AN254
Intermittent Cable Operations

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Abstract

An intermittent cable fault can be located with a TDR, but generally requires using the 20/20 TDR's "Intermittent Grabber" mode and following some simple rules to find the fault in a methodical manner. This application note covers the mode setups, procedures and troubleshooting tips for efficiently locating intermittent faults.

General

One of the most difficult cable faults to locate is an intermittent fault. It can be like chasing a ghost who appears and disappears before you understood what you've just seen. The 20/20 TDR has an "Intermittent Grabber" mode to aid with this type of fault finding. Unless the intermittent fault is re-occurring on regular basis, testing requires access to the cable to generate movement that will cause the fault to reveal itself, if only for at least one to three seconds.

Procedure

At the 20/20 TDR make all the instrument settings desired for the cable type, Impedance, input channel (multi-channel models), best viewing options etc. An accurate velocity setting is important if you want to use the distance measurement to locate the intermittent. The VF is less important if you plan to walk the cable and disturb each section and connection to force the fault to show. When the fault does appear, you will know what part of the cable the fault lies within. Set the H-Scale range to view the entire section believed to have an intermittent fault. Calibrating or zeroing out the test leads is optional.

Step 1. Connect the cable and note the termination at the end – Open or Shorted
(If the termination is open, Intermittent Grabber looks for opens, if it is shorted Intermittent Grabber looks for shorts)
Step 2. Press F4 and move the cursor to "INTERMTNT GRAB."
Step 3. Press any ▶ key to change the mode to ON, then press ENTER

This will set up the Intermittent Grabber mode and return the 20/20 TDR to the measurement screen, only now the trace will over paint with each sweep of the cable. This will cause some thickening of the trace, particularly if there is any

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noise present on the cable. Any point that is intermittent will paint a dark zone from the intermittent point to the end of the cable. See figures 1 and 2.

