



# TECHNICAL COLUMNS

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Originally appeared in the **July 2005** issue of *Communications Technology*.

## DOCSIS RFI

By RON HRANAC

The Data Over Cable Service Interface Specification (DOCSIS) Radio Frequency Interface Specification includes a variety of assumed RF performance characteristics for downstream and upstream data channels, cable modem input and output, cable modem termination system (CMTS) output, and a number of other parameters. Collectively these define a DOCSIS-compliant cable network.

Check out the table on page 16, the "Electrical Input to CM" table from the Radio Frequency Interface Specification.

Two of the table's parameters are of particular importance for ensuring reliable cable modem operation: level range (one channel) and total input power.

The first of these says the DOCSIS digitally modulated signal is supposed to be in the -15 to +15 dBmV range. Signal levels outside of the stated range might cause modem operational problems.

In theory, a DOCSIS-compliant modem should work fine if the digitally modulated signal's input is kept in the -15 to +15 dBmV range. Some cable operators with whom I've spoken like to keep modem input in a "sweet spot" between -5 and +5 dBmV.

Making sure the downstream digitally modulated signal is indeed in the desired input range is important. It should be verified at the time the modem is installed at the customer premises and during any follow-up modem-related service calls. But how does one accurately measure the downstream signal? My recommendation is to use test equipment that includes a digital channel power function. Most quadrature amplitude modulation (QAM) analyzers, newer signal level meters (SLMs) and some spectrum analyzers support this feature. Push a button or select an appropriate menu function, and the instrument measures the digitally modulated signal's average power automatically. No bandwidth, detector or other corrections are needed.

The other important cable modem input parameter is total power—that is, the total power of all downstream signals combined. The spec is less than +30 dBmV. Exceed this value, and the odds are pretty good that the modem input will be overloaded.

### How to figure input power

So how does one go about figuring out what the total downstream power is at a cable modem's input?

One way is to use Agilent's 8591C spectrum analyzer. (Note: Other spectrum analyzers may have this capability, too. Check with the respective manufacturer of the analyzer you're using.) There are two methods to measure total RF input power using the 8591C.

Make sure the instrument is turned off. Connect the RF source being measured to the spectrum analyzer's RF input connector. Turn on the analyzer by pressing [LINE]. Let the analyzer go through its power-up procedure. When it's finished, the screen will display the total RF power present at the RF input connector.



Alternatively, while the 8591C is operating, press the green [PRESET] button and let the analyzer perform its reboot routine. When it's finished, the total RF power present at the RF input connector will be displayed.

A more convenient method uses the 8591C's menu functions. While the analyzer is operating, press the following keys in the order shown: [MODE], [CABLE TV ANALYZER], [Setup], [Analyzer Input], [TOTL PWR @ INPUT]. The spectrum analyzer will measure and display the total RF power present at the input connector. When the measurement is finished, press [Prev Menu] twice followed by [CHANNEL MEAS].

Another way

All right, I can hear you saying something like "That's nice, but there aren't too many installers or technicians with spectrum analyzers in their company vehicles. Isn't there another way to figure out total power?"

I'm glad you asked. There is indeed another way.

This method requires nothing more than a conventional SLM and a calculator or even the back of a napkin and will yield a number that's within a couple dB or so of the actual total power.

Using the SLM, measure three or four channels across the downstream spectrum. Next, average the readings. Let's say Ch. 2 is +2 dBmV, Ch. 52 is 0 dBmV, and Ch. 116 is -2 dBmV. If we average these three readings, the average per-channel level is 0 dBmV.

Assume that you have only one channel on your system, and its level is 0 dBmV. What's the total power? The answer is 0 dBmV (I'm excluding the power from the aural carrier as well as system noise—these will have a minor impact on the actual value). If you had two channels on your system, each at 0 dBmV, the total power would be about +3 dBmV. Four channels, each at 0 dBmV, would be about +6 dBmV. Eight channels, each at 0 dBmV, would be +9 dBmV. Sixteen channels, each at 0 dBmV, would be +12 dBmV, and so on. Every time the number of channels is doubled—and assuming all channels have the same per-channel signal level—the total power goes up by 3 dB. So, even with 128 channels, each at 0 dBmV, the total power would be in the vicinity of +21 dBmV.

This says a couple things. First, it's easy to estimate the approximate total power, and second, given typical drop levels, there shouldn't be a problem meeting the DOCSIS cable modem total power input parameter. Where things can get iffy is in hot drop situations often found at duplexes and other multiple dwelling units (MDUs). If the per-channel signal level is, say, +20 dBmV, the total power with 128 channels will be in the vicinity of +41 dBmV. It's very likely that the modem input will be overloaded, and the modem probably won't work reliably—if at all. Pad the input down to get the total power down a bunch, while keeping the digitally modulated signal in the -15 to +15 dBmV range.

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