using a function generator. Connect the Tx or function generator to the "Video In" port on the modulator that you are going to test.

Next, connect your field unit to the modulator output and press the "SWEEP" button. Once you have adjusted your Start and Stop frequencies to match the particular channel plan, you will see the response of the channel under test.

Press the "func" and "6" key to store this trace as a Sweep Reference. Proceed out into the system, connect your field unit to the appropriate location and press the "SWEEP" button. You will again see the response of the channel under test.

The MAX/MIN reading on your unit is the In-Channel Response of that channel and dependent upon the marker locations. Below is an example of a channel plan to do the ICR test on channel 2.

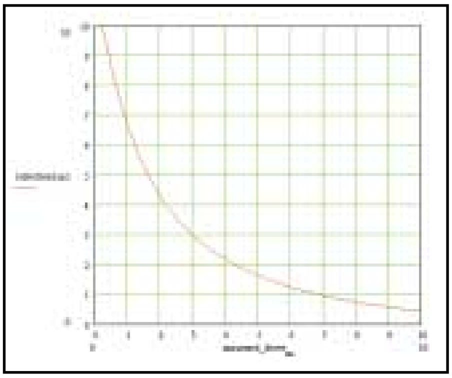
CNR & Distortions [76.605(a)(7,8)]
To get the best carrier-to-noise ratio (CNR) readings for a 79 channel loaded system, the RF level should be between 10 and 14 dBmV. The dynamic range of the field unit is 52 dB. Most fiber nodes don't have much better than 50 dB CNR. It would not be practical to do CNR headend tests with this device. The FCC specification is for CNR > 43 dB. Most systems design for ~ 48 dB CNR at the end-of-line to account for house amps, bigger TV screens, and to allow some head-room for digital loading effects.

▼ In-Channel Response (ICR) Test Channel Plan

Channel	Ch. Type	Freq(MHz)	Audio(MHz)	Meas BW	Noise Offset	Ena	Tilt	Swp	Scr
201	TV	54.75	4.50	4.0	2.50	x		x	x
202	TV	55.25	4.50	4.0	2.50	x		x	x
203	TV	55.75	4.50	4.0	2.50	x		x	x
204	TV	56.25	4.50	4.0	2.50	x		x	x
205	TV	56.75	4.50	4.0	2.50	x		x	x
206	TV	57.25	4.50	4.0	2.50	x		x	x
207	TV	57.75	4.50	4.0	2.50	x		x	x
208	TV	58.25	4.50	4.0	2.50	x		x	x
209	TV	58.75	4.50	4.0	2.50	x		x	x
210	TV	59.25	4.50	4.0	2.50	x		x	x

When performing manual tests be aware of correction factors, analyzer settings, and the test equipment's noise floor. Perform a "Noise Near Noise Test" by removing the input cable from the field unit and record the level of the noise floor. Subtract this from the original noise floor measurement.

Locate the difference between the two readings on the "X" axis of the following graph and find the corresponding correction factor on the "Y" axis. Add this correction factor to the CNR value. Any correction factor > 6 dB will be less reliable since a very small change in amplitude causes a large change in correction.



▲ Noise Near Noise Correction Chart

Use a bandpass filter and lab amp when levels are too low for the test equipment, or when doing distortion testing. The FCC specifies that these coherent distortions (CSO & CTB) should be > 51 dBc (below the reference carrier) for NCTA and > 47 for IRC & HRC systems.

For test equipment that uses a gated measurement for in-service tests, CNR can be measured on a modulated carrier, but not scrambled. If noise is already present on the signal, or there are no quiet lines, it may be warranted to insert a real "quiet" line or use another channel.

The Tip Box

Line 25 is recommended for a quiet line insertion when testing after a set-up box. For more detailed information, log-on to www.tvms.net.

Signal-to-Noise for the Return Path

To calculate the S/N for reverse, find the telemetry level at the headend read on the field unit, activate the "Noise" mode and move the marker to the same frequency. Record the difference.

Note: *The "Spectrum" mode RBW is set at 280 kHz and a VBW > 1 MHz. This is optimized for analog carriers and burst noise measurements. It has a peak noise detector so the noise reading may be significantly higher than a normal spectrum analyzer with the same RBW setting. Don't do manual C/N measurements with the Stealth unit.*

Calculating Digital S/N

Set up a "Digital" channel for 280 kHz of measurement bandwidth (MBW). Set up another "Digital" channel with 280 kHz of MBW at a frequency that is just noise. Label it "NOIS".

Note: *Measuring digital "haystacks" with a spectrum analyzer is very misleading. The level reading is based on the RBW of the analyzer and there are correction factors associated with this. A simple calculation may not be adequate or accurate because of the shape of the "haystack". This may warrant a thermal-coupled power meter or a device that can do an average digital power measurement.*

Measure levels of both channels and calculate the difference. This is the S/N. Because the test equipment noise floor may give faulty readings, a pre-amp may be warranted.