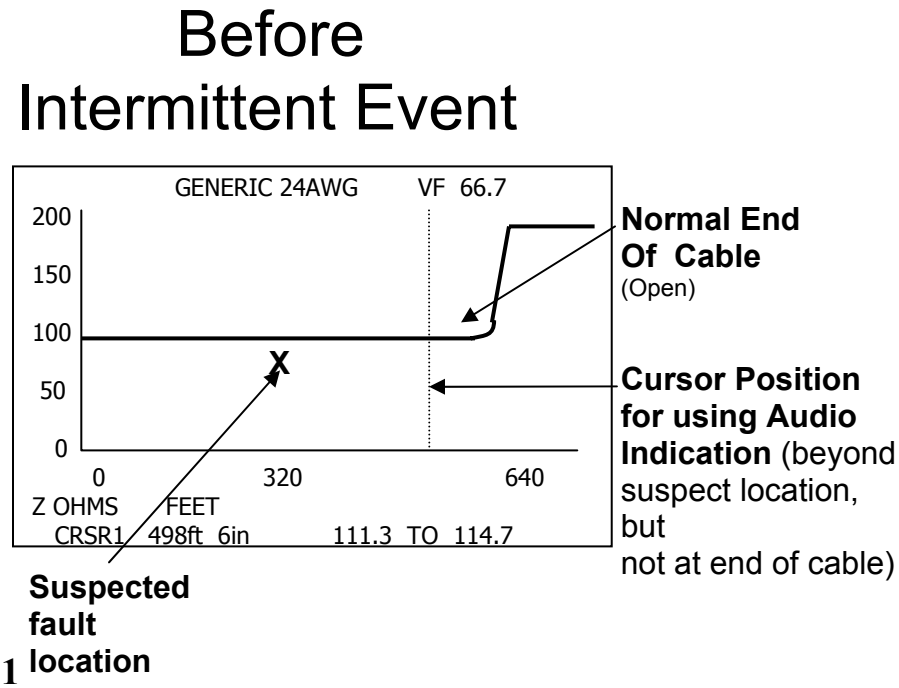

Figure 1

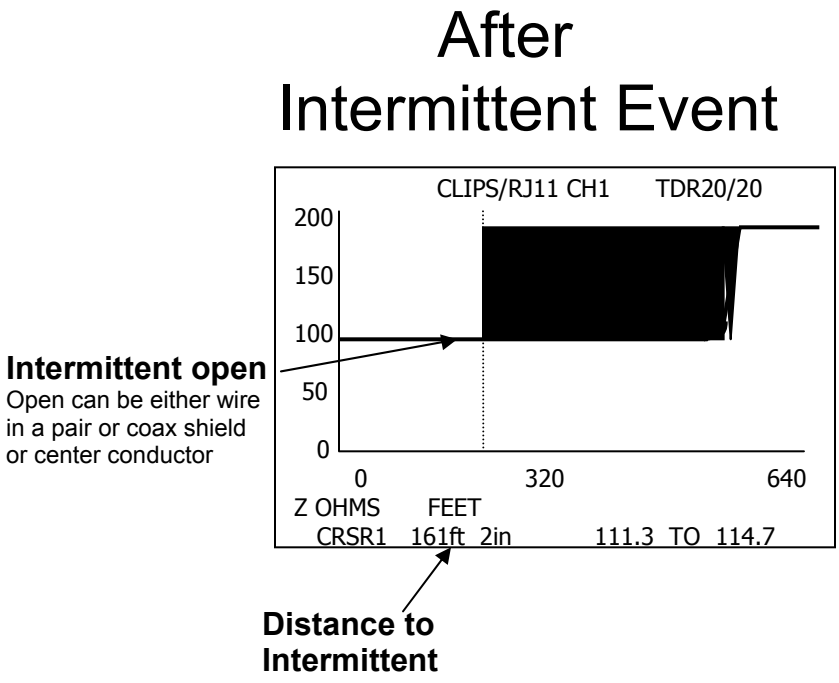

Figure 2

Step 4. Position the cursor at the leading edge of the dark zone to find the distance to the intermittent fault.

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If the fault does not reveal itself in a short time, start walking the cable and flexing each section that can be moved. Pay close attention to connectors and tie down points where constant movement could break a connection. Perform these flexes slowly, hold the flexed position and watch the TDR's trace for at least 3 seconds for change.
NOTE: The TDR's sweep of a cable takes longer with longer range settings.

If the trace goes black along the entire length of the cable from the TDR to the end, you have located or are very close to the intermittent fault's position. However the fault is the opposite of the cable's termination. Mark the spot on the cable that caused the change, reverse the termination either from open-to-short or short-to-open. Then reset the Intermittent Grabber mode in the F4 menu by turning it ON again (no need to go to OFF) and press ENTER. Now repeat the flexing process at the marked spot. The trace should now show the condition with distance to fault as shown in Figure 2. If the distance to the fault is the same as the point being flexed, it is likely that is where the fault is. If the distance to the fault is longer than the marked flex point, the actual fault may be further down the cable and you are only getting close enough to trigger it. This will require moving in measured steps down the cable, trigger the fault again, marking the cable and repeating this process until you can't trigger the fault any longer. You will now have a marked zone in which to isolate the fault. Note the point at which you are triggering the fault at a distance longer than the TDR's distance reading. This could indicate you have moved past the fault and provide a good centering point to isolate the fault. (Remember VF uncertainty can induce a difference between a cable's electrical distance reading and the jacket length. See AN203 Getting the Most Out of Your TDR)

Step 5. To exit Intermittent Grabber mode, press F4 again and press any ◀ key to change the mode to OFF, then press ENTER.

Audio Mode Indicator

If you or a work partner can't see the 20/20 TDR's display while walking the cable, then enable the audio mode. The audio mode will sound a tone at a particular frequency depending on the impedance reading at Cursor 1. Should the impedance reading at Cursor 1 change, the tone will change to a higher or lower pitch for an open or short respectively. This will indicate an intermittent detection.

