



SUNRISE TELECOM

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Application Series

SunSet xDSL: Traditional Digital Multimeter Tests for Prequalifying & Troubleshooting DSL Circuits

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INTRODUCTION

A Digital Multimeter has long been a valuable tool for the service technician. The same techniques traditionally used with a DMM are also applicable to DSL. This application note outlines how to apply your traditional DMM methods specifically to DSL circuits.

There are 5 different DMM tests used to prequalify and troubleshoot DSL: ACV measurement, DCV measurement, capacitance measurement, loop resistance measurement, and isolation resistance measurement. Each one is described in this application note. This application note divides the tests into 4 different testing categories: verify metallic criteria, check loop length, verify POTS voltage, and check for power.

Category	DMM Test	Testing Phase
Verify metallic criteria	Isolation resistance, capacitance	Prequalification of copper pair
Check loop length	Loop resistance, capacitance	Prequalification of copper pair & troubleshooting failed turn-ups
Verify POTS voltage	DCV	Service installation
Troubleshoot power influence	ACV	Troubleshooting faulty circuits

VERIFY METALLIC CRITERIA

During prequalification, DMM measurements can verify that the copper pair meets the requirements for the DSL service. For example, ANSI T1.413 (ADSL) specifies that the tip-ground/ring-ground isolation resistance measurement should be a minimum of 5 Mohm for ADSL service. These tests allow you to verify proper metallic criteria prior to installing DSL equipment.

Resistance quick check	
Tip-ring > 5 MΩ	If less, short exists
Tip-ground > 5 MΩ	If less, ground exists
Ring-ground > 5 MΩ	If less, ground exists

Figure 1 Resistance quick check

Measure resistance

A resistance meter verifies isolation resistance of tip-ground and ring-ground with an open at the far end. Both should be a minimum of 5 Mohm per ANSI 1.413 (ADSL standard).

1. Connect to the circuit. You will need to connect all 3 leads: tip, ring, and ground. Make sure to use the DMM/TDR/LINE jack on the right side of the SunSet.
2. Press the MENU key.
3. Enter DMM.
4. Use the arrow keys to cursor to OHM; press ENTER.
5. Use the F-keys for tip-ring, ring-ground, and tip-ground to see readings for all three types. Make sure that the tip-ground and ring-ground readings show greater than 5 Mohm.

Check for balanced pair

You can run a capacitance test to check for a balanced pair. A balanced pair means that both the tip and ring leads are of equal length.

1. Connect to the circuit. You will need to connect all 3 leads: tip, ring, and ground. Make sure to use the DMM/TDR/LINE jack on the right side of the SunSet.
2. Press the MENU key.
3. Enter DMM.
4. Use the arrow keys to cursor to CAP; press ENTER.
5. Use the F-keys for tip-ring, ring-ground, and tip-ground to see readings for all three types.
6. The tip-ground and ring-ground measurements should be roughly equal. If not, the tip and ring leads are not of equal length. If one of the leads is longer, this could indicate a split pair. A split pair is a wiring mistake when a wire of one pair is spliced to another wire in an adjacent pair. Splits are often connected by reconnecting the pair farther down the line (known as a resplit). Splits and resplits are troublesome for the DSL signal.

OHM	
TYPE :	TIP RING
T_R :	> 5 MO
T_G :	> 5 MO
R_G :	> 5 MO
TIP RING	TIP GND RING GND

Figure 2 Resistance measurement

CHECK LOOP LENGTH

Much attention has been focused on the distance between the customer and the central office. The distance can influence the maximum data rates. It may determine if DSL service can be supported at all. For this reason, it is critical to know the exact loop length during prequalification or installation testing. In addition, a distance measurement can be a good indication of a fault on the circuit. If your reading is significantly shorter than expected, there's a good chance you have a cut, open, or even short on the line. If you see a longer reading, you may have a bridge tap or split pair.

