Sonel®

USER MANUAL

TDR CABLE FAULT LOCATOR

TDR-410

USER MANUAL

TDR CABLE FAULT LOCATOR
TDR-410

SONEL S. A.
Wokulskiego 11
58-100 Świdnica
Poland

Version 1.07 28.06.2024

We appreciate your having purchased our measuring instrument. TDR-410 is a modern measuring device, which is easy and safe to use. Please acquaint yourself with the present manual in order to avoid measuring errors and prevent possible problems related to operation of the meter.

TABLE OF CONTENTS

1 Introduction

A time-domain reflectometer (TDR) is an electronic instrument used to characterize and locate faults in metallic cables.

The TDR-410 is a hand held Time Domain Reflectometer with 11-range-scale covering the range 0-4000 meters, with a 7 meter first range scale and a 0.5 meter dead zone close and far faults are clearly displayed on its 128x64 pixel back light LiquidCrystalDisplay.

The Auto Fault Location key will move the cursor directly to the first event or fault, thus it eliminates the need to interpret visiually the form of wave. When set in manual mode, the wave form may be scanned visually as on conventional TDRs. In both modes the user gains variably coverage of the range of default to 64 db's used to magnify small events identified on the waveform. The scan lock feature will allow the user to hold the trace for closer examination.

Designed for identifying and locating faults on all metallic cables with two or more insulated conductors. The TDR-410 has impedance matched circuits for 25, 50, 75 and 100 ohms and with velocity of propagation settings from 1-99% (or the equivalent in feet or meters/micro second) will cover the range of power, data, communication and CCTV cables.

Housed in a rugged IP54 rated ABS enclosure and weighs only 350 grams (12 ounces), the TDR-410 is suitable for outside use.

NOTE!
Only standard and additional accessories for a given device should be used. Use of different accessories can lead to errors in the test connection and can introduce additional measurement uncertainties.

Note:
Due to continuous development of the meter's software, the actual appearance of the display, in case of some of the functions, may slightly differ from the display presented in this operating manual.

Warning:

This instrument meets the safety requirements of IEC 61010-1:1995

TheTDR-410 is designed for use on de-energized circuits only.

Connection to line voltages will damage the instrument and could be hazardous to the operator.

This instrument is protected against connection to telecom network voltages according to EN 61326-1.

Safety is the responsibility of the operator

2 Working principles

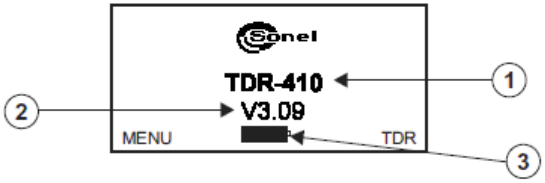
TDR-410 measures the time course of the signal (the probe pulse) in a pair from connecting the cable to the cable end or the nearest damage and back.

Probe pulses in the cable run at a speed Vp (the speed of propagation), which depends on the electrical parameters of the cable, in particular the material from which the insulation is made.

A reflectometer calculates the distance to the disturbance of wave impedance path and displays the cable's diagram showing any impedance discontinuity in the studied area based on Vp values selected by a user and and measured the course time of the pulse.

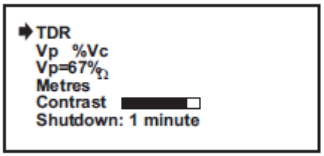
3 Preparing the reflectometer for use

Press button ⏻ to power the tester, the following screen will be displayed:

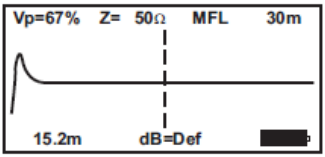


1. *Model.*
2. *Software version programmed into tester.*
3. *Battery condition indicator (all black battery, fully charged, as charge decreases symbol changes to white). Battery condition indicator is permanently displayed.*

To select a **menu display**, press the left button ◀ as indicated on the TDR-410 front panel:



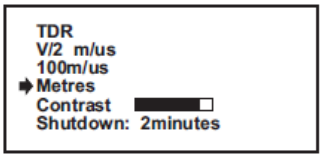
or to select TDR (**Trace Display**), press the right button ▶ as indicated on the TDR-410 front panel:



Prior to use the following parameters will need to be set:
Vp (velocity of propagation) – see part 3.5 and 3.6;
Z (impedance) – see part 4.1.2;
dB (gain) – see part 4.1.5.

