AN227
Testing Premise Telco or Network Cables

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Abstract

Testing telco pairs used to be a simple continuity check to ensure the pairs were connected correctly and with no shorts or opens. This worked fine for analog phones (aka POTS) and was pretty much OK for modems up to 56K. However, with the introduction of high speed digital services and increased deployment of IP level networking services including VoIP the pair's attenuation loss, reflective events from poor connections and insulation integrity demand another level of testing.

General

Cat 5 & 6 premise cable testers would be excellent for this task as they can also test Cat 3 or POTS cables. However, with a price tags ranging $4-6K they are truly too expensive for a company to equip its entire installation and maintenance force. Most Cat 5 & 6 testers will tell there is an attenuation or miswire, but won't tell you were.

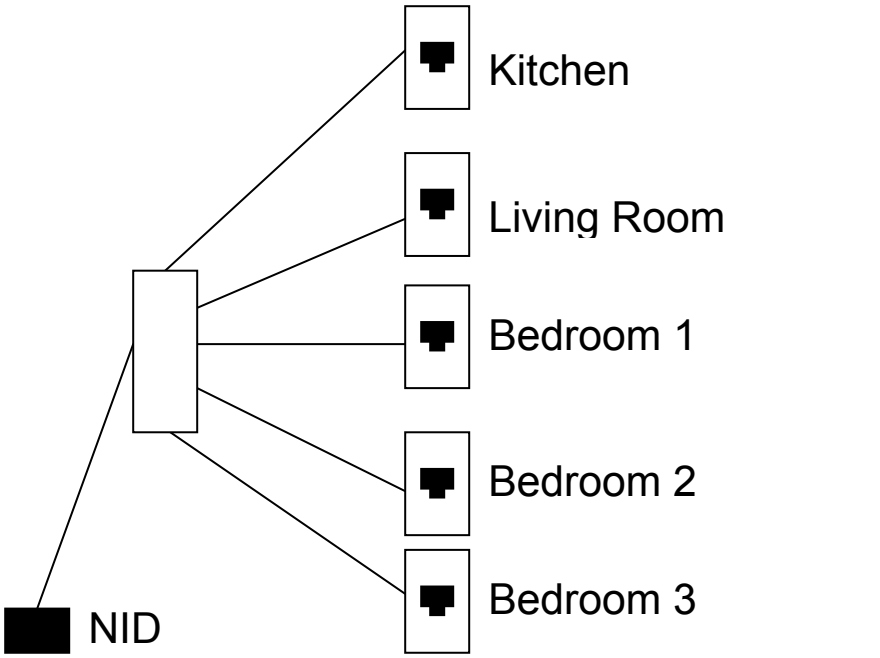
The 20/20 TDR from AEA Technology can be used to prove these pairs are correctly installed and up to the job of supporting services like ADSL2+, VDSL and VoIP. The 20/20 TDR is a "Step" TDR as opposed the more common "Pulse" TDR. With a step TDR, accurate distance on a twisted pair or coax cable can be obtained AND the impedance (Z) of the pair or cable over it's entire length is also displayed. Additionally, there is no "dead zone" on any range setting, no gain or pulse width to adjust and clearer indications of all events, large or small. The Step TDRs use a continuous wave of pulses to paint a clear picture of the cable's condition over its entire electrical length.

Application:

Single pair testing

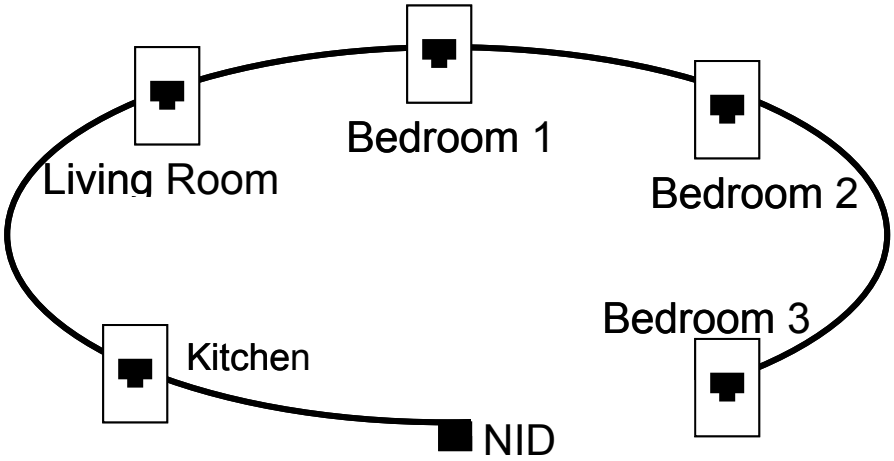
Testing can be done from the premise NID or CATV connection points using either the telco test lead set with Popper clips or by connecting an RJ11, RJ12 or RJ45 connector lead directly into the 20/20 TDR. A shorting plug is required at the far end of the pair to ensure the open end seen by the TDR is at the wall jack's pins and not inside the jack or before the jack. First step is to display the full length of the pair and place the TDR's cursor at the pair's end to mark length while it reads an open at the far end jack. If the premise wiring is a home run from a connection panel to the wall jack (see figure 1), there should be no other events on the pair except the open at the far end. If this is an older telco loop (see figure 2) there may be other jacks in series

that should only show small reflective events at each jack location. Now place the shorting plug in the far end jack. If the cable is wired correctly, the TDRs trace will change from an open to a short at the same distance.



Typical Star or Home Run Wiring

Figure 1



Typical Telco Loop Wiring

Figure 2

The first two sets of examples below show the difference in what the technician sees between a “Step” TDR and a “Pulse” TDR. With a step TDR there is never a question whether the event is a connection fault or the electrical end of the cable.

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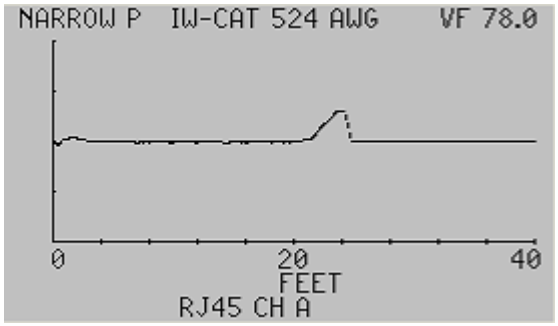
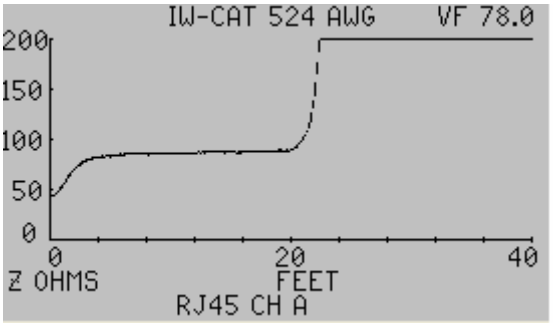
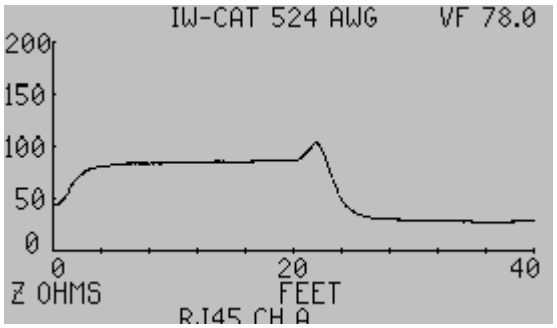