Perform a "Noise Near Noise Test". Remove the input cable from the field unit and record the level from the NOIS channel again. Subtract this from the original NOIS measurement.

Locate the difference between the two readings on the "X" axis of the previous graph and find the corresponding correction factor on the "Y" axis. Add this correction factor to the S/N value.

Any correction factor > 6 dB will be less reliable since a very small change in amplitude causes a large change in correction.

Terminal Isolation [76.605(a)(9)]

Terminal isolation shall be at least 18 dB. In reality, it's usually much better than this. Depending on the source of the purchase! I wouldn't want the high cable modem output or harmonics to "bleed" over into the TV or vice-versa.

Ground Loops & Voltage Potential Differences

A device called a 188A is used to test for dangerous voltage potentials before touching anything.

You could use a voltmeter in the ammeter mode. Connect one lead to the cable sheath/connector and another lead to a known good ground. If current is flowing, there is an obvious voltage potential difference. You may want to establish a ground before disconnecting the only ground you have going. Call the electric company if the ground is in question.

Common bonding is required for the elimination of ground loops, but if the power ground becomes dislodged a more serious problem could occur. If the power company entrance into the house becomes disconnected from corrosion or whatever, the house powering will use the cable grounding as its neutral. Eventually the dielectric will melt.

Assure the house is grounded & bonded correctly for safety and elimination of ground loops, which can cause hum related problems and impulse burst noise.

To eliminate hum bars try common mode coiling, ghost busters, or drop isolators. Drop isolators have capacitors installed to block the voltage from traveling on the sheath or center conductor while still allowing RF to pass. We could also use common mode coiling, which is used to eliminate common mode currents from entering through a breach in the cable sheath. Take 10 feet of cable and coil into 7 turns approximately 5 to 6 inches in diameter. Be careful not to exceed the minimum bending radius of the cable in question. If impulse noise or hum gets in at the TV tuner or from the power ground, it will travel on the cable braiding until it dissipates or is induced onto the center conductor. Coiling the drop cable prior to insertion into the house appliance will "choke" out this reverse ingress before it finds that breach. SignalVision also makes a snap-on ferrite bead to attach to the coax, which will impede common mode currents. One way to make a drop isolator would be to connect two 75/300 ohm transformers back-to-back. This is good for troubleshooting only. This technique may not conform to bonding ordinances and will cause signal loss and leakage.

Hum [76.605(a)(10)]

Acterna equipment can measure hum on an unscrambled, active channel. This is a peak-to-peak measurement. The definition of FCC hum is any low frequency disturbance (< 1 kHz) and must be < 3%. This is usually caused by power pack filter failure, bad solder connections, corroded connectors, impulse noise, etc.

Diagnosis for 1 or 2 bars slowly scrolling up on the TV is as follows: If it's one hum bar (50/60 Hz), check for bad connections where voltage is ac. If it's 2 hum bars (100/120 Hz), check the dc power pack for proper ac input, check for powerpack ripple (possible filter cap or diode failure). This is achieved by using an ac-coupled voltmeter and measuring ac voltage on the dc test point. It should be < 15 mVac. Two hum bars can be produced by any power supply that rectifies ac into dc and could include battery chargers.

If hum is only on 1 channel, suspect the headend. If it's only on a few lower channels, it could be a bad power transformer humming along outside. If it's on one house and not the neighbors, or on a digital channel, suspect the house grounding.

Headend Tests [76.605(a)(11)]
Headend proofing consists of chrominance-luminance delay (<170 ns), differential gain (< ± 20 %), and differential phase (< ± 10 degrees). This is a triennial test requirement, which means it must be performed every 3 years.

Leakage – Rule [76.609(h) & 76.605(a)(12)]
This measurement can be taken directly from an aircraft above the system and reported directly. 90% of leakage points shall not exceed 10 uV/m at an altitude of 450 meters.

Measurements may be taken on the ground and entered into a formula that simulates the interference it would cause at aircraft altitudes. The former method is called the fly-over and the latter is called cumulative leakage index (CLI).

If you opt to perform CLI instead of the fly-over, you must include at least 75 percent of the strand mileage of the cable, including all the cable that can be expected to have the least leakage integrity. You must substantially cover the plant in three months for a quarterly test and submit once a year on form 320.

A dipole antenna must be used 3 meters from the leak and 3 meters above the ground. The dipole should be rotated about a vertical axis and the maximum reading recorded.

Other conductors must be 10 or more feet away from the measuring antenna. See 76.609 through 76.616 for the complete regulation series.

A single source of radio-frequency leakage must not exceed a certain field strength, measured in microvolts per meter at a given distance with a "cut dipole". Leaks in excess of these strengths at respective distance and frequency must be repaired in a timely manner.

The formula to determine the full size of the dipole antenna in inches is:

$5650/f$ ("f" is the frequency in MHz).

Frequency	Field Strength	Distance
Up to 54 MHz	15 µV/m	30 meters
54 to 216 MHz	20 µV/m	3 meters
216 MHz and up	15 µV/m	30 meters

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