# Identifying and Understanding Common Noise Problems Using the 990DSL CopperPro™

*Noise is one of the most common problems affecting service and customer satisfaction. Understanding circuit noise, the problems it causes and how to solve them is essential to any technician's job.*

*Fluke Networks' CopperPro™ can be an invaluable tool to assist technicians in identifying noise problems quickly so that they can be resolved effectively and efficiently.*

*In this application note, we will identify common sources of noise, describe how loop impairments, like pair imbalance, can aggravate the problem, and discuss methods for identifying and measuring both voice band and wideband noise.*

## Noise is caused by induction

Noise is caused by any unwanted signals induced onto a telephone pair. The noise source acts like a transmitter. The telephone pair acts as a receiver. The affected service often has a relationship to the frequency and source of the noise. Lower frequency noise, like 60 Hz power influence, generally interferes with voice frequency service, such as plain old telephone service (POTS). Higher frequency noise can interfere with or interrupt digital services. Because higher frequency signals can travel longer distances than lower frequency signals, they can be more troublesome.

## Power lines a common source of induced noise

When electrical power is distributed, energy is radiated or broadcast from power lines. A cable pair acts like an antenna to receive any radiated signals. This is more common in aerial applications, but can happen anywhere. Proper bonding and grounding minimizes the effect of this interference.

This radiated energy from power transmission lines is called "power influence" and can be measured by the CopperPro using the VF Noise test in the POTS Toolbox (Figure 1).

## Balance key to minimizing noise

Because the energy being radiated affects the tip and ring conductors equally with respect to ground, an electrically balanced pair will reject the noise. However, in the real world, perfect balance rarely exists. Wet cable, bad splices or unequal conductor lengths can lead to balance problems. Any imbalance will result in a potential difference between tip and ring. Voltage will flow, and if the magnitude is great enough, the customer will complain.

This is known as metallic noise, and is measured along with power influence by the CopperPro in the VF Noise test (Figure 1). Figure 1 shows the results of a voice frequency noise test on a pair. Set-up information and results are displayed at the top of the screen. In the example, the pair has passed because metallic noise (Nm) and Power Influence (PI) are less than CopperPro's default limits; Nm is less than 30 dBrnC and PI is less than 80 dBrnC. Had the test failed either Nm or PI, the failure would be highlighted by blinking reverse video.

When metallic noise is a problem, but PI is acceptable, the problem is probably in the pair, as a result of poor balance or excess

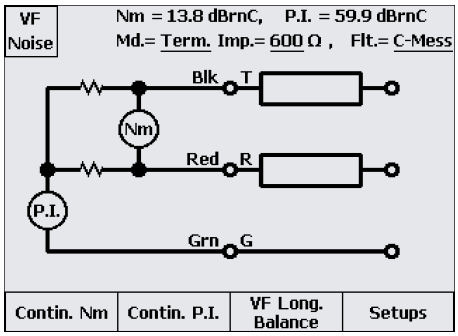


*Figure 1 VF Noise Result*

power harmonics. When both metallic noise and PI fail, the problem is most likely related to a poor sheath ground or bonding problems.

Because good pair balance is key to eliminating noise problems, CopperPro provides several methods to verify balance:

- Longitudinal balance
- Capacitive balance
- Resistive balance

## Longitudinal Balance

When a pair is unbalanced, the noise induced on it may vary with the time of day. This corresponds directly with power demand on the grid. For example, noise may be more prominent at noon on a hot day, when air conditioners are drawing a lot of power.

The longitudinal balance elimates that variability by simulating the presence of noise and measuring the difference between the noise and the level of the signal it induces on the pair.

CopperPro provides a longitudinal balance test in the POTS Toolbox. An example is shown in Figure 2 on the next page.

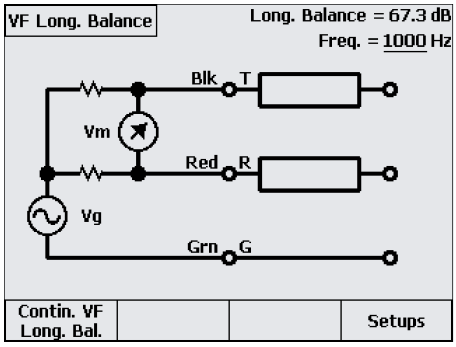


*Figure 2 VF Longitudinal Balance Test Results*

In the example, a reading greater than 60 dB has passed CopperPro's default setting. As with the VF Noise Test, the pass/fail limits and the disturbing frequency can be changed.

