TECHNICAL COLUMNS

Official archives of articles and columns written by Ron Hranac for Communications Technology and some of its sister publications, published by Access Intelligence, LLC. Reprinted with permission of the author.

By **Ron Hranac**, former ***Senior Technology Editor,*** **Access Intelligence** and ***Communications Technology*** **Magazine**

Originally appeared in the **June 2010** issue of *Communications Technology*.

DIGITAL LEVELS IN THE AERONAUTICAL BANDS

By RON HRANAC

As cable operators migrate to more digital signals in their channel lineups, one factor that must be considered is maximum allowable signal levels when operating on aeronautical frequencies. This also applies to those situations in which a cable network might be changed from a sub-split to a high-split band plan. The latter may well place future upstream signals on formerly downstream aeronautical frequencies. Why are aeronautical-band signal levels important? If leakage occurs, interference to aircraft navigation and communications is possible.

"Existing leakage detectors cannot be used for measuring leaking digital signals."
The FCC's cable rules on operation in the aeronautical bands originally were crafted with the downstream spectrum in mind. The practical matter is that any signals carried in the aeronautical bands—the direction of signal transmission is irrelevant—must comply with what is stated in the current rules. Let's look at some of those rules: §76.605(a)(12) defines the maximum allowable leakage field strength at specified measurement distances. The following is applicable whether the signals are analog TV channels, continuous wave (CW) carriers or digital signals:

(12)...signal leakage from a cable television system shall be measured in accordance with the procedures outlined in §76.609(h) and shall be limited as follows: Less than and including 54 MHz, and over 216 MHz, 15 μV/m at 30 meters distance; over 54 MHz up to and including 216 MHz, 20 μV/m at 3 meters distance.

§76.609(h) defines how to measure leakage. Where things get a little confusing with respect to leaking digital signals is §76.609(h)(2). The text refers to the "rms (root mean square) value of the synchronizing peak," which is equal to the peak envelope power of the visual carrier. Digital signals obviously don't have a "synchronizing peak" in the sense described in the rules. The convention for the amplitude of a digital signal is its digital channel power, which is average power integrated over the channel's occupied bandwidth. A further complication is the fact that existing leakage detectors cannot be used for measuring leaking digital signals (more on this later).

(h) Measurements to determine the field strength of the signal leakage…shall be made in accordance with standard engineering procedures. Measurements made on frequencies above 25 MHz shall include the following:

(1) A field strength meter of adequate accuracy using a horizontal dipole antenna shall be employed.

(2) Field strength shall be expressed in terms of the rms value of synchronizing peak for each cable television channel for which signal leakage can be measured.

(3) The resonant half wave dipole antenna shall be placed 3 meters from and positioned directly below the system components and at 3 meters above ground...

(4) The horizontal dipole antenna shall be rotated about a vertical axis and the maximum meter reading shall be used.

(5) Measurements shall be made where other conductors are 3 or more meters…away from the measuring antenna.

§76.610 specifies the maximum amplitude of signals that may be carried in the 108 MHz-137 MHz and 225 MHz-400 MHz frequency ranges. The stated 10-4 watt is equal to +38.75 dBmV. The latter applies to signal power in a 25 kHz bandwidth so, to get an equivalent power in, say, a 6 megahertz-wide digital channel slot, it's necessary to add a bandwidth correction: +38.75 dBmV + 10log10(6,000,000/25,000) = +62.55 dBmV. This means a 6-megahertz-wide digital signal can be as high as +62.55 dBmV average power (other occupied channel bandwidths will be different). The latter is safely above the +61 dBmV single-channel maximum spec for a DOCSIS 3.0 modem transmitting a quadrature phase shift keying (QPSK) signal, and well-above typical digital signal levels one would see at any downstream or upstream amplifier's output.

§ 76.610 Operation in the frequency bands 108–137 and 225–400 MHz—scope of application

The provisions…are applicable to all…carriers or other signal components carried at an average power level equal to or greater than 10−4 watts across a 25 kHz bandwidth in any 160 microsecond period, at any point in the cable distribution system in the frequency bands 108 MHz–137 MHz and 225 MHz–400 MHz for any purpose…

Things get a little trickier when looking at §76.612(a), which specifies frequency offsets. One cannot offset a digital signal to reduce the potential for interference because doing so has no effect on what happens when a noise-like digital signal interferes with an over-the-air service. That said, I do suggest that digital signals carried on aeronautical frequencies be offset anyway. In the event a given digital signal is inadvertently or intentionally switched to unmodulated mode, the resulting CW carrier will be offset.

(a) In the aeronautical radiocommunication bands 118–137, 225–328.6 and 335.4–400 MHz, the frequency of all carrier signals or signal components carried at an average power level equal to or greater than 10−4 watts in a 25 kHz bandwidth in any 160 microsecond period must operate at frequencies offset from certain frequencies…

The regular leakage monitoring requirements in §76.614 still apply to digital signals as well as upstream transmission on aeronautical frequencies, as do rules for cumulative leakage index and flyovers. As mentioned previously, currently available signal leakage detectors cannot be used to measure digital signals, so a CW carrier or analog TV channel must be measured.

The final part of the rules that needs to be considered can be found in §76.616(a) and (b). In particular, even lower maximum levels than previously discussed apply to operation on or near certain frequencies. The stated 10-5 watt in §76.616(a) is equal to +28.75 dBmV. §76.616(b) does accommodate digital signals, which must be measured with an RMS detector (this will give average power), and cannot exceed +28.75 dBmV in a 30 kHz bandwidth. Converting to 6 megahertz equivalent power gives +28.75 dBmV + 10log10(6,000,000/30,000) = +51.76 dBmV. So the rules are pretty clear about operation on or near the frequencies specified in §76.616. The maximum digital channel power for a 6-megahertz-wide digital signal is +51.76 dBmV (as before, other occupied channel bandwidths will be different), whether the signal is traveling in a downstream or upstream direction.

(a) The transmission of carriers or other signal components capable of delivering peak power levels equal to or greater than 10−5 watts at any point in a cable television system is prohibited within 100 kHz of the frequency 121.5 MHz, and is prohibited within 50 kHz of the two frequencies 156.8 MHz and 243.0 MHz.

(b) At any point on a cable system from 405.925 MHz to 406.176 MHz analog transmissions are prohibited from delivering peak power levels equal to or greater than 10−5 watts. The transmission of digital signals in this range is limited to power levels measured using a root-mean-square detector of less than 10−5 watts in any 30 kHz bandwidth over any 2.5 millisecond interval

Ron Hranac is technical leader, HFC Network Architectures, for Cisco Systems, and former senior technology editor for *Communications Technology*. Reach him at rhranac@aol.com.