AN228
Testing Shielded Network Cables (STP) Shield

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Abstract

Application Note AN227 discusses testing the pairs in network cabling, basically UTP (unshielded twisted pair) cables. Now that shielded Cat 5 and higher speed shielded Cat 6, 6A, 7, and 8 cables are being installed testing the shield on these cables becomes important. As with UTP cables STP cable can only be TIA 568C or ISO 11801 certified using a tester with that battery of tests. However, some of those tests can fail and the tester may not reveal the distance to the fault causing the failure. In that case it will be faster and easier to use a Step TDR to find the distance to the fault, particularly an open shield.

Preliminary

The E20/20 Step TDR can be used to locate distance to shield faults on STP network cabling systems. Before getting into the steps and testing it's important to understand some basics of shield testing. First TIA and ISO certification tools provide a Pass/Fail results on the shields based on continuity from the main tester to the far-end unit. If the continuity is not there the test fails. However, with earlier testers this test can Pass, but be false in its results if there is a secondary path between the main tester and the far-end unit providing the continuity. So TIA and ISO now require a length test on the shield to closely match the length of the cable being tested to ensure the tested cable's shield is the one providing the continuity for the Pass indication.
Secondary paths can come from the shielded RJ-45's connection to the metal rack through an adjacent shielded cable's shield to the far-end and another metal rack or metal wall plate completing the circuit to the cable under test far-end shielded RJ-45. The path can also be provided via the building's ground system providing a common path to both ends of the cable since the racks are grounded and the wall outlet plate should be grounded to a common earth grounding point in the building.

Shield testing Steps using the E20/20 TDR

Step 1 – Press the **Cables** key and select a Cat 5 or 6 cable type (these are similar in they have the same impedance as Cat 6, 6A, 7, and 8 Cable types. Only the velocity factor may vary). If the Velocity Factor (VF aka VoP or NVP) does not match the cable type being tested use the TDR's procedure to modify the cable's VF. Alternatively, you can connect the STP cable's RJ-45 plug to the E20/20's RJ-45 Input Jack to measure the cable pairs' VF and use that VF. Refer to the Operator Manual, Section 3, Velocity Search, for these procedures. Due to the capacitive coupling of the pairs' to the shield any single wire in the cable will have a VF identical or very close to the pair's Nominal Velocity Factor NVF (aka NVP Nominal Velocity of Propagation as it is more commonly known in the network cable testing environment).
NOTE: As you may already be aware, each of the four pairs in the cable will have slightly different VFs.to get the best single wire-to-shield VF recommend either take the VF measurements for all four pairs and average them, or take the VF of the pair who's electrical length most closely matches the cable's jacket length and use that VF. In either case, the goal is to obtain a single wire-to-shield length measurement and impedance that is compatible with the cable's length. If there is any possibility for another shielded cable to have a similar length running parallel to the cable under test, the far end single-wire being used and shield should be shorted to ensure only the cable under test's shield is being measured as indicated by the short at the far-end. This will eliminate the potential for measuring any secondary paths which will have a dramatically higher impedance and/or length measurement than the cable under test pairs' measurement. Typical impedances for STP cable are: Pair impedance 100-110Ω or 120Ω, Single-Wire-to-shield ~ 60-65Ω. The lower wire-to-shield impedance is the result of only one wire's insulation (dielectric) separating the two conductors; wire and shield.

Step 2 - Since the E20/20 TDR does not use a shielded RJ-45 the next measurement of the shield's length will require two accessories: 1-Coax-to-alligator clips lead (included with the TDR. Depending on the model it may have either a BNC or F style coax connector) 2-either male or female shielded RJ-45-to-short length of bare wire(s). These can be made up on-site per Figures 1 and 2 shown on page 2. Recommend keep the STP cable under 4 inches. Added to the Alligator clips test lead this will make a test lead of 14 to 16 inches which must be added to the cable under test's length.

NOTE: In the following Figures and subsequent discussions the orange wire was chosen as an example for testing a single-wire to shield. Any of the 8 wires can be used and should be selected based on the VF criteria discussed early in Step 1.