## Capacitive balance

All cable pairs have distributed capacitance. Capacitive balance results when the capacitance of tip-to-ground versus ring-to-ground is equal. Bad or corroded splices, shorts-to-ground or crosses-to-battery, split pairs, or unbalanced bridge taps can disturb capacitive balance.

With CopperPro, capacitive balance is measured using the Opens test, located in the POTS Toolbox. Because it uses a three terminal method, it's essential to have access to cable sheath ground. Also, for accurate distance measurement, the proper cable type should be defined in Setups.

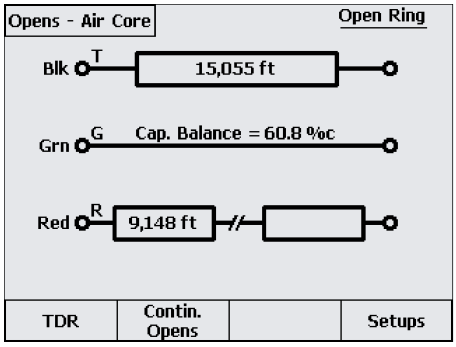


*Figure 3 Opens Test Results*

The Opens test results (Figure 3) will report pair length, percent balance of the pair, and distance to any open, if present. The default pass/fail limit is set at >95% capacitive balance. In this example, the test has failed due to an open ring conductor at 9,148 feet. Again, the failure is highlighted in blinking reverse video.

## Resistive balance

As with capacitance, cable pairs have distributed resistance. Resistive balance results when tip-to-ground and ring-to-ground are equal. Resistive imbalances can result from the same type of problems as capacitive imbalance. Many digital services, such as HDSL, are particularly sensitive to resistive balance.

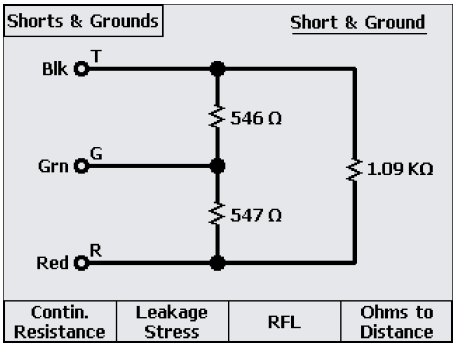


*Figure 4 Resistive Balance Result as displayed in Shorts and Grounds test*

Resistive balance can be verified by using the Shorts and Grounds test in the POTS Toolbox. The far end of the tip and ring conductors are shorted to ground, and resistance on each leg is measured. Example results are shown in Figure 4.

A pair is resistively balanced when the tip-to-ground and ring-to-ground resistances are within 3 ohms of one another.

## Harmonics

A pure, AC signal (undistorted sine wave) will not create harmonics. However, when AC power is induced on a telephone pair (PI), some distortion occurs, and therefore, harmonics are generated.

In North America, AC power is distributed at 60 Hz and will generate harmonics 60 Hz apart (120, 180, etc.). The power transmission system will cancel the even number harmonics (2nd, 4th, 6th, etc.). As a result, most induced noise is created by odd harmonics (1st, 3rd, 5th, etc.).

Customers usually can't hear 60 Hz noise, and the C-Message filter suppresses it for most voice frequency tests. However, higher harmonics, such as the 9th harmonic (540 Hz) is clearly audible.

With experience, noise mitigation specialists can identify the likely source of a problem based on prevalent harmonics. For example, a large 9th and 13th harmonic may be an unbalanced three-phase load in the power company grid.

CopperPro provides the ability to measure harmonic noise, up to the 50th harmonic. (See Figure 5.) After performing a voice frequency noise test, press the Power Harmonics soft key to view the level and frequency of any measured harmonics.