3.1 Set Unit of Measure from menu display

Press ▼ (**SET**) to move ➡ to unit of measure (feet or meters):

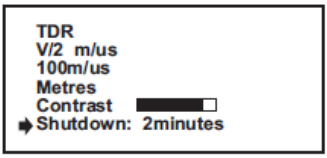


Press ▶ or ◀ to scroll between feet and meters. Press **ESC** to store selected setting in memory.

Note: When unit of measure has been selected, this will automatically change the V/2 figure, which will also be displayed in the selected unit of measure.

3.2 Set Auto Shutdown from menu display

To preserve battery life the TDR-410 is fitted with an auto shutdown feature. Shutdown time is selectable between disabled 1, 2, 3 and 5 minutes.

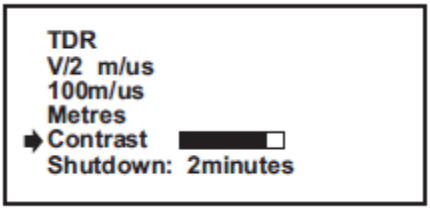


To change settings press ▼ (**SET**) to move ➡ to Shutdown, use ▶ or ◀ to select setting:
- **Disabled**, or
- **1 minute**, or
- **2 minutes**, or
- **3 minutes**,

then press **ESC** to store setting to memory.

3.3 Set Contrast from menu display

Press ▼ (SET) to move ➡ to Contrast. Press ▶ to decrease contrast, press ◀ to increase contrast, then press **ESC** to store setting to memory.



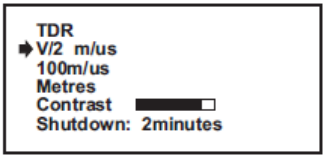
3.4 Backlight

The LCD display is fitted with an electro-luminescent backlight to enable easy viewing under a variety of different lighting conditions. The backlight is switched on and off with the key .

Note: When switched on, the backlight will significantly shorten the battery life!

3.5 Set Velocity of Propagation from menu display

Velocity of propagation (Vp) may be set as % or speed in micro seconds (µs). The unit of measure, the speed is displayed in (feet or meters), will be determined by the setting selected in section 3.1
Press ▼ (**SET**) to move to displayed unit, press ➡ to scroll between ”V/2 m/µs” or ”Vp %Vc”.



To change the value of the V/2 (or Vp) factor, go one level down (press **SET** button ▼) so that the indicator points to the "..... m/µs" (or "Vp = ...%").
Pressing the cursor ▶ or ◀ to increase / decrease the value of the Vp.
Press **ESC** to store selected setting to memory.

Note: Setting the correct Velocity of Propagation value is also possible from Trace Display.

3.6 How to determine Vp settings

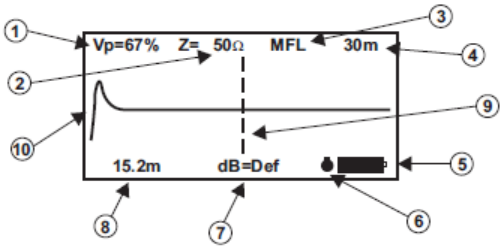
If the TDR-410 is to be used with a cable type for which the Vp is unknown, this must first be determined by the setting selected in section 3.5

1. Take a sample of the cable at least 10m or 30 ft long (as long as possible).
2. Measure the actual length of cable using a rule or tape measure or some other reliable method.
3. Connect the TDR-410 and adjust the Vp setting such that the tester gives a correct reading of the sample length, (refer to section 4.1 Setting cable parameters).

Note: After disconnecting the TDR-410 the current parameter settings are stored, including the recently selected values Vp propagation factor and impedance Z.
This feature of the device is particularly advantageous in situations where multiple tests are performed on the same type of cables.

