

Copper Access Team

For many years, telecommunications service providers measured the power of noise on circuits in order to determine the acceptability of their circuits. Hundreds of thousands of technicians, armed with portable test sets, have become very accustomed to recording the amount of noise on the local loop and throughout the transmission path. With terms like C-message noise (CN), dBrnC0, noise metallic (NM), multiline test (MLT) noise, etc., the idea was to measure the total amount of noise that would disturb a person talking on the phone. In fact, C-message filters (in North America) and psophometric filters (in the rest of the world) were built into nearly every test set as a way to measure the amount of noise a person would hear, while eliminating higher-frequency noise that was thought to be irrelevant to voice circuits.

Once the world started to move past dial-up modems and started to run data directly over the copper local loop, new ways to measure noise had to be created. This led to the invention of several filters: a 50-kilobit filter for 56 or 64 kb/s digital data service (DDS); the E filter for basic-rate ISDN; the F filter for HDSL; and the G filter for the first available ADSL services. All of these filters would allow noise that was of interest to pass into the test set, while rejecting the rest. The measuring circuitry would then measure the noise power of all the noise that passed through the noise filter. This all worked fine until discrete multitone (DMT) technology came along. For those of you who do not follow this technology, DMT is the transmission method used by nearly all ADSL, ADSL2+, VDSL and soon VDSL2 modems. The bad news for technicians is that a noise power figure, regardless of the filter type selected, will not predict the performance of a DSL service.

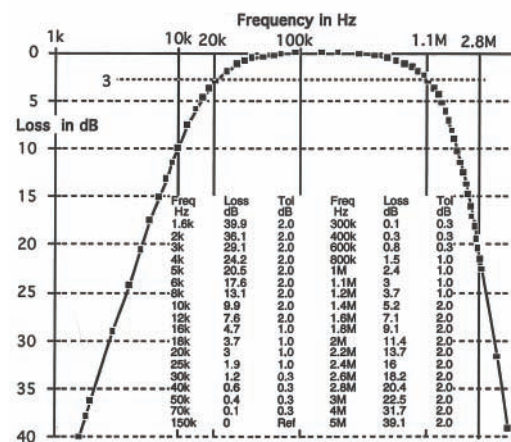


Figure 1 - G Filter for the ADSL

### DMT and Noise Filters

A noise power value alone is not enough to determine the quality of DSL, and this is mainly due to the way DMT transports digital information from a central office to the customer premises. DMT typically uses 256 analog ADSL carriers (whereas ADSL2+ uses 512), which are spaced at around 4 kHz apart. For ADSL transmission, it takes 1.1 MHz of local-loop bandwidth to carry all 256 carrier signals, although longer loops use fewer carriers (ADSL2+ uses 2.2 MHz). At regular intervals, each signal is amplitude-modulated, based on the string of high-speed ones (1) and zeros (0) that needs to be transmitted. So at any point in time, each carrier signal can be at one of 16 amplitudes. The problem with measuring total noise power is that it does not indicate if the noise on the line disturbs 1, 20 or all 256 carriers.

As an example, let us consider two noise sources. The first is an AM radio station, which is located near the customer premises and pumps out thousands of watts of 680 kHz. The second is a company that uses arc welders when they replace radiators in cars. The first one generates noise that is very specific to one frequency (680 kHz; located in the middle of the ADSL band), and the second generates a wide spectrum of noise.

Suppose that a technician goes on-site and takes with him a test set with a G filter, which has enough bandwidth to include the ADSL carrier frequencies. Now let us suppose that the noise meter measures, for example, a noise power of 50 dBrnC on the two different loops that are affected by those noise sources. That is the equivalent of -40 dBm. In other words, that is a lot of noise.

How does this affect ADSL service? The circuit with AM radio interference will lose one or two signals from the 256 available carriers, whereas near the arc welder, **all 256** carriers will be affected. In the extreme case, the circuit affected by AM radio noise may be able to operate at full ADSL rates, both in the upstream and downstream directions, whereas the modem affected by the arc welders may not be able to communicate at all. So the question remains: What good does a single noise power measurement provide?

Carrier Load(bits/tone):

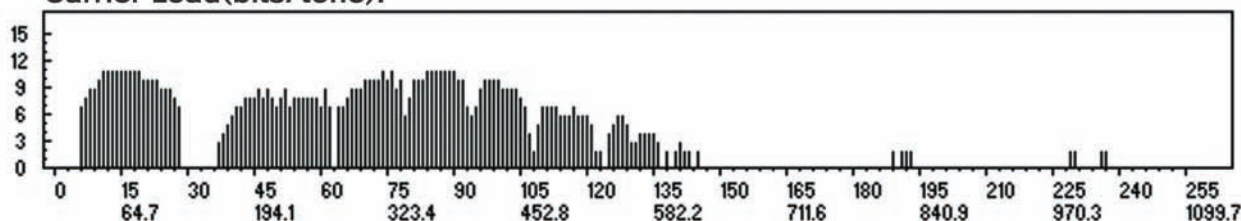


Figure 2 – Carrier Load

**Is there a better way?**

Fortunately, there is a better way to test DSL services. Today, many test sets measure and display the power level of the actual carrier signals. During the qualification phase, it is possible to measure the noise for the channel used by each carrier. The result is 256 individual noise measurements. During the service deployment phase, test sets can display the actual carrier map. In the industry, this is called the bits per bin or carrier load map.



Figure 3 – EXFO's CableSHARK P3

For these measurement applications, EXFO provides the CableSHARK P3, a portable test set that is used to pre-qualify and troubleshoot the local loop for DSL services. For ADSL, it measures the noise that would affect each of the 256 carriers, while for ADSL2+, it measures the noise as it would affect 512 carriers, etc.

EXFO also offers the CoLT-450P. This ADSL, ADSL2, ADSL2+, and RE-ADSL installer's test set displays the actual bits per bin of the actual connection between the test set and the DSLAM. Users can view the display to see if noise and crosstalk are affecting few or many of the carriers. The other advantage of using purpose-built DSL test sets is that the predicted or achieved upstream and downstream connection rates are displayed along with the bits-per-bin display.



Figure 4 – EXFO's CoLT-450P

**Conclusion**

As discussed above, the advent of DMT has brought about new testing requirements, as single measurements of noise power no longer provide the value they once did. Therefore, it is important for carriers to be aware of these changes and to pass on that knowledge to their technicians so that more effective testing procedures can be deployed in the field.

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