MEGGER CFL510E - TDR1000

Time Domain Reflectometer

User Guide
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MEGGER®

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Symbols used on the instrument

Caution: Refer to accompanying notes

Equipment protected throughout by
Double or reinforced Insulation

Instrument flash tested to 3.7 kV r.m.s. for 1 min.

Equipment complies with current EU Directives

SAFETY WARNINGS

This instrument meets the safety requirements of IEC 61010 part 1 to 150V cat III. If it is to be used in situations where hazardous live voltages may be encountered then an additional blocking filter must be used.

CAUTION (Risk of electric shock)

Although this tester does not generate any hazardous voltages, circuits to which it can be connected could be dangerous due to electric shock hazard or due to arcing (initiated by short circuit). While every effort has been made by the manufacturer to reduce the hazard, the user must assume responsibility for ensuring his, or her, own safety.

- The instrument should not be used if any part of it is damaged.
- Test leads, probes and crocodile clips must be in good order, clean and with no broken or cracked insulation.
- Check that all lead connections are correct before making a test.
- Disconnect the test leads before accessing the battery compartment.
- Refer to operating instructions for further explanation and precautions.
- Safety Warnings and Precautions must be read and understood before the instrument is used. They must be observed during use.

NOTE

THE INSTRUMENTS MUST ONLY BE USED BY SUITABLY TRAINED AND COMPETENT PERSONS.

Introduction

Thank you for purchasing this quality AVO product. Before using your new instrument please take the time to read this user guide, ultimately this will save you time, advise you of any precautions you need to take and could prevent damage to yourself and the instrument.

The MEGGER TDR1000 is an advanced instrument capable of identifying a wide range of cable faults. The instrument uses a technique called Time Domain Reflectometry (TDR) which in many ways is similar to radar. Narrow pulses of electrical energy are transmitted along a pair of conductors in a cable. The pulse travels through the cable at a velocity determined by the insulation between the conductors and this resistance to the flow of the pulse is characterised as impedance for the cable. Changes in cable impedance will cause a proportion of the pulse to be reflected. The pulse velocity is normally described as a fraction of the speed of light and is called the Velocity Factor. By measuring the time between the transmitted pulse and the reception of the reflected pulse, and multiplying this by the speed of light and the velocity factor, the actual distance to the reflection point can be given.

Faulty cables, poor joints or discontinuities will all cause a change in impedance. Impedance's higher than the cable's cause a normal reflection; Impedance's lower than the cable's cause an inverse reflection. Matched terminations absorb all the pulse hence no reflection will occur, the cable appearing endless. Open or Short circuits will reflect all the pulse energy and the TDR will not 'see' the cable beyond that fault.

As a pulse is transmitted down a cable, the size and shape of that pulse is gradually attenuated by losses in the cable: the pulse gets smaller in height and more spread out. The level of attenuation is determined by the cable type, the condition of the cable and any connections along its length. The limit of how far you can see is determined by the point beyond which you will not discern a reflection. To maximise the instruments range, the TDR1000 has an adjustable gain setting on its input to allow you to discern a reflection from farther away. By combining this variable gain with increasing pulse widths, the TDR1000 can discern faults up to 3 Km away.

The MEGGER TDR1000 can be used on any cable consisting of at least two insulated metallic elements, one of which may be the armouring or screen of the cable. The TDR1000 has internal matching networks to allow testing of 25 Ω, 50 Ω, 75 Ω and 100 Ω cables. (These correspond to power, coaxial data and data/telecoms cable). The instrument can be closely balanced to the cable using the balance control; this allows long lengths of cable to be easily tested. The velocity factor can be adjusted to match the cable, thus allowing an accurate distance measurement to be directly read from the instrument. To enable a wider range of faults to be detected, the gain of the instrument is adjustable; this allows more minor faults to be identified along the entire length of the cable. Other setting options include changing the distance units between metres and feet, changing the propagation velocity units between a ratio and a distance per microsecond. Display contrast is fully adjustable to compensate for all viewing conditions. A backlight aids viewing in low ambient light conditions.

The batteries to power the instrument are housed in the compartment on the case back, the cover is held in place with two screws. The batteries are held in a carrier, which hold the batteries securely, and allow a quick change of rechargeable battery packs. The instrument can be powered by manganese-alkali, nickel-cadmium or nickel-metal-hydride batteries. All cells must be of the same type.

