



# TECHNICAL COLUMNS

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## A LEAK IS A LEAK...OR IS IT?

By **RON HRANAC**

If something in the outside plant causes signal leakage, does it stand to reason that leakage exists more or less across the cable network's operating RF spectrum? Some camps have long held that when it comes to leakage, there is indeed correlation among various frequencies. In other words, if a given shielding defect causes leakage at one frequency, it causes leakage at most, if not all, active frequencies.

At first glance, it makes sense to assume that whatever is causing a leak behaves somewhat like a wideband antenna, radiating signals across the spectrum. A leak is a leak, right? Going the other way, if properly operating leakage-detection equipment shows no leakage, then there is no leakage at any frequency. After all, how can there be any leakage if the test equipment says the plant is tight?

Guess what? I'm going to argue that there is little or no correlation across the spectrum. The field strength of a leak at one frequency has little to do with the field strength of a leak at other frequencies. Likewise, just because one's leakage detection equipment shows no leakage does not mean there isn't leakage. This isn't something I am assuming might be the case – I've seen this behavior in the field. While not particularly surprising, it's not good news.

For many years, U.S. cable operators have been required to comply with the signal leakage regulations in Part 76 of the FCC's Rules. The following table, taken from §76.605(a)(12), clearly states the maximum allowable signal leakage field strengths across various frequency ranges:

Frequencies	Signal leakage limit (micro-volt per meter)	Distance in meters
Less than and including 54 MHz and more than 216 MHz	15	30
More than 54 up to and including 216 MHz	20	3

Nearly all cable operators monitor for signal leakage in or near the 108 MHz-137 MHz aeronautical band, within which the maximum allowable leakage field strength is 20 microvolts per meter ( $\mu\text{V}/\text{m}$ ) at a distance of 3 meters (~10 feet) from the plant. Most commercial leakage-detection equipment is designed to operate in this same frequency range, typically tuned to an analog-TV channel's visual carrier or sometimes a dedicated leakage carrier (remember the Cuckoo?).

A common monitoring frequency is the 133.2625 MHz visual carrier of CEA cable channel 16, although others also are used. While a number of cable operators use the FCC's 20  $\mu\text{V}/\text{m}$  limit as a threshold for when leaks must be repaired, many ops are even more aggressive and use a tighter spec, along the lines of 10  $\mu\text{V}/\text{m}$  or maybe even 5  $\mu\text{V}/\text{m}$ . A handful simply say, "If there's a leak of any field strength, fix it." Period.

"So what's the big deal?" you ask. The big deal is that while leakage performance in the aeronautical band may be hunky-dory, it can be out of whack at other frequencies.

The LTE Problem



I didn't think this was a big deal until last year. At the time, Verizon's field engineers were discovering that leaking quadrature amplitude modulation (QAM) signals in the 698 MHz-806 MHz frequency range were interfering with their newly deployed LTE 4G service in several markets (see "Some Thoughts On LTE Interference," [www.cable360.net/ct/sections/columns/broadband/48482.html](http://www.cable360.net/ct/sections/columns/broadband/48482.html)). What got my attention was the fact that little or no leakage was showing up in the aeronautical band, yet in some cases the leakage field strength in the vicinity of 750 MHz was substantial. In one example, a defective tap caused a 10  $\mu\text{V/m}$  leak in the aeronautical band, but the same defective tap produced a field strength some 40 dB greater (1,000  $\mu\text{V/m}$ !!) at 750 MHz.

To get a handle on what might be happening, I teamed with several colleagues to conduct tests in an operating cable network using the same make/model test equipment that Verizon's field engineers use: a Rohde & Schwarz PR100 receiver and companion HE300 antenna. I was surprised to see just how easy it was to find leakage at 750 MHz and equally surprised to confirm that, in many instances, leakage was measureable at 750 MHz when little or no leakage was measureable in the VHF aeronautical band. Details about that field testing appeared in my November 2011 column, "LTE Interference (Part 2)" ([www.cable360.net/ct/operations/testing/48917.html](http://www.cable360.net/ct/operations/testing/48917.html)).

