

CATV Leakage

By Ron Hranac, NOIVN

Are you experiencing what could be defined as harmful interference from CATV signal leakage? Not getting suitable support or cooperation from local CATV system personnel? Problems with CATV Channel 18 interfering with your local repeater at 145.250 MHz? If so, let Ron Hranac, NOIVN share some thoughts on the problem of CATV leakage.

The FCC's Signal Leakage Requirements

Part 76 includes some specific regulations that pertain to signal leakage from cable TV networks. In general, the rules comprise two major areas: Quarterly monitoring and an annual flyover or ground-based measurement. Regarding the former, cable operators are required to monitor essentially 100% of the network for leakage once per quarter, log any leaks found that are greater than 20 microvolts per meter (at a 10 ft measurement distance), and repair those leaks in a timely manner. Once per year, the cable operator must conduct either a flyover or ground-based measurement to come up with a "snapshot" of leakage performance. A flyover involves an aircraft-based measurement of the network's leakage from an average altitude of 450 meters above the community, and the network must be in the 90th percentile with regard to a 10-microvolt per meter field strength at the measurement altitude.

Alternatively, the cable operator may conduct a ground-based measurement of at least 75% of the plant, record leaks 50 microvolts per meter or greater, and calculate a "cumulative leakage index." The CLI is a figure of merit that shows leakage performance at a given point in time. The cable operator also is required to comply with the harmful interference clause of Part 76.

In theory, if the quarterly monitoring and repair have been conducted as required, the annual flyover or ground-based CLI should show no leaks. The reality is that leakage does occur--even in the best-maintained cable networks--often from consumer-installed devices such as poorly shielded cable-ready TVs, VCRs, etc. As well, the occasional craftsmanship issue crops up, as does cable damage from rodents, weather, and so forth. So, leakage monitoring and repair is an on-going battle for cable operators.

In the vast majority of cases, when CATV interference to amateur radio occurs, it's able to be resolved locally. Every now and then for whatever reason, the affected amateur is unable to get the interference resolved locally. Contact the ARRL for help in these cases.

Conversion of Analog TV Channels to all Digital

Now, let's talk about the cable industry's move from analog TV channels to digitally modulated signals.

This move is being done in part to "reclaim" RF spectrum. If you think about it, allocating a 6 MHz chunk of spectrum to a single TV channel is pretty inefficient, especially considering that digital compression and available digital modulation formats such as 64- and 256-QAM

(quadrature amplitude modulation) allow the carriage of, say, 10 or 12 channels in the same 6 MHz bandwidth that one analog TV channel now occupies!

So, does the move to digital represent an interference nightmare ready to pounce on us hams? Not likely. Indeed, a 64- or 256-QAM digitally modulated signal has LESS probability of interfering with over-the-air communications such as ours. Here's why:

When an analog TV channel is the source of interference to, say, 2-meter voice communications, the usual culprit is the TV channel's visual carrier. The vast majority of the channel's RF power is in that carrier, so it represents the signal most likely to cause problems. Naturally, the aural carrier can be an issue, too, but its lower amplitude (typically about 15 dB lower than the visual carrier) often means the visual carrier is the one we have to worry about.

A downstream digitally modulated signal occupies the same 6 MHz bandwidth as an analog TV channel, but its power is spread across the entire channel bandwidth rather than concentrated in a discrete visual or aural carrier! The digitally modulated signal's average power also is intentionally set 6 dB to 10 dB below what an analog TV channel's visual carrier amplitude would be on the same frequency. The noise-like characteristic of the digitally modulated signal is going to be less likely to cause interference if leakage exists, too!

If we look at a digitally modulated signal's noise power bandwidth, it is equal to the symbol rate. For 256-QAM, the symbol rate is 5.360537 million symbols per second (Msym/sec), which means the equivalent noise power bandwidth (-3 dB points) is 5.360537 MHz.

A 2 meter transceiver with an equivalent noise power bandwidth of, say, 15 kHz (the IF bandwidth), won't be affected by the entire 6 MHz of "noise" (OK, 5.36 MHz), but rather the noise power in the IF bandwidth: 15 kHz. This means the received signal strength will be $10\log(15000/5360537)$ lower, or 25.53 dB below the noise power in a 5.36 MHz bandwidth. So, if the digitally modulated signal is carried -6 dBc relative to what an analog visual carrier would have been on the same channel, the received "noise" power from the digitally modulated signal will be $25.53 + 6 = 31.53$ dB LOWER than the interference from a discrete visual carrier on the same channel.

If the cable operator is just complying with the FCC's 20-uV/m leakage limit (10 ft from the network), that limit will yield a dipole level of -43.67 dBmV (75 ohms), or -92.42 dBm (6.55 microvolts) at the dipole's terminals for an analog TV channel visual carrier at 145.25 MHz. If that analog signal were a digitally modulated signal at -6 dBc relative to the visual carrier, when you factor in bandwidth correction (25.53 dB), the dipole level will now be -75.2 dBmV (-123.95 dBm).

As well, rather than a carrier, the interference will be noise-like. At this low level, it's unlikely the interference could be differentiated from normal background noise, or at worst, a slight increase in background noise.

Interference to 145.250 MHz

This problem is typically associated with the visual carrier on CATV Channel 18. This carrier is at 145.250 MHz, which also happens to be a common repeater output frequency. In fact, we have this very scenario here in the Denver area. A local 2-meter repeater is on 145.25 MHz, and I can receive some localized--but fairly low level--interference from signal leakage. It appears to be coming from a nearby house, suggesting that the likely culprit is a poorly shielded cable-ready TV set connected directly to the cable. Fortunately the interference is low enough level that it's not an issue when the repeater transmits. Unfortunately, this is not always the case...

If severe enough to warrant attention, there is a potential work-around to this problem. The cable company's headend equipment that creates TV channels can in some cases be offset from the standard xxx.250 MHz visual carrier frequency. Many headend modulators include an offset switch that facilitates an offset of 12.5 kHz or 25 kHz from the nominal xxx.250 MHz frequency. Offsets are used in the aeronautical navigation and communication bands to comply with FCC offset requirements in Part 76 of the FCC Rules. Fortunately, most offset-capable modulators can be offset outside of the aeronautical bands, too, which allows continued operation on a given channel. TV set AFC circuits have no problem with a channel being offset 12.5 or 25 kHz, and it should be enough to eliminate the occasional interference problem that crops up on the repeater's 145.25 MHz output frequency.

Here is my suggestion if having a problem with interference to 145.250 MHz:

Contact the local cable system, and ask for the Plant Manager (may also be called "Chief Engineer," "Chief Tech," "VP of Engineering," or similar). Let him or her know what's been going on with leakage on Ch. 18. Add that you'd be appreciative of any cooperation to resolve specific leakage problems. Also let him or her know that offsetting Ch. 18 might go a long way toward reducing or eliminating interference on 145.25 MHz, and ask if it would be possible for to do that.

As a side note, some cable systems have done this where a 145.25 MHz repeater was in use. The nice thing is it's a "free" fix that works quite well. Granted, it won't eliminate leakage (that still has to be kept in check), but it will substantially reduce the possibility of on-frequency interference.