User Controls and Display:
The controls of the TDR have been arranged such that the instrument is easy to use and easy to learn how to use. The instrument controls consist of the following:

1) Instrument Display:
The display shows the user the current settings of the instrument and the reflected energy trace from the cable connected.

2) Balance:
This is an analogue control which allows the user to match the instrument impedance to that of the cable under test more closely, thus enabling faults to be more easily detected.

3) Cursor Left:
This control moves the cursor left or selects a lower value depending on which mode the instrument is in.

4) Menu:
This control is a bi-directional switch and can be used to navigate around the various control options. The control option to be adjusted is shown in reverse video and its name is displayed in the top left-hand corner of the display. Menu options are cursor, range, VF, V unit, Zo & m/ft.

5) Cursor Right:
This control moves the cursor right or selects a higher value depending on which mode the instrument is in.

6) Power:
Pressing this button will turn the instrument on or off depending on the current state.
7) Gain:
This control is a bi-directional switch and can be used to increase or decrease the gain of the instrument. This helps the user see faults over the entire length of the cable.
8) Backlight:
Pressing this button will toggle the backlight on and off.
9) Contrast:
This is a dedicated control that allows the user to manually correct the display contrast for the extremes of temperature.
10) Output Sockets:
These are designed to accept the leads supplied with the instrument.
Battery cover:
This is on the back of the instrument and provides the user with access to the batteries. The cover must not be removed while the instrument is on or connected to a cable. The instrument must not be operated with the cover open.

Operation

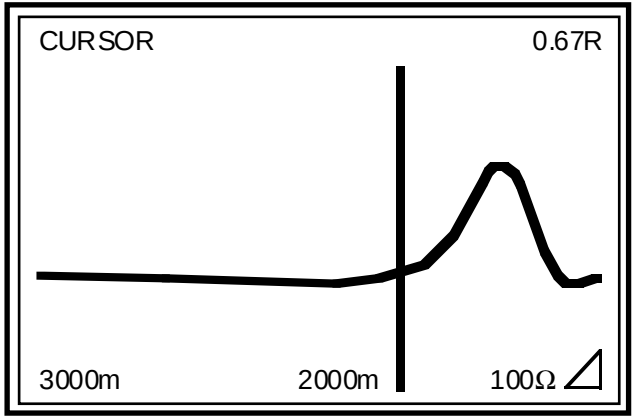
Ensure the test leads are firmly fitted into the sockets of the instrument. Connect the test lead to the cable under test. If working on live power cables a blocking filter must be used to isolate the instrument from the live line. When used in 25Ω mode, the internal balance circuit expects the blocking filter to be used. If not fitted achieving balance may not be possible and the instrument will not be isolated from the cable under test. This will result in erroneous result and could result in damage to the instrument or user if the cable is live.

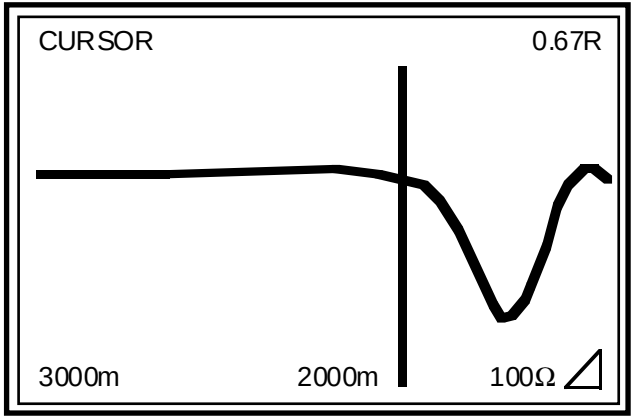
Switch the instrument on and the instrument will display the start screen for a couple of seconds. The TDR will then display a trace. The instrument will have powered up, set to the last used range and velocity factor. If these settings are different for the cable under test (C.U.T) then use the menu and cursor keys to set the correct values. The menu key is bi-directional and allows you to cycle through the various settings, the current setting shown in reverse video and named in the top left-hand corner of the display. Having highlighted the required parameter, e.g. range or velocity factor, use the left and right cursor keys to correct the settings for the C.U.T.

