AN250
Measuring a Cable from Both Ends

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Abstract

While a TDR is well known for its convenient ability to measure a cable from one end, in certain cases it is necessary to measure a cable from both ends. This application note discusses those cases and provides instructions on obtaining accurate measurements.

General

The following are three cases where measuring from both ends of a cable is highly recommended:

1. Can't ID opposite end – A case where measuring from one end of a cable, the open or shorted state at the end of the cable appearing in the TDR's trace can NOT be changed by physically opening and shorting the conductors at the opposite end.
2. A wet cable to find the actual length of a wet section – Velocity Factor (VF) in a wet cable slows to some uncertain speed making all distance measurements in and after the wet section unreliable.
3. A cable of uncertain length and uncertain VF with a fault – If a fault is somewhere along the cable and not at an accessible end a two-ended measurement will help with locating the fault.

Can't ID Opposite End

Usually one easily recognizes the electrical end of the cable by measuring from one end with a step TDR. The impedance trace rises quickly to infinity for an open or drops quickly to zero for a short. However, this might not be the physical end of the cable. Perform a quick check to ensure the electrical end seen on the TDR trace corresponds to the physical end by changing the state of the end's conductors. If the cable reads open, short the far end; if the cable reads shorted, open the far end. If the opposite state appears on the TDR trace and remains at the same distance, you have positively identified the physical end of the cable. However, if the state does not change there are two possible reasons:

1. The conductor's state was changed on the wrong cable.
2. The cable is broken or shorted before the end.

In case 1, its time to go back to the cable diagrams or use a tone and probe to locate correct cable's ends. Once you are sure you are opening and shorting the same pair the TDR is on with no results, then it's time to measure the cable with the TDR from the opposite end to confirm the distance to the fault.

Wet Cable to Find the Actual Length of the Wet Section

Water inside a cable leaves a recognizable signature of erratic reductions in impedance as depicted in Figure 1.

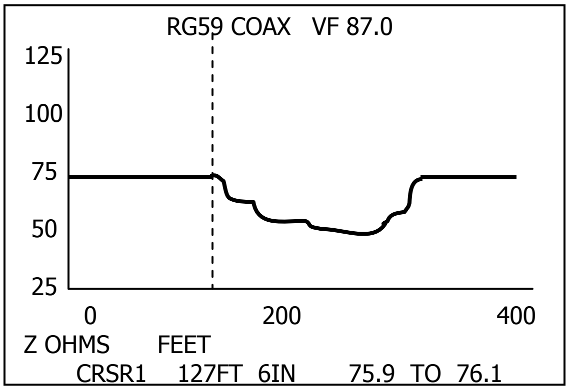

Figure 1

A wet cable has a droop in the impedance curve that looks very similar to the pinched coaxial cable. If the droop lasts for a longer distance, the damaged area of the cable is also longer. If there is good cable beyond the wet section, impedance returns close to the expected level. Note: If water damage appears, do not trust the distance measurements over the length of the low impedance zone or from the wet zone to any point beyond the zone. Water in the cable seriously reduces the VF and makes the distance readings in and after these areas inaccurate. Trust only the distance measurement from the TDR to the start of the wet area. If you require a measurement of the wet area, follow these steps:

1. Use on your cable map to find the distance between two access points, with one access point on each side of the wet zone.
2. At the first access point, measure the distance from the TDR to the start of the wet zone. Write down the measurement or save the plot.
3. At the opposite access point, measure the distance from the TDR to the start of the wet zone. Again, write down the measurement or save the plot.
4. Add the two measured distances together and subtract that total from the distance between the access points as shown on the cable map. The result will be the length of the wet zone.

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Cable of Uncertain Length and Uncertain VF with a Fault

In this case, you have two unknowns or uncertainties, the cable length and the velocity factor. Even when the length could be ascertained by cable markings or diagrams, the fault prevents measuring the cable's VF as described in AN256. Use the following two-ended measurement to locate the fault.

You can still get an indication of the cable's condition even if you don't know what VF to use. Just make an estimate of the VF based on generic cable properties.

Use the "Relative Distance" method estimate the fault's location. Take a distance reading from each end of the cable using the same pair or pairs, store the traces or write down the results of each reading. If the lengths of the pair(s) or the coax are different from each end, there is a fault in the cable. If the two readings are nearly identical, but are only ½ the expected distance, the fault is near the middle of the cable. If one reading is twice the distance of the other you can assume a fault 1/3 the length of the cable from the shorter reading, etc.

$$\text{Relative distance from first end} = (1^{st} / (1^{st} + 2^{nd}))$$

Using the estimated or relative distance from the 20/20 TDR readings as a starting point, utilize visual inspection techniques to pinpoint the likely fault location. Visual inspection techniques involve looking for construction zones, dig sites (old digs often leave a symmetrical depression in the ground), storm damage, new fences, pedestals, posts, etc.

Once the fault is located and repaired, don't reach for a cool drink yet! Take a measurement to ensure the impedance bump at the repair displays as a minor event. But most important, ensure you can ID the entire cable end-to-end as described in the first case. If you can, great! Now use the 20/20 TDR to get a VF reading on this cable (see AN256). If you can not ID the opposite end you have a second fault. Use the relative distance method again to get an estimated distance to the second fault and repeat this process until both ends can be ascertained.

Conclusion

Measuring from both ends of the cable can be useful to improve the accuracy of fault locating, measure wet cable sections, and locate faults on cables with uncertain velocity factors. The 20/20 TDR's ability to show faults and cable ends clearly, measure VF accurately, and store traces easily helps you overcome difficult measuring situations.

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