AVTMMTDR300/100
Rev 1
Apr 2012

MTDR300 / 100
User Guide

CE

HIGH VOLTAGE EQUIPMENT
Read this entire manual before operating.

Megger

Valley Forge Corporate Center
2621 Van Buren Avenue
Norristown, PA 19403-2329
U.S.A.

610-676-8500

www.megger.com

MTDR100 / 300 User Guide

MTDR100
1-phase TDR as installed in PFL systems

MTDR300
3-phase stand-alone TDR

NB: Some features differ between models.

The information presented in this manual is believed to be adequate for the intended use of the product. The products described herein should not be used for purposes other than as specified herein. Specifications are subject to change without notice.

WARRANTY

Products supplied by Megger are warranted against defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. Equipment returned for repair must be shipped prepaid and insured. Contact your local MEGGER representative for instructions and a return authorization (RA) number. Please indicate all pertinent information, including problem symptoms. Also specify the serial number and the catalog number of the unit. This warranty does not include batteries, lamps or other expendable items, where the original manufacturer's warranty shall apply. We make no other warranty. The warranty is void in the event of abuse (failure to follow recommended operating procedures) or failure by the customer to perform specific maintenance as indicated in this manual.

Local Megger Offices		
Australia	**Canada**	**France**
Megger Pty Limited Unit 1, 11-21 Underwood Road Homebush NSW 2140 T: +61 (0)2 9397 5900 F:+61 (0)2 9397 5911	110 Milner Avenue Unit 1 Scarborough Ontario M1S 3R2 Canada T: 1 416 298 6770 F: 416 298 0848	23 rue Eugène Henaff ZA du Buisson de la Couldre 78190 TRAPPES T: 01 30 16 08 90 F: 01 34 61 23 77
Germany	**India**	**Kingdom of Bahrain**
Megger GmbH Obere Zeil 2 61440 Oberursel Deutschland T: 06171-92987-0 F: 06171-92987-19	Megger (India) Pvt Limited 501 Crystal Paradise Mall Off. Veera Desai Road Andheri (W) Mumbai 400053 T: +91 22 26740468 F: +91 22 26740465	P.O. Box 15777 Office 81, Building 298 Road 3306, Block 333 Manama Kingdom of Bahrain. T: +973 177 40 620 F: + 973 177 20 975 mesales@megger.com
Kingdom of Saudi Arabia	**South Africa**	**Sweden**
PO Box 1168 Khobar 31952 T: +966 3889 4407 F: +966 3889 4077 mesales@megger.com	PO Box 22300 Glen Ashley 4022 Durban South Africa T: +27 (031) 5646578 F:+27 (031) 5637990	Megger Sweden AB Eldarvägen 4 Box 2970 SE-187 29 TÄBY SWEDEN T: +46 8 510 195 00 F: +46 8 510 195 95
Switzerland	**United Kingdom (Dover)**	
Megger Schweiz AG Ob. Haselweg 630 5727 Oberkulm Aargau T: +41 62 768 20 30 F: +41 62 768 20 33	Megger Limited Archcliffe Road Dover CT17 9EN T: 01304 502101 F: 01304 207342	
United States (Dallas)	**United States (Valley Forge)**	**United States (College Station)**
4271 Bronze Way, Dallas, Texas 75237-1019 USA T: 1-800-723-2861 F: 1-214-331-7399	Valley Forge Corporate Centre 2621 Van Buren Avenue Norristown, PA 19403 USA T: 610 676 8500 F: 610-676-8610	4064 State Highway 6 South College Station, TX 77845 USA T: 979-690-7925 F: 979-690-0276

Safety

Voltages of greater than 50 V applied across dry unbroken human skin are capable of producing heart fibrillation if they produce electric currents in body tissues which happen to pass through the chest area.[citation needed] The electrocution danger is mostly determined by the low conductivity of dry human skin. If skin is wet, or if there are wounds, or if the voltage is applied to electrodes which penetrate the skin, then even voltage sources below 40 V can be lethal if contacted. Additionally research has shown that where the skin has been compromised, very small voltage of up to 3V can kill.

Accidental contact with high voltage supplying sufficient energy will usually result in severe injury or death. This can occur as a person's body provides a path for current flow causing tissue damage and heart failure. Other injuries can include burns from the arc generated by the accidental contact. These can be especially dangerous if the victim's airways are affected. Injuries may also be suffered as a result of the physical forces exerted as people may fall from height or be thrown a considerable distance.

Table of Contents

UPON RECEIPT OF YOUR DELIVERY

Prior to operation, check for loosened hardware or damage incurred during transit. If these conditions are found, a safety hazard could exist, DO NOT attempt to operate equipment.

Please contact Megger as soon as possible.

Please check your delivery against:

a) your order
b) our advice note
c) the item delivered, and
d) the parts list

Any shortages must be reported immediately.

STANDARD MANUAL CONVENTIONS

This manual uses the following conventions:

Bold indicates emphasis or a heading.

NOTE: *is used to set off important information from the rest of the text.*

A WARNING symbol alerts you to a hazard that may result in equipment damage, personal injury, or death. Carefully read the instructions provided and follow all safety precautions.