Separately, engineers with Arcom Digital have been testing their QAM Snare – a QAM-compatible leakage detection product – in several cable networks. I can't share the cable companies' names or locations but, once again, leakage is being found at higher frequencies, and little or no leakage is measureable in the VHF aeronautical band using a commercial leakage detector. Here are some examples:

>> In one system a couple months ago, several leaks at CEA cable channel 85 carrying a downstream QAM signal were found, but nothing was measureable in the aeronautical band. Here are the field strengths of some of the Channel 85 leaks and their causes: 141  $\mu\text{V/m}$  (loose 90 degree connector), 178  $\mu\text{V/m}$  (loose hardline connector), 35  $\mu\text{V/m}$  (corroded RF gasket in amplifier housing), 501  $\mu\text{V/m}$  (amplifier and hardline connector) and 79  $\mu\text{V/m}$  (tap and connectors). All of these field strengths are 3-meter (10 feet) measurement values, which from a free-space loss perspective would have been 20 dB lower at a 30-meter (100 feet) measurement distance. The gotcha for all of these is no measureable leakage in the 108 MHz-137 MHz aeronautical band.

>> In another system, QAM Snare was configured to measure leakage on two QAM signals, one carried on Channel 66 and the other on Channel 115. Here, it was useful to see leakage field strengths on the two channels reported by the QAM Snare equipment plus VHF aeronautical band leakage on a conventional detector. Some examples (3 meter measurement distance): A loose hardline connector underneath heat shrink tubing produced a 25  $\mu\text{V/m}$  leak on Channel 115, 17  $\mu\text{V/m}$  on Channel 66, and <10  $\mu\text{V/m}$  in the aeronautical band. Another leak, caused by a bad drop, created field strengths of 20  $\mu\text{V/m}$  (Channel 115), 44  $\mu\text{V/m}$  (Channel 66) and "low level" in the aeronautical band. A damaged hardline cable that a tree limb had grown over produced field strengths of 158  $\mu\text{V/m}$ , 35  $\mu\text{V/m}$ , and 8  $\mu\text{V/m}$ , respectively.

And so it goes, where several other leaks were found at higher frequencies but leakage in the aeronautical band was either low level or non-existent. Loose hardline connectors seem to be a common culprit, but they certainly aren't the only causes.

#### Higher Frequencies, Higher Leakage

I had a chance to go out in the field in a system where QAM Snare recently had been deployed, and I observed much the same thing as just described: Higher leakage field strengths at higher frequencies. One explanation that has been considered as a possible cause of this is the tilt used in outside plant actives, where higher frequencies are operated at higher levels than lower frequencies. I think this may play only a small part, though.

Consider the previously discussed 501  $\mu\text{V/m}$  leak at Channel 85. There was no measureable leakage in the aeronautical band, but had it been, say, just 5  $\mu\text{V/m}$ , that's a bit more than 40 dB difference. One leak from a

tap I observed in the field was  $>100 \mu\text{V}/\text{m}$  in the 700 MHz spectrum; in the aeronautical band, it was only  $5 \mu\text{V}/\text{m}$  to  $6 \mu\text{V}/\text{m}$ , on the order of 24 dB~26 dB difference. These differences far exceed the tilt used in any cable network.

Arcom Digital's QAM Snare is, as of this writing, the only currently shipping QAM-compatible leakage detection setup, but I've been told that ComSonics and Trilithic expect to have QAM-compatible products available this year. All of this is good news, especially as cable operators migrate to mostly- or all-digital lineups. Conventional leakage detectors were not designed to measure noise-like QAM signals. The latter requires that operators leave an analog TV channel or CW carrier in the aeronautical band of their "all-digital" networks to ensure compatibility with the thousands of legacy leakage detectors already in the field.

Given the poor correlation between leakage field strengths in the aeronautical band and at higher frequencies, it's critical that operators consider measuring leakage in both frequency ranges. Arcom Digital's QAM Snare supports operation at higher frequencies, and it's my understanding that ComSonics' and Trilithic's QAM-compatible detectors also will support higher-frequency operation. For those who want to go the home-brew route for measuring leakage at higher frequencies, my October 2011 column discusses a spectrum analyzer-based method. And don't forget the previously mentioned Rohde & Schwarz PR100 and accessories, which work well for calibrated field-strength measurements.

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