There are two basic methods for determining loop distance: capacitance and loop resistance. Each has its advantages and disadvantages. Capacitance can be less reliable, but does not require a short at the far end. Loop resistance is more reliable, but requires a short at the far end. Each method is discussed below.

Measuring distance with capacitance

The capacitance measurement can provide a rough estimate of distance to the far end. It is only a "rough estimate," since any resistive faults like bridge taps or wet cable will be included in the calculation. Be wary; if your cable has any faults, this measurement will give a longer distance than reality. For example, if your cable pair is actually 8,000 feet long, but also has a bridge tap with a lateral length of 2,000 feet, the capacitance reading will give 10,000 feet (not 8,000). Capacitance does have its advantage since it should be performed with an open at the far end, as opposed to the loop resistance test that requires a short at the central office or far end.

Distance is calculated using the following conversion ratio for tip-ring measurement:

- 83 nF= 1 mile (5,280 feet)
- 51 nF= 1 km

But, don't worry, you don't need to bring a calculator with you for your prequalification testing. The SunSet xDSL will provide the distance calculation for you.

1. Connect to the tip/ring of the cable pair. Make sure to use the DMM/TDR/LINE jack on the right side of the SunSet.
2. Press the MENU key.
3. Enter DMM.
4. Use the arrow keys to cursor to CAP; press ENTER.
5. Use the F-keys for tip-ring, ring-ground, and tip-ground to see readings for all three types.
6. Refer to bottom of screen for your distance reading.

Note: If your capacitance reading shows $>2 \mu\text{F}$, there is a short on the pair. You can use the OHM measurement to verify this.

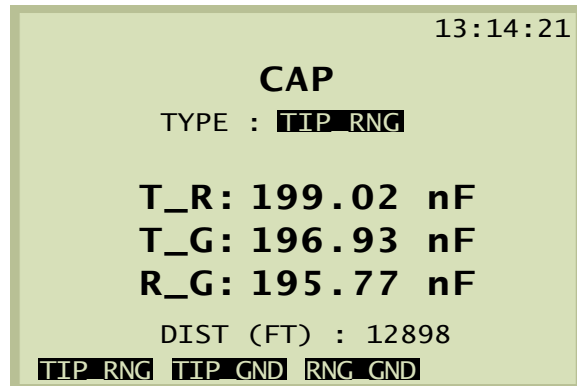


Figure 3 Capacitance

Measuring distance with loop resistance

You can also use a loop resistance measurement to provide an estimated distance. This test must be performed with a short at the far end.

1. Connect to the tip/ring of the cable pair. Make sure to use the DMM/TDR/LINE jack on the right side of the SunSet.
2. Press the MENU key.
3. Enter LINE, then CONTROLLER.
4. Enter LOOP RESISTANCE.
5. Use the F-keys for tip-ring, ring-ground, and tip-ground to see readings for all three types.
6. Refer to the bottom of the screen for your distance reading. The SunSet xDSL provides the calculation for you, based on ANSI T1.601 Annex G. This conversion factor is based on cable type and temperature. The screen provides three different readings based on 22, 24, and 26 AWG or 0.6, 0.5, 0.4 mm cable. If you are testing mixed-gauge cable, try to make an appropriate estimate based on the percentage of each type.

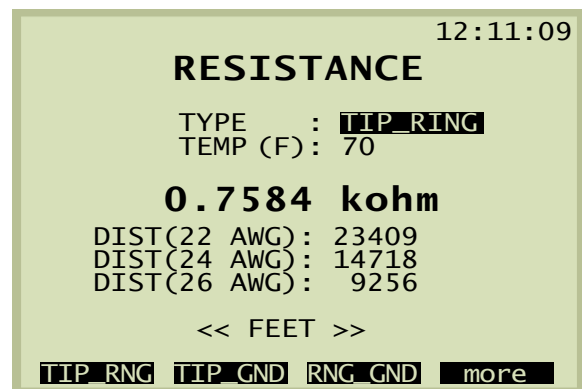


Figure 4 Loop resistance

For example, if half your cable is 22 AWG and half is 24 AWG, you should add half of the 22AWG distance and half of the 24 AWG distance.