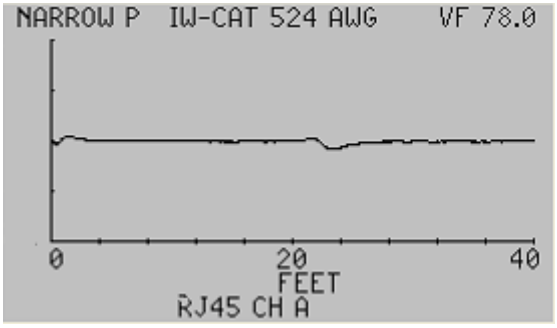
Open pair on a Pulse TDR



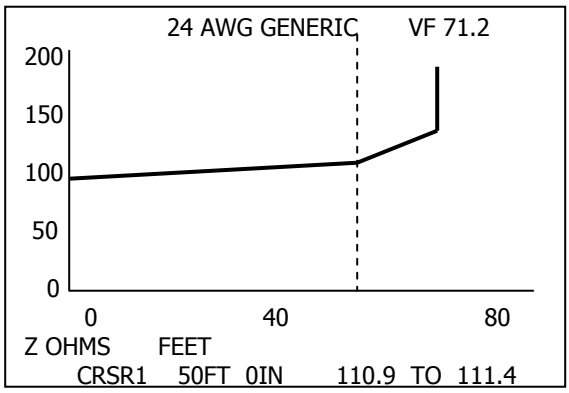
Open pair on a Step TDR



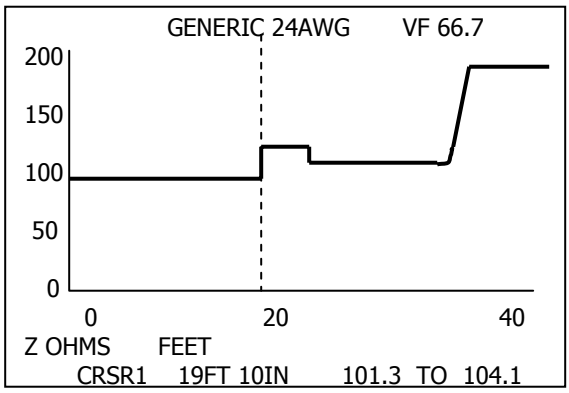
(Note the minor up-swing in the trace just before going to a short. This is a normal telco or Cat 5 jack and plug's impedance event due to untwist at the connections)



Poor quality patch cord in last 20 ft.



Poor quality splice or telco loop connection at an in-line wall jack outlet



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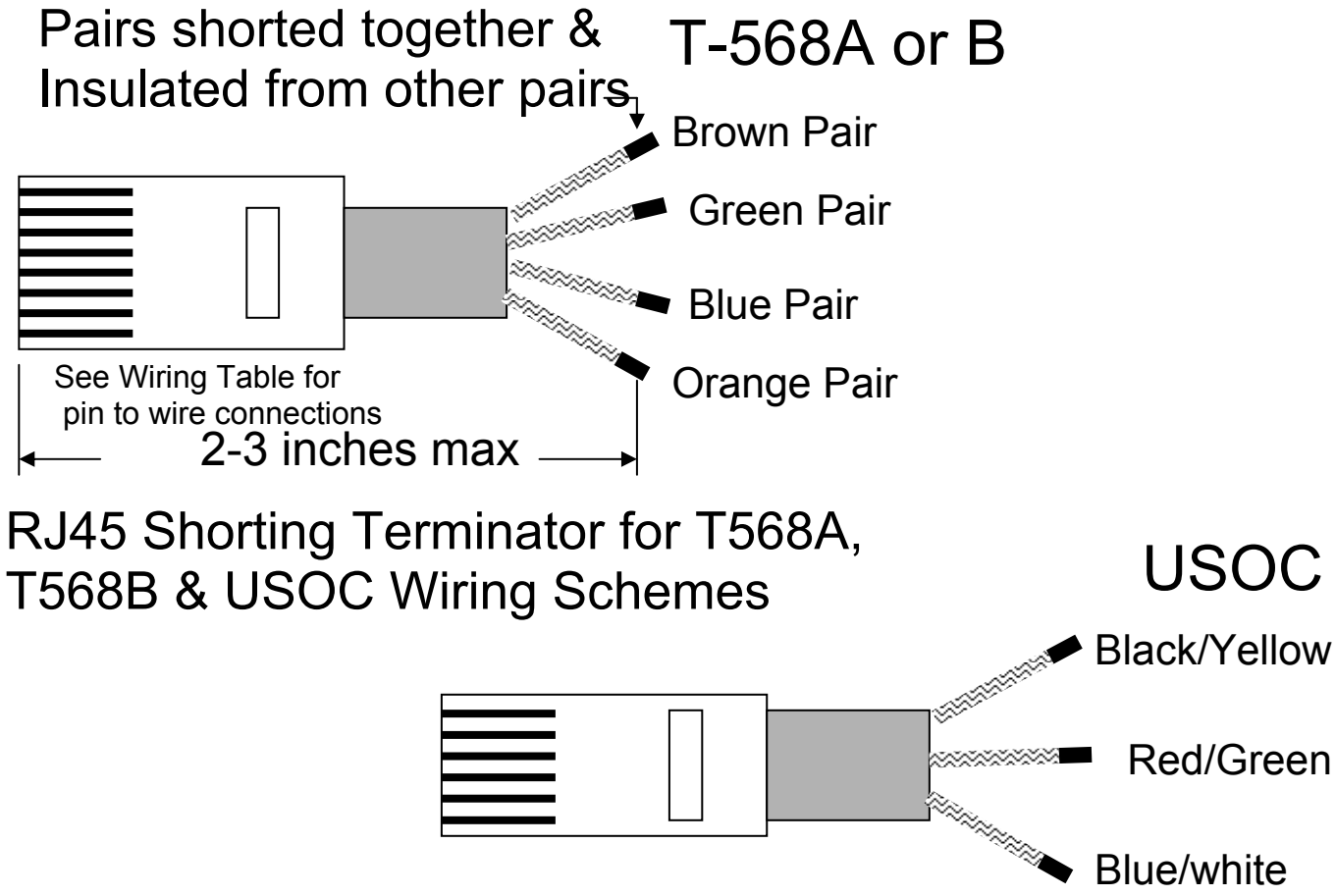