Figure 1 – Cat 6 RJ45 Shielded plug with STP cable & one wire stripped for connection

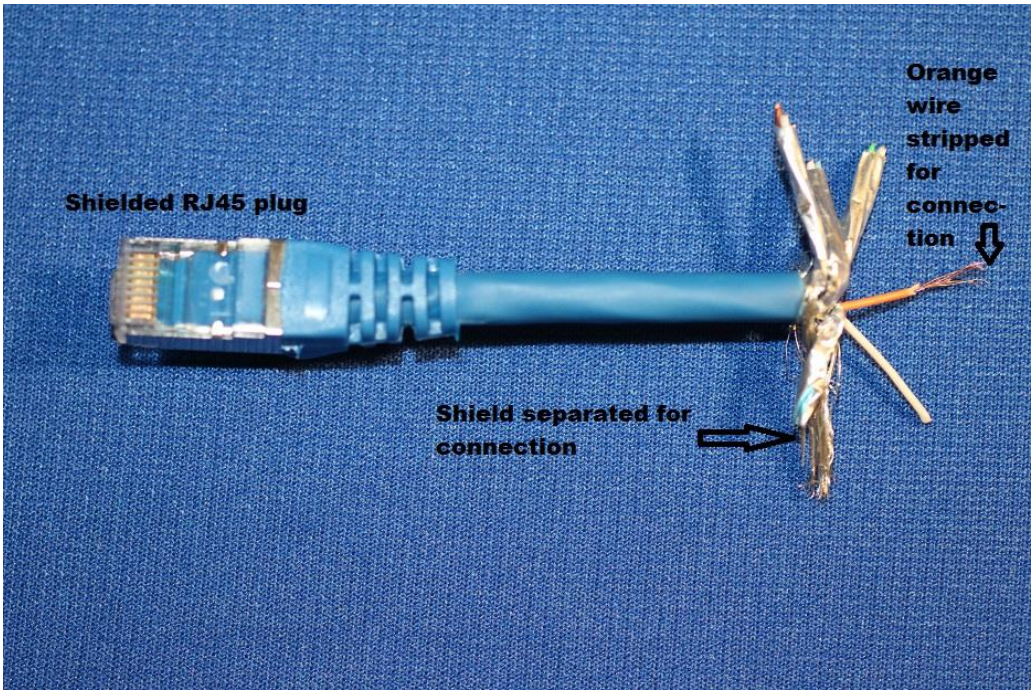
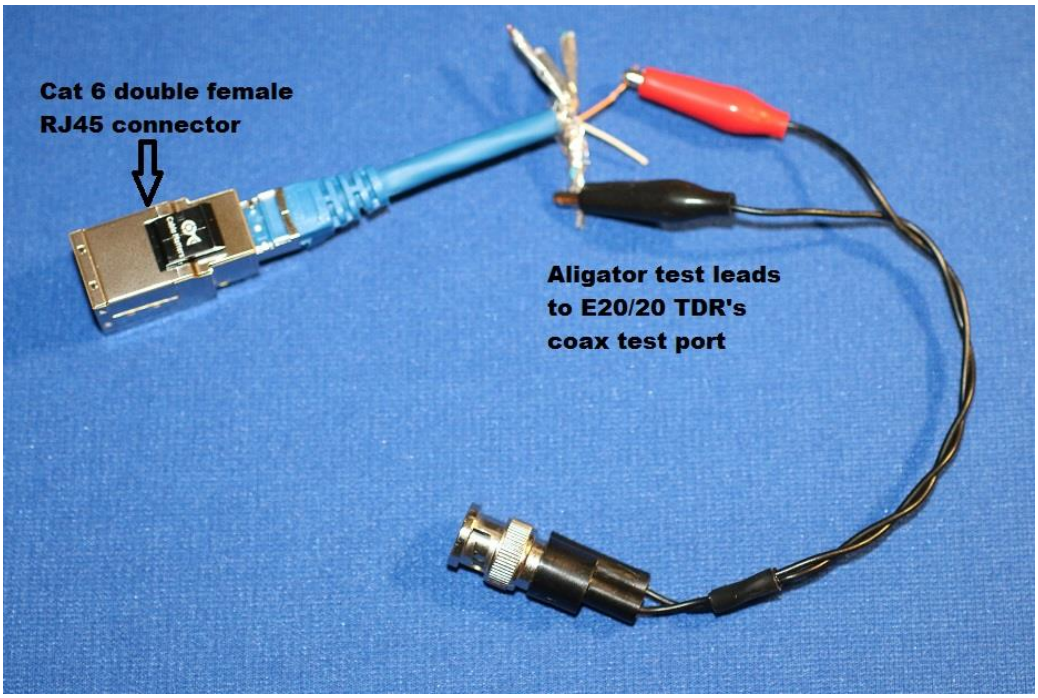