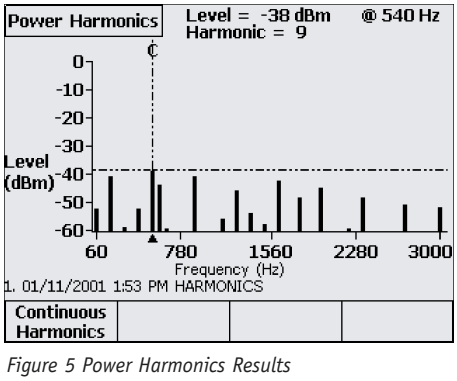


*Figure 5 Power Harmonics Results*

## Wideband noise

Digital services, which use square waves to transport data, can create substantial interference. Signals radiated from pairs carrying service can cross-talk to adjacent pairs carrying other voice and data services.

Due to the square wave, noise induced by digital services has a lot of harmonic content and can cause interference over a broad range of frequencies. Because high-speed services can be in the same binder group or in close proximity to other working pairs, this noise interferes with a broad range of services, from ISDN to ADSL.

CopperPro provides a wideband noise and level measurement tool (XDSL Toolbox) that can look at all signal levels simultaneously across a wide frequency spectrum. This capability often goes by the name "spectral analysis." Because common sources of interference have a characteristic shape, a mask can be overlaid on the measured signals to help the technician identify the source of the noise.

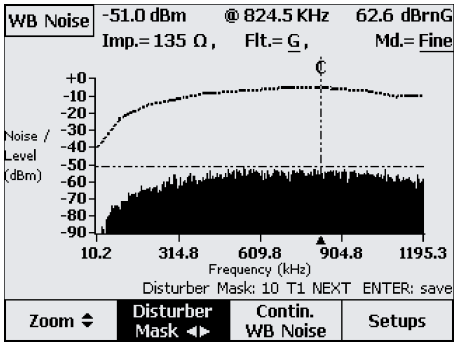


*Figure 6 Wideband Noise Spectrum – T1 Interference on a spare pair*

Figure 6 is an example of interference of a T1 circuit on a spare pair. The T1 mask helps to verify the source of the noise.

CopperPro can also be used with active lines to identify interfering signals. Figure 7 shows the level spectrum of an ADSL line. Here, noise spikes at the higher frequencies above approximately 600 kHz are being induced by an AM radio transmitter near the user.

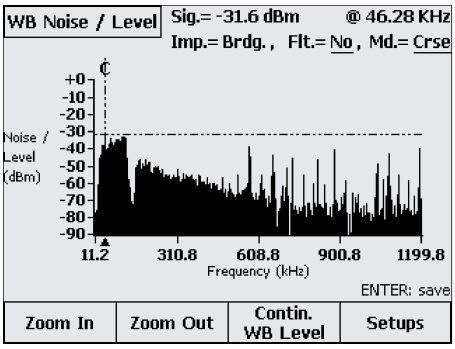


*Figure 7 ADSL signal with AM radio interference*

## Impulse noise

Intermittent, high-frequency noise is a difficult problem to identify. Yet, these noise spikes emitted by machinery or lighting, appliances, or copy machines, can interrupt data services, with delays of up to a minute.

To identify such noise sources, CopperPro provides an impulse noise test (XDSL Toolbox), which can be set to detect and record all high-frequency spikes over a certain amplitude over a set time interval. Example results are shown in Figure 8.

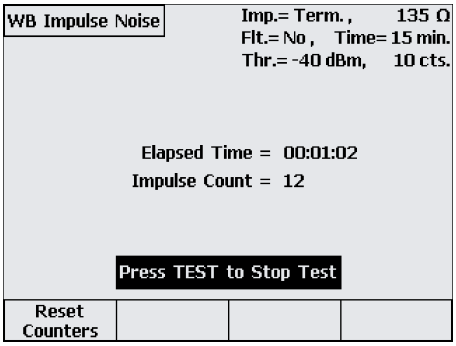


*Figure 8 Impulse Noise Test Result*

## Summary

Noise is a common problem in telecommunications networks. Good design, grounding and bonding will minimize or eliminate interference. Electrically unbalanced pairs, or crosstalk from adjacent pairs, can cause problems for both voice and data customers. CopperPro provides a wide range of tools to help the technician to quickly measure and identify the root causes of interfering noise.

## Fluke Networks is working for you

CopperPro is a part of our Network SuperVision Solutions™ – a complete family of leading-edge tools, services and training from Fluke Networks. If you require technical support, for application or operation assistance, or for more information about the CopperPro tester, email:
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