Figure 3

For RJ11 plugs, connect & short only the Blue and Orange pairs for TIA 568 cable or the red/green and yellow/black pairs for USOC
For RJ12 plugs, connect & short only the Blue, Orange and Green pairs for TIA 568 cable or the red/green, yellow/black and blue/white pairs for USOC

Multi-pair testing

With one pair proven good, switch the 20/20 TDR to the pairs' differential mode and perform the same steps – look at the difference in the good pair an another pair in the same jacket. The two pairs should be open at the far end, then shorted at the far end. The results should be the same length. A flat trace near 0 with minimal deflection at the cable end. Note the shorting plug needs to be wired per the pair's wiring scheme with each pair shorted individually and no shorts between pairs. See the attached table for USOC (old telco), T-568A or T-568B wiring schemes and figure 3 for wiring RJx plugs for testing.

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TIA/EIA and USOC Wiring Standards Table

Authority	Wire Map Scheme	Jack/Plug & pins	Wiring Color Code	20/20 TDR Input Channel
AEA	Coaxial Connector	Coaxial	Alternative Red/Black Lead	COAX
Technology	Red/Black Clips	4 & 5	N/A	RJ45 CH A
Accessories	Green/Black Clips	3 & 6	N/A	RJ45 CH B
	Red/Blk & Green/Blk Clips	4/5 & 3/6	N/A	RJ45 CH A Δ B
TIA/EIA 568A	T-568A Pair 1	4 & 5	Blue/White	RJ45 CH A
	T-568A Pair 2	3 & 6	White/Orange	RJ45 CH B
	T-568A Pair 3	1 & 2	White/Green	RJ45 CH C
	T-568A Pair 4	7 & 8	White/Brown	RJ45 CH D
	T-568A Δ Pairs 1 & 2	4/5 & 3/6	Blue/White & White/Orange	RJ45 CH A Δ B
	T-568A Δ Pairs 1 & 3	4/5 & 1/2	Blue/White & White/Green	RJ45 CH A Δ C
	T-568A Δ Pairs 1 & 4	4/5 & 7/8	Blue/White & White/Brown	RJ45 CH A Δ D
	T-568A Δ Pairs 2 & 3	3/6 & 1/2	White/Orange & White/Green	RJ45 CH B Δ C
	T-568A Δ Pairs 2 & 4	3/6 & 7/8	White/Orange & White/Brown	RJ45 CH B Δ D
	T-568A Δ Pairs 3 & 4	1/2 & 7/8	White/Green & White/Brown	RJ45 CH C Δ D
TIA/EIA 568B	T-568B Pair 1	4 & 5	Blue/White	RJ45 CH A
	T-568B Pair 2	3 & 6	White/Green	RJ45 CH C
	T-568B Pair 3	1 & 2	White/Orange	RJ45 CH B
	T-568B Pair 4	7 & 8	White/Brown	RJ45 CH D
	T-568B Δ Pairs 1 & 3	4/5 & 3/6	Blue/White & White/Green	RJ45 CH A Δ B
	T-568B Δ Pairs 1 & 2	4/5 & 1/2	Blue/White & White/Orange	RJ45 CH A Δ C
	T-568B Δ Pairs 1 & 4	4/5 & 7/8	Blue/White & White/Brown	RJ45 CH A Δ D
	T-568B Δ Pairs 2 & 3	1/2 & 3/6	White/Orange & White/Green	RJ45 CH B Δ C
	T-568B Δ Pairs 3 & 4	3/6 & 7/8	White/Green & White/Brown	RJ45 CH B Δ D
	T-568B Δ Pairs 2 & 4	1/2 & 7/8	White/Orange & White/Brown	RJ45 CH C Δ D
Telcordia	USOC Pair 1	4 & 5	Blue/White (old = red/green)	RJ45 CH A
	USOC Pair 2	3 & 6	White/Orange (old = black/yellow)	RJ45 CH B
	USOC Pair 3	2 & 7	White/Green (old = blue/white)	RJ45 CH D
	USOC Pair 4	1 & 8	White/Brown	RJ45 CH C
	USOC Δ Pairs 1 & 2	4/5 & 3/6	Blue/White & White/Orange	RJ45 CH A Δ B
	USOC Δ Pairs 1 & 3	4/5 & 2/7	Blue/White & White/Green	RJ45 CH A Δ D
	USOC Δ Pairs 1 & 4	4/5 & 1/8	Blue/White & White/Brown	RJ45 CH A Δ C
	USOC Δ Pairs 2 & 3	3/6 & 2/7	White/Orange & White/Green	RJ45 CH B Δ D