With the gain set at the lowest level required to easily identify the cable feature, e.g. an open or closed circuit, move the cursor to the very beginning of the reflection. This is done by using the Menu key to set the instrument into Cursor mode and then using the left and right cursor keys to set the cursor position. The distance is then directly read from the display. The distance calculation is performed using the current velocity factor. If this velocity factor is not correct, the displayed distance will be incorrect.

To enable partial cable faults to be identified, the gain of the instrument can be adjusted. With the gain at minimum the end of the cable should be seen on the trace, if a minor fault is suspected then increase the gain until the fault is more visible.

Below are shown two typical trace displays. The top one is an open circuit cable the open circuit at 2000 m away; the second is a short circuit at 2000m away.





Balance Control
Without Balance Control (point 2 in the User Controls and Display section) the transmitted pulse would be visible at the beginning of the trace, swamping any reflections within the pulse length (the dead zone). The balancing circuit attempts to match the characteristic impedance of the cable under test to produce an equivalent pulse. Subtracting this equivalent pulse from the transmitted pulse effectively removes the dead zone and allows cable features much closer in to be detected.

NOTE: In many cases, it will be impossible to completely null the transmitted pulse.

Velocity Factor
The velocity factor is the scalar that is used to convert the measured time interval into an actual length of cable. It can be displayed in one of two ways: a ratio of the transmitted pulse speed to the speed of light, or as a distance per microsecond. When it is displayed as the distance per µs (either m/µs or ft/µs) the velocity factor will be indicated as half the speed of the pulse in the cable. This is because the pulse in fact has to go along the cable to the cable feature and back again which is twice the distance to the feature.

If the exact length of a piece of cable of the same type as the C.U.T is known and the reflection from the cable end is visible then a more accurate value can be determined:

Locate the reflection caused by the end of the known length of cable with the instrument set on the shortest possible range to see the end of the cable.

Locate the start of this reflection as described in the Operation section of this manual.
Adjust the velocity factor until the correct cable length is shown.

The measurement of the distance to the fault can now be made with more confidence that the measurement will be correct. The ability of the instrument to accurately measure the distance to a cable feature relies on the velocity factor being correct, any errors in the velocity factor are directly proportional to distance measurement errors.

Pulse Widths

The TDR1000 pulse widths range from 7 ns to 3 µs to overcome signal attenuation and enable the instrument to see further down a length of cable. In distance terms for the size of the transmitted pulse, this represents a transmitted pulse from as small as 1.4m to 602m! (This assumes a velocity factor of 0.67.) Without Balance Control, this would be an enormous dead zone, but with the instrument correctly balanced, faults can be seen well within the pulse width.

As the measured distance is taken at the start of the reflected pulse, the size of the pulse width does not affect the accuracy of the measurement. However, if the first feature does not give a complete reflection such that the instrument can see beyond it to a second feature, the ability to discern between features is affected by the pulse widths. If there are multiple features, the instrument can only fully discern between them if the features are more than the pulse width apart. Hence, for discerning multiple features, the instrument should be used with the shortest range, and so smallest pulse width, that can see both features (refer to the pulse width table in the specification).

Techniques to improve accuracy
To improve on the accuracy of the measurement, numerous methods can be used, depending on the situation encountered. Not every situation can be described, but the following points are effective and the most common and easily implemented methods.

Test the cable from both ends
When fault finding a cable it is good practice to test the cable form both ends. Particularly in the case of open circuit faults, the true end of the cable is not visible. Thus, it is harder to estimate whether the answer obtained is realistic. If the measurement is made from both ends, then the combined answer should add up to the expected length of the cable. Even in the case when the true end of the cable is still visible, the reflections after the fault may be too obscure to analyse clearly. In this case, measurement from both ends yields a clearer picture as well as improved accuracy.

It is also good practice to follow the cable route with a cable tracer, as not all cable runs will be straight. It can save a great deal of time if the exact route of the cable is known as faults will usually be found at points were human intervention has occurred, junction boxes splices etc.

Care and Maintenance
Other than replacing the batteries, the instrument has no user serviceable parts. In case of failure it should be returned to your supplier or an approved AVO INTERNATIONAL repair agent.

Cleaning the instrument should only be done by wiping with a clean cloth dampened with soapy water or Isopropyl Alcohol (IPA).

Specificaton

Except where otherwise stated, this specification applies at an ambient temperature of 20°C.