Note: You can also verify that the circuit shows acceptable loop resistance values (tip-ring with a short at the far end):

- HDSL Requirement: 900 ohm max
- ADSL Requirement: 600 ohm max

Identifying possible bridge taps with distance measurements

You can identify possible bridge taps on the circuit by measuring distance using the two methods discussed above: loop resistance and capacitance. If the length given by the CAP measurement is longer than the length from Loop Resistance, this could indicate a bridge tap. This is because the capacitance measurement includes any resistive faults, like bridge taps, in its measurement. The difference between the two measurements could also indicate the length of the lateral.

If the capacitance measurement is larger, you should try a TDR measurement or Insertion Loss test ("Detaptor") to confirm the presence of a bridge tap.

VERIFY POTS VOLTAGE

The POTS loop is powered by 48-VDC from the central office. The voltage is placed on the ring lead, with the tip as an insulated ground. You can run a DCV measurement to verify that the cable pair is connected to the POTS switch and is properly powered.

1. Connect to the circuit. You will need to connect all 3 leads: tip, ring, and ground. Make sure to use the DMM/TDR/LINE jack on the right side of the SunSet.
2. Press the MENU key.
3. Enter DMM.
4. Use the arrow keys to cursor to DCV; press ENTER.
5. Use the F-keys for tip-ring, ring-ground, and tip-ground to see readings for all three types.
6. You should see -48 VDC for the ring-ground measurement and +48 VDC for tip-ring. Otherwise, the cable pair is not connected to the POTS switch at the central office.

TROUBLESHOOT AC INTERFERENCE

An AC voltage measurement can check for unwanted power influence. This power influence is caused by induction between the tip-ground and ring-ground from power lines running near the cable pair.

1. Connect to the circuit. You will need to connect all 3 leads: tip, ring, and ground. Make sure to use the DMM/TDR/LINE jack on the right side of the SunSet.
2. Press the MENU key.
3. Enter DMM.
4. Use the arrow keys to cursor to ACV; press ENTER.
5. Use the F-keys for tip-ring, ring-ground, and tip-ground to see readings for all three types.
6. You should see minimal values (i.e. 0) for all three measurements. A large value indicates power influence.

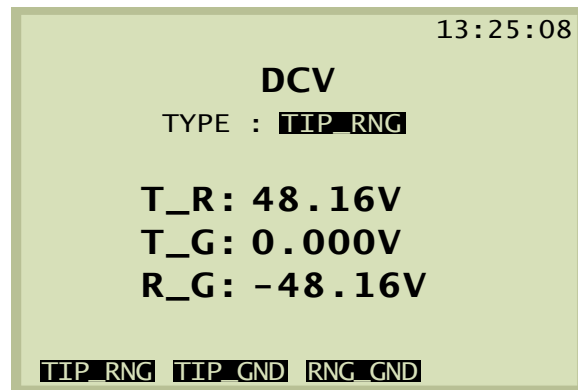


Figure 5 VDC measurement

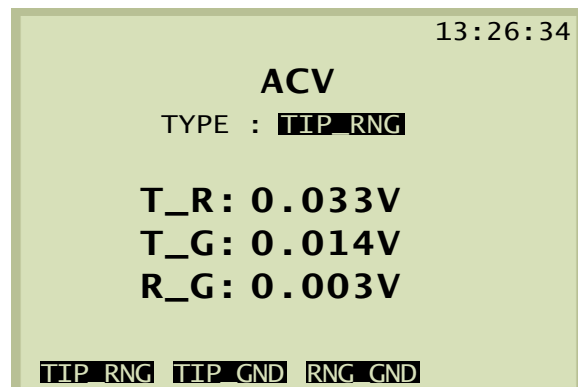


Figure 6 ACV measurement