	USOC Δ Pairs 2 & 4	3/6 & 1/8	White/Orange & White/Brown	RJ45 CH B Δ C
	USOC Δ Pairs 3 & 4	2/7 & 1/8	White/Green & White/Brown	RJ45 CH C Δ D

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Testing Tips

1. First establish the type of premise wiring scheme, Home Run or Loop.
2. If testing a Home Run network, tone out the cables and mark their position from both ends. Mark the distribution box with the room & wall, and mark the room jack plate with the distribution box's jack number or position. This can also be done with the shorting plug and the 20/20 TDR by noting which run gets shorted at the moment the shorting plug is inserted.
3. If testing a loop, measure the full length first then plug in the shorting plug it what you believe is the last jack on the loop. The distance should remain the same open and shorted. A large drop in distance indicates you are not on the end jack. Keep trying.
4. If one or more believed end jacks cannot be located, start at the closest jack to the NID and work toward the end of the loop until the broken connection is located. The broken connection will usually be in the first unseen jack or the previous jack on the exit side.
5. Once the end jack on the loop is located and all the wires are proven good, move to each jack, in loop order, back towards the NID or TDR connection point. The shorting plug should show which pairs are connected at each room & wall jack. If a pair is not connected, you may need to open the wall plate and see if that jack was intentionally unwired or if the pair is broken.
6. Here are some of the most common failures in premise wiring:
    A. Jack was removed to paint a wall and a wire that is broken in the process goes unnoticed when it is reinstalled
    B. Jack pins and/or connection corrosion due to cats spraying the jack to mark their territory. Go ahead and laugh, but its real.
    C. Home made patch or extension cables with miswires or the wrong type RJx connector. These connectors come with different teeth on the pins for solid or stranded cable.
    D. Cable damage due to nails, staples, drilling or other activity that causes penetration into the cable's jacket and damages pairs.
    E. Cat 5 cable installed with hard staples or sharp bends. With time the pressure on the FEP Teflon insulation used on the pairs will compress causing impedance events that can be seen on the 20/20 TDR.

Conclusion

As the bandwidth of services increases copper twisted pair cable the need for higher quality testing on premise cable is required. High speed data and voice services will not operate at their full potential unless the cable is properly installed. IP level services are more severely impacted by impedance mismatches that elude older standard telco test equipment. Without a "Step" TDR today's technicians will spend excessive time and money searching for problems or simply rewire a premise to solve simple problems the 20/20 TDR will locate with ease.

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