4 Using the reflectometer

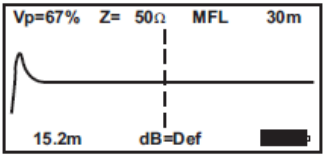
Upon completion of the set up procedures in section 3, press **ESC** to return to start up display and select **TDR** (pressing the cursor ▶), or press **START**.
The following screen will be displayed:



1. *Vp setting*
2. *Impedance setting (Z)*
3. *Manual / Auto Fault Location*
4. *Range scale*
5. *Battery condition indicator*
6. *Scan hold icon*
7. *User variable gain (by user or auto)*
8. *Cursor distance reading*
9. *Cursor*
10. *Output pulse*

4.1 Setting the fault location

You can set all the necessary parameters of the cable fault location from **Trace Display**:



- Velocity of Propagation
- Impedance value (Z)
- Auto or Manual location mode (AFL, MFL)
- Range Scale
- Gain

To set a parameter, press the **SET** button (▼). Until the parameter is highlighted, use ◀ or ▶ to change the value or the option.
Press **ESC** to store selected setting to the memory of the device.

Note: Current parameter settings are stored after disconnecting the TDR-410

4.1.1 Setting Velocity of Propagation (Vp)

Use **SET** button (▼) to scroll to “Vp=...%”, when parameter is highlighted, use ◀ or ▶ to change values.
Press **SET** button (▼) to move to next parameter, when set up is completed press **ESC** to store settings.
If Vp cable is unknown, refer to section 3.6.
TDR-410 will display the values last used after the start up.

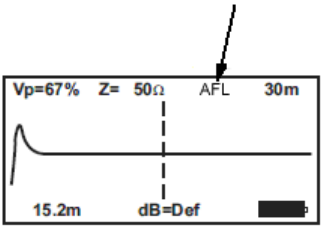
4.1.2 Value Impedance Setting (Z)

Use **SET** button (▼) to scroll to “Z=.... Ω”, when parameter is highlighted, use ◀ or ▶ to change values.
Press **SET** button (▼) to move to next parameter, when set up is completed press **ESC** to store settings.

4.1.3 Auto Fault Location and Manual Fault Location

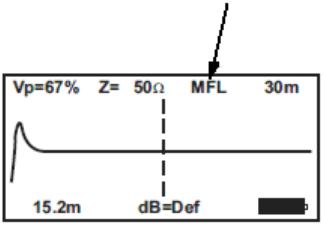
The TDR-410 may be used in auto or manual fault location modes. Use **SET** button (▼) to scroll to displayed setting (AFL or MFL) use key ◀ or ▶ to change setting. Press **ESC** to store settings.

Auto Fault Location



When set in auto fault location (AFL) the TDR-410 will scan the cable run and the cursor will automatically stop at the first event. To start the scan press **START** key, if the scan stops within the first meter (3 feet) it will identified the connection between the TDR-410 and the cable under test as an event, press the key **START** to continue the scan. The end of the cable run would normally be identified as an open or short (refer to section 12 for typical fault displays). Small events identified in the cable run may be enlarged by increasing the gain thereby making the fault more obvious (refer to section 4.1.5 Gain Settings).

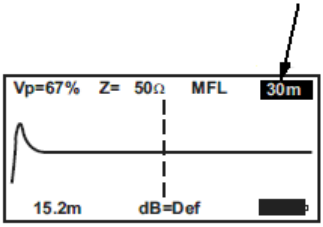
Manual Fault Location



When the manual fault location (MFL) is set, the operator selects the range manually and then he needs to scan the displayed trace, and align the cursor manually to the identified event.
Note: – see chapter 6.1 „Scan hold and continuous scan mode".

4.1.4 Selecting range scales

The TDR-410 has 11 range scales covering the range of 0 to 4,000 meters (7m, 15m, 30m, 60m, 120m, 250m, 500m, 1000m, 2000m, 3000m and 4000m). To select a range scale, or scan the cable run, press SET button (▼) to scroll to range scale, then press ◀ to decrease range or press ▶ to increase range. To save and exit press **ESC**.



Note: Manual measurement range change is just for MFL mode.

