

DIGITAL MULTIMETER: THE DIRTY DOZEN

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APPLICATION NOTE

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Telecom field technicians rely on “dirty dozen” electrical measurements to determine the basic quality of a circuit. Traditionally, technicians used an analog multimeter, sometimes affectionately referred to as a “kick meter”, since the needle would “kick” across the measurement window. Today, technicians use digital multimeters that are easier to read thanks to LCDs that can lock onto the strongest value for the measurement. These meters provide technicians with the electrical information needed to rapidly determine the health of the circuit under test. Where the multimeter was once limited to VF circuit quality, it can now, with the use of “dirty dozen” electrical measurements, also provide a good indication of network health for DSL circuits.

The term “dirty dozen” refers to AC voltage, DC voltage, loop resistance and loop capacitance when measured for T-R, T-G and R-G (also known as A-B, A-Earth and B-Earth, respectively). Individually, these measurements offer the technician little insight, but collectively, they can provide a wealth of information for both VF and DSL circuits.

DC Voltage

On a properly provisioned voice circuit, there should be approximately -48 VDC when measuring between R-G (-52 VDC is also acceptable), which indicates a connection to the voice switch. A value that is too low can indicate that no voice switch is connected or that there is a fault on the circuit. A value that is too high (higher than -48 VDC to -52 VDC) could indicate a digital service (e.g., power feed for HDSL or SHDSL repeaters). If no voice switch is connected to the circuit, the DC voltage should be 0 VDC.

AC Voltage

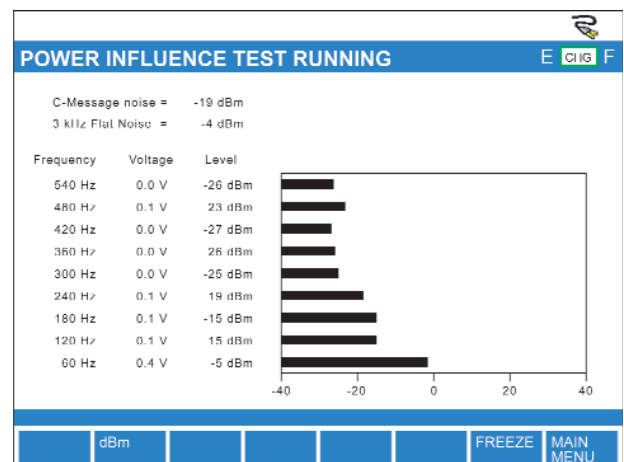
Any AC voltage can indicate a power influence problem. The most prominent reason for a power influence problem is poor grounding or bonding in either the telephone company or the electrical power company. Telephone cables need to be grounded periodically (i.e., every 400 m or 1300 ft), and they sometimes share the same ground rod as the electrical power company.

A power influence test can provide additional information to the technician. The power influence test measures the voltage and noise levels related to 50/60 Hz interference.

Resistance

Resistance measurement gives the technician insight into potential resistive faults that could exist on the circuit under test. A short circuit is the most severe resistive short there is. In most cases, however, a partial short could exist. The technician can follow up with an isolation resistance test or a resistive fault location (RFL) test to further qualify or determine the distance to a resistive fault.

Loop resistance can be measured on a circuit that has been shorted at the far end. The loop resistance can be used to calculate the length of the circuit. An accurate calculation can only be made if the correct resistance per unit length is used (i.e., resistance per mile or resistance per km). Caution needs to be exercised when setting up a loop resistance test as different wire gauges have significantly different resistances per unit length; therefore, using the wrong value can provide erroneous results.



$$\text{Distance} = \frac{\text{Measure Loop Resistance}}{\text{Resistance per unit length}}$$

Resistance measurement is probably the most accurate method of determining loop length as compared to capacitance; however, it requires a truck roll to apply a short at the far end of the circuit. The capacitance measurement will include resistive faults such as bridge taps, splits pairs and water in its measurement so capacitive length will provide a length longer than expected in these cases. However, capacitance only requires an open circuit (typically means no truck roll).

Note: If the T & R wires are shorted to ground at the far-end, the resistance between T-G and R-G should be the same value (or within 5%). Otherwise, the circuit has a resistive balance issue, which may affect DSL service.

Capacitance

Capacitance is a quick test to determine loop length in which only one open circuit is needed. Capacitance measurement is greatly facilitated by the more popular wire gauges (i.e., 26, 24 and 22 AWG or 0.4, 0.5 and 0.6 mm) as they are designed to have the same (or similar) capacitance values per unit length (i.e., 83 nF/mile or 52 nF/km).

$$\text{Distance} = \frac{\text{Measure Loop Capacitance}}{\text{Capacitance per unit length}}$$

Capacitance measurement will include resistive faults such as bridge taps, splits pairs and water in its measurement, so capacitive length could provide a length longer than expected in these cases. In addition, if equipment is connected to circuits such as a POTS splitter, a microfilter or a DSL modem, additional capacitance can be measured.

It should be noted that, on an idle line, the capacitance between T-G and R-G should have the same value (or within 5%). Otherwise, the circuit has a capacitive balance issue which may affect DSL. When the line is active and the T wire is grounded, T-G capacitance cannot be measured.

EXFO's CableSHARK

EXFO's CableSHARK covers all these important points, for accurate, hassle-free testing. The unit provides AC voltage measurements for T-R, T-G and R-G connections and shows the predominant AC frequency for each connection. In addition, power influence information is provided up to the 9th harmonic and DC voltage measurements are available for T-R, T-G and R-G connections.

As for resistance measurements, the CableSHARK easily tests T-R, T-G and R-G connections and automatically calculates the equivalent length for the same connections. Measurements in the MΩ range indicate an open circuit (use the capacitance measurement for open circuits).

Finally, the CableSHARK also provides capacitance measurements for T-R, T-G and R-G connections and automatically calculates the equivalent length for the same connections. Measurements indicating less than 200 pF would signify a bad connection to the line (use the resistance measurement to determine if the circuit has a resistive fault).

Getting through the dirty dozen has never been easier.



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