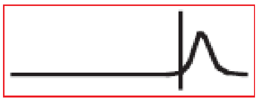
Basic TDR Operation

Introduction

A TDR (time domain reflectometer) uses the radar principle to identify faults on cables. A pulse is “fired” down the cable. Any changes in the impedance of the cable will result in reflections being sent back down the table. These are measured and displayed so that a “map” of the cable is shown. Many faults are found at terminations or cable joints or other locations where there has been disruption to the route of the cable.

TDRs require 2 conductors running in parallel to operate – they identify the change in impedance. Any connection, change of cable type, break in the cable, or fault will cause a change of impedance. Each type of change has a different effect on the display of the TDR; a positive reflection shows a higher impedance, a lower reflection shows a lower impedance.

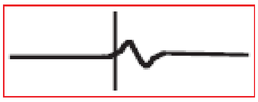


Open conductor

- A large positive trace.

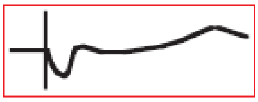
Short circuit

- A negative trace.



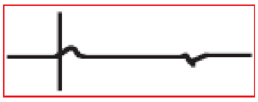
Cable splice/joint

- A small positive followed by a small negative trace.



T joint

- A negative trace followed by long positive.

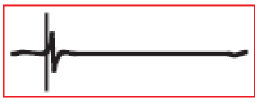


Bridge tap

- A small positive followed by a small negative trace after a few metres.

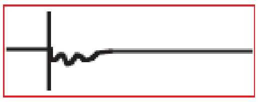
Spilt/resplit

- Negative trace followed by stretched positive



Wet splice/water

- Short positive/negative trace



Water ingress

- Long irregular pulse

Use of TDR

Identify the location of both ends of the cable.

Identify the faulty cable with an insulation tester. If the fault is low resistance, determine the value – a TDR can only identify faults below 200 Ohm. An insulation test lowest measurement may only be 10 kOhm so a kilo-ohm range or multimeter may be required to fill in the measurements between continuity (below 100 Ohm) and insulation (above 10 kOhm).

Use a good pair of cables running alongside to compare a good pair with a bad pair. It is likely the fault will be easier to identify by looking for the difference between 2 traces. Some TDRs offer the facility to show both traces on the same display or the difference between 2 traces.

Velocity Factor
To operate a TDR it is necessary to tell the TDR the speed of the pulse in the cable. This enables the TDR to convert the time the reflected pulses take into distance. Different types of cable have different velocity factors (VF)

VF is the ratio of the speed of the cable to the speed of light. It may also be entered as m/us and is sometimes also called velocity of propagation.

If you do not know the VF of the cable under test it may be possible to test a known length and adjust the VF until the distance displayed to the end of the cable is correct.

Typical VFs

Cable Type	**Construction**	**Velocity Factor** %	**Velocity Factor** m/μs
Power	Paper Oil Filled	0.72 to 0.84	216 to 252
Power	XLPE	0.54 to 0.62	162 to 186
Power	EPR	0.45 to 0.57	135 to 171
Twisted Pair	Polyethylene	0.64 to 0.67	192 to 201
Twisted Pair	PTFE	0.71	213
Twisted Pair	Paper	0.72 to 0.88	216 to 264
Telecomms	PIC	0.65 to 0.72	195 to 216
Telecomms	Pulp	0.66 to 0.71	198 to 213
Telecomms	Gel filled	0.58 to 0.68	174 to 204
Telecomms	Coax	0.82 to 0.98	246 to 294

Accuracy
A TDR cannot be used to pinpoint a fault. The TDR accuracy will depend on the velocity factor (maybe only with a resolution of 1%); the cable may twist or not lie in a straight line and the resolution of the display will not show down to fine detail unless zoom is used. The best way to locate a fault is to test the cable from both ends and the fault will lie between the points identified.

Output pulse level
The output pulse level can be varied to assist in locating the fault. Small faults and those at the far end of the cable will require a high pulse level. High pulse energy at near-end faults will distort a large section of the displayed trace and so lower pulse levels will be required.

Range
Initially it is best to set the range to well above the expected length of the cable so you can see the complete picture. A large fault can be missed if the fault is off the display.

Automatic Fault Finding
Many TDRs have an automatic facility that may help identifying some faults. It is also necessary to be able to use the TDR manually in order to get the most from the instrument.