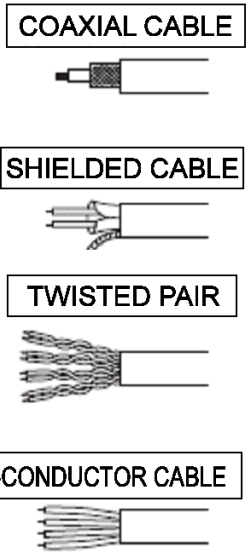
4.1.5 Gain settings

The TDR-410 has pre set gain for each of its 11 range scales, there is in addition to this a user controllable gain to a maximum of 64 dB in 1 dB steps. To use this function, use navigation key (**SET** ▼) to scroll to **dB** setting, press ◀ to decrease gain, ▶ to increase gain, press **ESC** to store setting.
Note: The "Def" means the default settings.

5 Connecting the reflerctometer to a cable to be tested

Attach the test lead set to the TDR-410 via the 2 safety sockets located at the top of the unit.

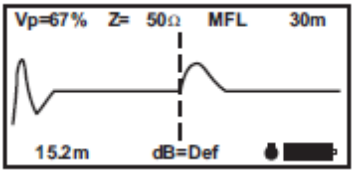
1. Ensure that no power supply or equipment is attached to the cable to be tested
2. Ensure that the far end of the cable under test is open or shorted (not fitted with a resistive termination)
3. Attach the TDR-410 to one end of the cable to be tested



Coaxial Cable:
Connect the red clip to the centre wire and the black clip to the shield/screen.
Shielded Cable:
Connect the red clip to a wire adjacent to the shield and the black clip to the shield.
Twisted Pair:
Separate out one pair and connect the red and black clips to the two wires of the pair.
MulticoreCable:
Connect the clips to any two wires.

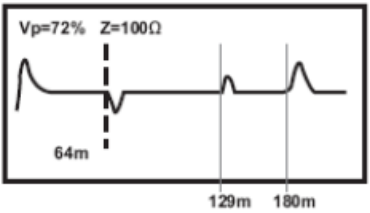
6 Cable Fault Location

Having followed the set up procedures in the preceding sections, a typical display showing impedance anomalies is shown below. Further examples are shown in section 12.



The vertical cursor line is moved left or right along the line of the trace by pressing ▶ or ◀ buttons to determine the distance to the event. Position the cursor at the beginning of the event and read off the distance at the bottom left corner.

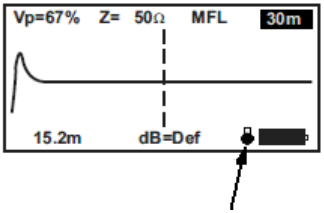
Example:



On the fault display shown above a low impedance fault occurs at 64 meters shown by a negative spike, and a high impedance at 129 meters. The open end of the cable is shown as a large positive spike, this is used to determine the end of the cable run and the overall length of the cable being 180 meters.

6.1 Scan hold and Continuous Scanning Modes

This function only operates in manual fault location mode. When the TDR-410 is first switched on, it is set to “Continuous scan”mode. In this mode the TDR-410 fires pulses into the cable under test thus enabling intermittent faults to be identified. Scan hold allows the user to hold a trace for closer examination and to disconnect from test cable whilst leaving the trace displayed.
To select / unselect scan hold, press key **START** (**HOLD**) for approximately 1 second then release, scan hold icon is displayed at the bottom right hand corner ( ).



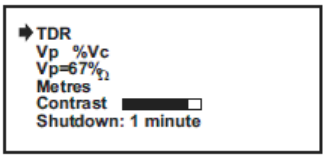
6.2 Accuracy

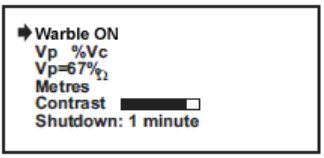
The TDR-410 is able to measure distances to faults and cable lengths to an accuracy of +/- 1%.
This measurement accuracy is based on the correct value of Vp being used for the cable under test, and homogeneity of the Vp along the cable length.
If the Vp is set incorrectly by the operator, or the Vp varies along the length of the cable, then additional errors will be incurred and the measurement accuracywill be affected.
Note: The Vp is less well defined with unshielded multicore cable, including power cable, and is lower when a cable is tightly wound on a drum than when installed.