Step 1. Perform all the preliminary setups in the procedure and in Step 1 as outlined earlier.
Step 2. After noting the termination of the cable, position Cursor 1 at a point well beyond the suspected fault, but before the cable's end.
Step 3. Press F2 and move the menu cursor to AUDIO VOLUME. Set the volume so you can hear the 20/20 TDR.

Step 4. Move the menu cursor down to AUDIO MODE and press any ▶ key to set the mode to CONTINUOUS. Then press ENTER.

When back in the Measurement Screen the tone's pitch will be controlled by the impedance reading at Cursor 1's position. Now walk the cable, a change in pitch signals to you the intermittent fault changed its condition. The Audio Mode can be used with or without Intermittent Grabber mode engaged.

Intermittent Fault Locating Tips

There are basically two methods of walking a cable to trigger an intermittent fault.

Method one is a systematic hand-over-hand walk from the TDR connection outward till either finding the fault or reaching the end of the cable. The later case requires starting over again at the TDR or working backwards toward the TDR until the intermittent reveals itself.

Method two is a visual Easter egg hunt. Go directly to suspect points along the length of the cable and flex or strain connection points and cable spots that look suspicious. This method succeeds most often when used by experienced cable people who know what to look for in systems under their care, but may be used by a novice. Some indicators of cable problems are:

- Corrosion or damage around a connection point
- Cracked or flaking jacket near strain relief on a connector
- Chafing damage to a cable's insulation at a tie down point
- Evidence of past kinking in the cable, warped or distressed insulation areas from excessive pulling tension
- Sharp bends
- Animal teeth marks (no fair suspecting coworkers)
- Bullet holes
- Staples or nails, or holes from removed staples and nails

When using the Easter-egg hunt method on a long cable, AEA Technology recommends carrying markers or tape to mark the points that have already been checked or cleared. This will save time and energy. Two different color markers or tapes is a good idea in the event a second pass is required to find the fault.

If you chose to find the intermittent by letting the fault reveal itself without prodding the cable, following a few suggestions gives the TDR the best chance to display the intermittent.

First, set the correct velocity factor (VF) for the cable under test. This greatly improves the length measurement to the fault. If possible measure the cable from end to end and use the "Sample a Cable" feature in the 20/20 to calculate the nominal velocity of the cable. This is often a far more accurate velocity than

the manufacturer's specifications. Also see AN203 Getting the Most Out of Your TDR.

Second, work to replicate the same conditions when the intermittent fault is causing problems. If the fault is only happening at night, measure the cable at night. If it's only a problem when windy, either wait for the wind or ask if the cable can be moved by hand in a manner the wind moves it. Some intermittent problems are hard to repeat. If a cable fails only when a jet flies low overhead, it could be a problem replicating that condition unless the cable is located near an airport runway and jets fly over it constantly. However, rapping on the cable or on the cable's support with a mallet may reproduce the vibration required for the TDR's sweep to pick up the fault.

Think repeatability before starting on repairs. One look at an intermittent fault may not be reliable. Whenever possible, take the time to repeat the condition and get a second revealing trace to measure.

Lastly, after repairs are completed on the intermittent fault, retest the cable. This retest should include duplicating the condition that detected the intermittent. It is possible to have two faults in close proximity. The one the TDR locates can mask a second fault that may have been less active.

Conclusion

The 20/20 TDR's Intermittent Grabber Mode and Audio Tone can be extremely helpful in locating intermittent faults. The keys to finding them is to replicate the suspect cause whenever possible, hold the cable flexing or cause condition a few seconds to ensure the sweep catches the fault and be patient and methodical in searching the cable.

Keywords: find intermittent cable faults with a TDR, intermittent fault location using TDR, Intermittent cable fault location made easy, How to locate intermittent cable faults,

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