Figure 2 – Shielded double female RJ45 added and Alligator-to-BNC connector test lead added for connection to E20/20 TDR



Step 3 - Measuring the shield

With the STP adapter(s) male or double female as required and alligator clips connected to the TDR's coax connector it's time to measure the shield for connection to the far-end.

On the TDR, press the Meter key and change the test port to "Coax" then press ESC key to exit back to the Measurement Screen.

You should see a trace similar in length to the STP Cable under test. However, the impedance will be lower. About 60-65Ω. The length should be about the same at the cable under test. If you want to be absolutely sure you are measuring the cable under test's shield use a short piece of single-wire stripped on both ends and make contact with the RJ45 pin connect to the orange wire that was stripped on the near-end. Consult the Operator Manual Appendix B, for the Wiring Guide. The orange wire should be connected to either pin 2 or 6 depending on which wiring scheme was used T568A or T568B. with the shorting wire pressed firmly on the correct pin and the RJ45's shield the TDR will show a short between them at the cable's far-end. An alternative way to short the far-end to is to make up a second STP adapter identical to the one in Figure 2 and short the orange wire to the shield. This is a better method if you plan to test a lot of installed cable shields.

Failure Analysis

If the STP cable passes the test in Step 3 you are in good shape. However, if you encounter any of the following results the test is a failure and needs troubleshooting to resolve the issue:

Length is correct to the far-end open, but single-wire to shield impedance is high (well over 100-110Ω) – This indicates the TDR is measuring only to the end of the single-wire and taking an alternate shield path, not the shield in the cable under test. Try shorting the far end's orange wire pin to the shield with a short piece of wire to see if the short appears at the end of the TDR's trace. If it does not appear then the TDR is measuring the single-wire couple with another cable's/adjacent cable's shield or grounding path. The later is not likely as the impedance would be higher than 1KΩ the TDR's maximum reading. Next try disconnecting the near-end's connection from the grounded rack and see if the trace shortens down to the length of the test lead adapters and alligator clips combined. That would indicate the cable under test's shield connection is open at the near-end of the cable. This might also be the indication with the cable connected to the rack, if the test lead is at expected impedance, but the impedance jumps very high at the end of the test lead.

Length is correct to the far-end open, impedance is at expected level, but when the far-end is shorted the short does not show on the TDR's trace. Most likely the cable's shield is not connected to the RJ-45 connector at the far-end. Recommend measure the cable from the far-end and see if the wire-to-shield impedance jumps very high (open appearance) at the end of the test adapters and alligator clips lead (12-14 inches) from the TDR. That would confirm an open connection between the STP cable and the RJ-45 connector at that end. The open could be either the wire selected to test with or the RJ-45's shield to cable's shield. In either case the RJ45 connector should be re-terminated and re-tested for shield continuity as well as TIA-568C or ISO 11801 Certification using a qualified certification tester.

Length is longer than the test leads, but far short of the cable's length and shorting the single wire-to-shield at the far-end does not indicate a short in the TDR's trace. This indicates either the single-wire or the shield is broken in the cable at the distance to the open. To confirm which, recommend run the Wire Map test using the cable certification tool to check the continuity of all the wires or use the TDR to check the length of all the pairs. If all the pairs reach the far-end then the shield is open in the middle of the cable. This result is possible, but improbable. Most likely causes would be excessive pull strain on the cable during installation or a serious manufacturing defect in the cable. The cable will need to be replaced.