7 Tone generator

The TDR-410 may also be used as a tone generator to trace and identify cables and wires. The user will need a conventional inductive tone probe within the range 810Hz to 1110Hz.

To select tone generator **from menu display**, press **SET** ▼ to move ➡ to **TDR**. Press ◀ to scross between TDR and warble. Press the **ESC** button to exit. "**Warble Tone**" on screen mesage is displayed after pressing **ESC** and TDR generate the tone. TDR mode is switched back if **ESC** is pressed once again.





Note: The auto off function is disabled in tone generator mode so that the tone can be injected into a cable for extended periods while tracing takes place.

8 Power supply

Reflectometer TDR-410 is powered by four 1.5 V AA batteries. Use alkaline batteries to ensure proper functioning of the device. Low battery is signaled by the appearance of the symbol on the screen of the reflectometer.
To replace the batteries:
- disconnect the instrument from any cable or network link,
- turn the instrument off,
- loosen the two black screws and remove the battery compartment cover,
- replace the batteries with 4 x 1.5 volt alkaline batteries, observing the polarities
- refit the battery compartment cover and refit the two screws

9 Cleaning and maintenance

NOTE!
Apply solely the maintenance methods specified by the manufacturer in this manual.

The casing of the meter may be cleaned with a soft, damp cloth using all-purpose detergents. Do not use any solvents or cleaning agents which might scratch the casing (powders, pastes, etc.).

The electronic system of the meter does not require maintenance.

10 Storage

In the case of storage of the device, the following recommendations must be observed:
• Disconnect all the test leads from the meter.
• Clean the meter and all its accessories thoroughly.
• In the case the meter is to be stored for a prolonged period of time, the batteries must be removed from the device.

11 Dismantling and utilization

Worn-out electric and electronic equipment should be gathered selectively, i.e. it must not be placed with waste of another kind.
Worn-out electronic equipment should be sent to a collection point in accordance with the law of worn-out electric and electronic equipment.
Before the equipment is sent to a collection point, do not dismantle any elements.
Observe the local regulations concerning disposal of packages, worn-out batteries and accumulators.

12 Typical Fault Displays

The following diagrams show typical fault traces to assist you in the identification of faults using the TDR-410:

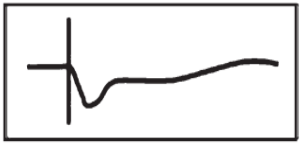
OPEN CONDUCTOR

SHORTED CONDUCTOR

SPLICE

BRIDGE TAP

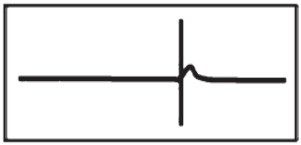
SPLIT/ RESPLIT



WET SPLICE/ WATER

FRAYED CABLE

WATER INGRESS



TAP

SPLITTER

13 Typical Cable Vp and Impedance Values

Cable type	Insulation type	Vp
Electricity	paper saturated with oil	0.50 – 0.56
	Cross-linked Polyethylene	0.52 – 0.58
	paraffin	0.64
	polyethylene	0.67
	PTFE	0.71
	paper	0.72 – 0.88
	polyethylene foam	0.82
	air	0.94 – 0.98
Phone	polyethylene outer diameter 0.912 mm	0.69
	polyethylene outer diameter 0.643 mm	0.68
	polyethylene outer diameter 0.511 mm	0.66
	polyethylene outer diameter 0.404 mm	0.65
	gel, outer diameter 0.912 mm	0.68
	gel, outer diameter 0.643 mm	0.65
	gel, outer diameter 0.511 mm	0.64
	gel, outer diameter 0.404 mm	0.63
	paper outer diameter 0.643 m	0.69
	paper outer diameter 0.511 mm	0.68
	paper outer diameter 0.404 mm	0.66
CCTV	QR PARA III	0.88
	PARA I	0.82
	T, TR	0.87
	TX, TX10	0.89
	RG6, RG11, RG59	0.82
	Times Fiber RG-59	0.93
	Dynafoam	0.90
Data transmission	RG58	0.78
	RG58U	0.76
	UTP 26	0.64
	Thinnet	0.66 – 0.70
	Ethernet	0.77
	Token Ring	0.78
	Twinaxial Air	0.80
	Twinaxial	0.71
	Thicknet	0.77
	RG58	0.78
	RG58/U	0.66
	Twisted Pair	0.64 – 0.66
	U/UTP cat. 5e	0.67
	U/UTP cat. 6	0.67