General Ranges: 10m, 30m, 100m, 300m, 1000m, 3000m (30ft, 90ft, 300ft, 900ft, 3000ft, 9000ft)

Accuracy: ±1% of range ± pixel at 0.67 VF

[Note- The measurement accuracy is for the indicated cursor position only and is conditional on the velocity factor being correct.]

Resolution: 1% of range.

Input Protection: The inputs will withstand 150 V d.c. or 150 V a.c. up to 500 Hz.

Output pulse: 5 volts peak to peak into open circuit. Pulse widths determined by range and cable impedance:

	25Ω	**50Ω**	**75Ω**	**100Ω**
10m	7 - 40ns*	7ns	7ns	7ns
30m	30 - 50ns*	20ns	20ns	30ns
100m	100ns	60ns	100ns	100ns
300m	300ns	130ns	170ns	300ns
1000m	1000ns	520ns	680ns	1000ns
3000m	3000ns	2020ns	2340ns	3000ns

*Varied by the gain setting

Gain: Set for each range with four user selectable steps.

Velocity Factor: Variable from 0.30 to 0.99 in steps of 0.01

Output impedance: User selectable between 25 Ω, 50 Ω, 75 Ω, 100 Ω

Balance Adjustment: 0 Ω to 120 Ω

Update Rate: Once a second for 5 minutes after last key press.

Power Down: Automatic after 5 minutes with no key press.

Backlight: Stays on for 1 minute when activated.

Batteries: Six LR6 (AA) type batteries, Manganese-alkali or nickel-cadmium or nickel-metal-hydride cells

Nominal voltage: 9V for Alkali of 7.2 V for NiCad.

Low battery warning occurs at 6.5 V

Battery consumption 100 mA nominal, 140 mA with backlight (20/30 hours continuous use depending on backlight dependency)

Safety: This instrument meets the safety requirements of IEC 61010 part 1 to 150 V cat III. If it is to be used in situations where hazardous live voltages may be encountered then an additional blocking filter must be used.

EMC: Complies with Electromagnetic Compatibility Specifications
(Light industrial)
BS/EN50081-1-1992
BS/EN50082-1-1992

Mechanical: The instrument is designed for use indoors or outdoors and is rated to IP54.

Case Dimensions:
230 mm long (9 inches)
115 mm wide (4.5 inches)
48 mm deep (2 inches)

Instrument weight 0.6kg (1.32lbs)

Case material: ABS

Connectors: Two 4mm-safety terminals.

Lead: 2 metres

Display: 128 x 64 pixel Graphics LCD.

Environmental

Operational Temperature: -15°C to +50°C (5°F to 122°F)

Operational Humidity: 95% at 40°C (104°F)

Storage Temperature: -20°C to 70°C (-4°F to158°F)

Included Accessories

Test & Carry case with strap	6420-125
Miniature Clip Test Lead Set	6231-652
User Guide	6172-445

Optional Accessories

Blocking Filter	6220-669

REPAIR AND WARRANTY

The instrument contains static sensitive devices, and care must be taken in handling the printed circuit board. If an instrument's protection has been impaired it should not be used, but sent for repair by suitably trained and qualified personnel. The protection is likely to be impaired if for example; it shows visible damage; fails to perform the intended measurements; has been subjected to prolonged storage under unfavourable conditions, or has been subjected to severe transport stresses.

NEW INSTRUMENTS ARE GUARANTEED FOR 3 YEARS FROM THE DATE OF PURCHASE BY THE USER.

NOTE: Any unauthorized prior repair or adjustment will automatically invalidate the Warranty.

INSTRUMENT REPAIR AND SPARE PARTS

For service requirements for MEGGER Instruments contact:

AVO INTERNATIONAL
Archcliffe Road
Dover Kent, CT17 9EN
England
Tel: +44 (0) 1304 502243
Fax: +44 (0) 1304 207342

or

AVO INTERNATIONAL
Valley Forge
Corporate Center
2621 Van Buren Avenue
Norristown, PA 19403
U.S.A.
Tel: +1 (610) 676-8579
Fax: +1 (610) 643-8625

Or an approved repair company. **Approved Repair Companies**

A number of independent instrument repair companies have been authorised for repair work on most MEGGER instruments, using genuine MEGGER spare parts. Consult the Appointed Distributor/Agent regarding spare parts, repair facilities, and advice on the best course of action to take.

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