Engineer's Notebook

Time Domain Reflectometer

Time Domain Reflectometer (TDR) TECHNOLOGY REVIEW

Time Domain Reflectometers use simple transmission line theory and pulse reflection principals to detect impedance changes along a cable. The Time Domain Reflectometer transmits high frequency electrical pulses. When applied to a cable these pulses travel through the cable until a change in characteristic impedance is encountered. Depending on the nature of the impedance change either all or part of the transmitted pulse will reflect back to the TDR.

Impedance is the total resistance, inductive reactance and capacitive reactance encountered in a cable. A change in a cable's characteristic impedance will cause one of two types of reflections: positive or negative. Positive reflections are caused by increases in impedance. Increased impedance results from increases in metallic resistance or inductive reactance. Negative reflections are caused by decreases in impedance. Decreased impedance results from decreases in insulation resistance or changes in capacitive reactance.

Reading a TDR is similar to reading a map. Before reading a map you must learn what the symbols mean and before reading a TDR you must also learn what the TDR signatures represent Figure 1.

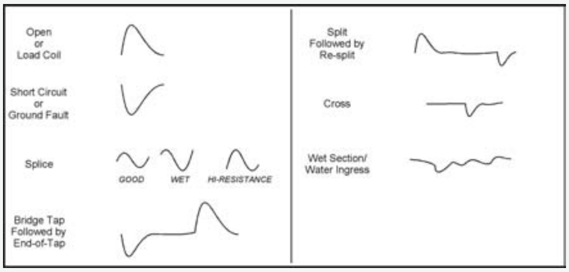

Figure 1: Typical TDR Signatures

TDRs have varying pulse width settings. The larger the pulse width, the more energy and, therefore, the further the signal will travel on a given cable. A TDR's distance range is determined by how far the transmitted pulse will travel and a detectable reflection is returned. The width of the transmitted pulse will affect the TDR's ability to identify reflections. The width of the pulse is sometimes referred to as the dead zone. As the pulse increases in width it becomes more difficult to identify reflections. Closely spaced reflections may become masked by the dead zone.

When measuring distances to an event on a TDR, the TDR measures the time it takes a pulse to travel down a cable, encounter an impedance change, and reflect back. By knowing the velocity of the pulse the TDR converts this time to distance. Pulses travel at different velocities on different cables much like a ball travels at different velocities through different liquids. The type of insulation and cross section geometry of a cable will affect the velocity of a pulse.

Table 1: Common Telephony Velocity Factors

Cable Types	Velocity Factor
PIC	0.67
Jelly Fill	0.64
Pulp	0.72
Butyl Rubber	0.65
KYNAR	0.36
Natural Rubber	0.58
Polyethylene	0.66
Polypropylene	0.66
Polyvinylchloride	0.45
Polyurethane	0.39
SBR Rubber	0.59
Silicone Rubber	0.57
Teflon	0.69
TPR	0.61

If the velocity factor of a cable is unknown it can easily be determined by connecting onto a sample cable of known length. Place the TDR's cursor at the reflection representing the end of the cable. Simply adjust the velocity setting until the unit reports the correct length. This setting will be the velocity of propagation for the cable. If neither the velocity nor length of the cable is known an accurate locate can still be accomplished by measuring the distance to the fault from both ends of the cable. If an error exists in the velocity setting the TDR will either over measure or under measure from both ends of the cable. The fault will be between the two measurements.

Table 2: Common CATV Velocity Factors

Cable		Velocity Factor
BELDEN	RG-59 FOAM	0.78
	SOLID	0.66
CAPSCAN	RG-59	0.82
	CC	0.88
COMM/SCOPE	RG-6, 11 & 59	0.82
	PARA I	0.82
	PARA III	0.87
	QR	0.88
CZ LABS	RG-59	0.82
GENERAL CABLE	RG-59	0.82
	MC2	0.93
SCIENTIFIC ATLANTA	RG-59	0.81
	TRUNK	0.87
TIMES FIBER	RG-59	0.83
	T 4, 6 & 10	0.87
	TR+	0.87
	TX, TX10	0.89
	DYNAFOAM	0.9
TRILOGY	(MC2)	0.93
	TRUNK/FEEDER (FOAM)	0.83
	DROP FOAM (59, 6 & 11)	0.82
	7 SERIES	0.88
	MC2	0.93

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