Note: TDR-410 measures the distance to a fault in a cable or the cable length with an accuracy specified in the technical specifications. The current accuracy of the measurement depends on:
- how the the propagation factor Vp was determined,
- its stability on the whole lenght of the tested cable.

The measurement has an additional fault if:

- you set an incorrect value of Vp,
- this ratio is not constant over the measured distance.

Please note that the value of the Vp factor is smaller for cable wound on the drum than cable uncoiled / unwound and installed. Furthermore, it may also change with the cable aging.

The above examples of Vp factor for different cable types are only an indication for the user to make swift and calculate the measurement with reasonable accuracy
The use of Vp allows the highest measurement accuracy calculated by the user with a known length of the tested cable section, as described in detail in section 3.6.

Typical values of impedance Z	
Cable type	**Z**
Cat 5 STP	100
Cat 5 UTP	100
Coaxial air	50/75
Coaxial drive	50/75
Coaxial PE foam	50/75
Coaxial full PE	50/75
Symmetrical PE gel	100
Symmetrical dry PE	100
Symmetrical PTFE	100
Symmetrical PVC	100
Paper 72nF	100
Paper 83nF	100

14 Technical data

Ranges Meters:	7, 15, 30, 60, 120, 250, 500, 1km, 2km, 3km, 4km
Ranges Feet	20, 45, 90, 180, 360, 750, 1500, 3000, 6000, 10000, 14000.
Range Selection	Manual range control / Auto range
Accuracy	1% of selected range*
Resolution	Approx 1% of range
Minimum cable lenght:	4m (14ft)
Sensitivity	Min 3 pixel return at 4km on 0.6mm Ø, PE, TP
Velocity Factor	Adjustable from 1% to 99%
Output Pulse	5 volts peak to peak into open circuit
Output Impedance	Selectable 25, 50, 75 & 100 Ω
Output Pulse	Width 3 ns to 3 µs, Automatic with range
Scan Rate	2 scans/second or scan held, pre set for each range scale
Tone Generator	810 – 1100Hz
Battery Life	30 hours continuous scanning
Power Supply	6 volts 4 x 1.5 AA Alkaline cells, on-screen low voltage indicator
Power Down Selectable	1, 2, 3, 5 minutes or disabled
Back Lit Display	128 x 64 pixel
Operating Temp	-10º / 50ºC
Storage Temp	-20º +70° C
Dimensions	165 x 90 x 37 mm (6.5 x 3.5 x 1.5 ins)
Weight	350 g (12oz)
EMC	BS/EN 61326-1
Water/Dust Proof	IP54

CE Symbol complies with the current EU directives

* Measurement accuracy of <+/- 1% assumes the instrument setting for velocity of propagation (Vp) of the cable under test to be accurately set, homogeneity of the Vp along the cable length, and accurate cursor positioning.

The device does not have the character of a standard and therefore is not subject to calibration. The proper form of control for this type of instrument is checking.

15 Manufacturer

The manufacturer of the device, which also provides guarantee and post-guarantee service is the following company:

SONEL S.A.
Wokulskiego 11
58-100 Świdnica
Poland
tel. +48 74 884 10 53 (Customer Service)
e-mail: customerservice@sonel.com
web page: www.sonel.com

Attention:
Service repairs must be realised solely by the manufacturer.

Made in the United Kingdom.

NOTES

NOTES

NOTES

SONEL S.A.
Wokulskiego 11
58-100 Świdnica
Poland

Customer Service
tel. +48 74 884 10 53
e-mail: customerservice@sonel.com

www.sonel.com