A CAUTION symbol alerts you that the system may not operate as expected if instructions are not followed.

1

Specification

MTDR300/100 Specification

Operation	Jog-Dial
Modes	Single – Phase (**MTDR100**) Three – Phase (**MTDR300**)
Low Voltage Prelocation **High Voltage Prelocation**	Pulse Echo, Direct, Comparison, Arc Reflection, Arc Reflection Plus (ARP), Differential Arc Reflection (DART), Impulse Current (ICE), Voltage Decay (NOT available PFL22M1500)
Ranges	10 ranges:
Pulse Echo	Auto, 100m to 55km / 328ft to 34miles
Transient Analysis	100m to 200km / 328ft to 137miles
Pulse Width	50ns, 100ns, 200ns, 500ns, 1µs, 2µs, 5µs, 10µs
Pulse Amplitude	25V into 50 Ohms
Sampling Rate	100 Megasamples/sec
Resolution (VP=55%)	0.82m / 2.7ft
Timebase accuracy	200 ppm
Output impedance	50 Ohms
Gain	Variable over 60dB in 5dB steps
Display	Colour, full XGA 1024 x 768 : 26.5mm (10.4")
Storage	On-board and USB

Ports:	1 x USB
Software:	CAS-1 (Cable analysis software)
Mains Supply	100 to 240VAC, 45 to 65Hz
Battery Supply	14.4V NiMH Battery (**MTDR300 Only**) Approx. 2hrs operation on full charge Approx. 2hrs recharge time
Dimensions	305mm x 194mm x 360mm (**MTDR300**) 12in x 7.6in x 14.2in
Weight	6.7kgs (14.7lbs) (**MTDR300**)
Temperature	Operating: -4 to +122F (-20C TO +50C) Storage: -4 to +133F (-20C TO +55C)
Humidity	< 95percent none condensing

MTDR300 (only)

Accessories

Standard (supplied with instrument)

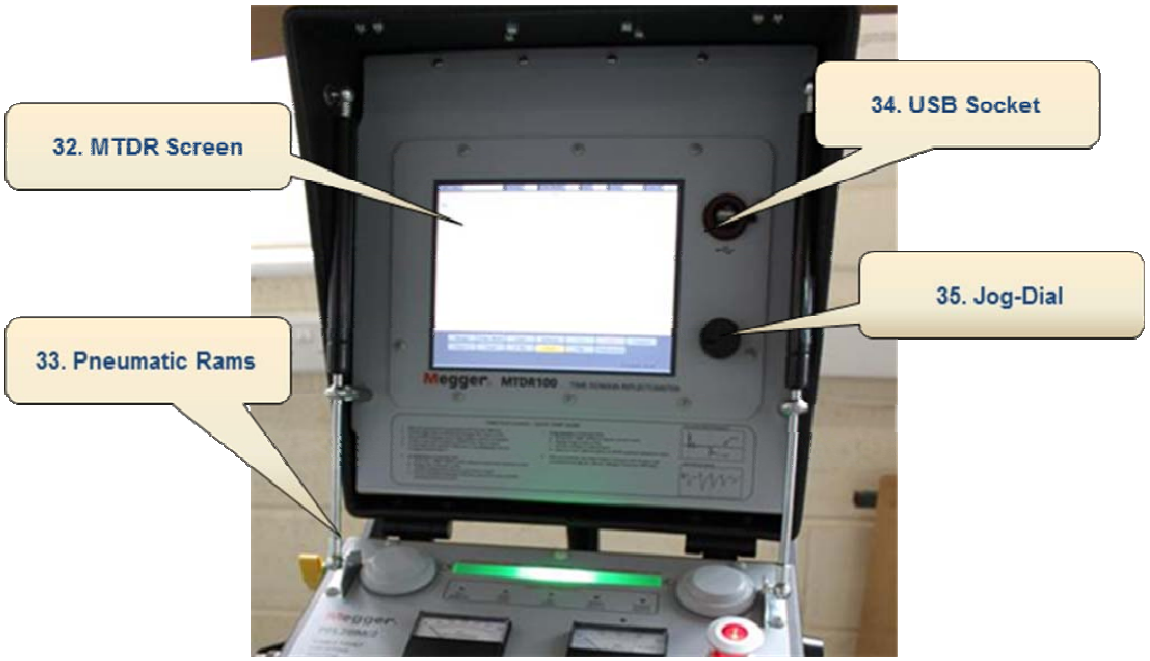
Accessory Pouch	Accessory pouch mounted on Lid	6320-244
Test Leads (qty 3)	Coaxial cable 10ft (3m)	19907-11:
Connectors (qty 3)	BNC (F) to alligator clip adapter	36828
Safety Ground Cable	Flexible Ground/Earth cable	2003-022
Input/Supply Cable	1 x USA 1 x SCHUKO 1 x UK 1 x International	17032-4 17032-13 17032-12 17032-5
Documentation	User Guide	AVTMTDR300:
Software	Cable Analysis Software	CAS1:

2

Getting to know your MTDR

MTDR100

(shown integrated into the PFL22M1500)



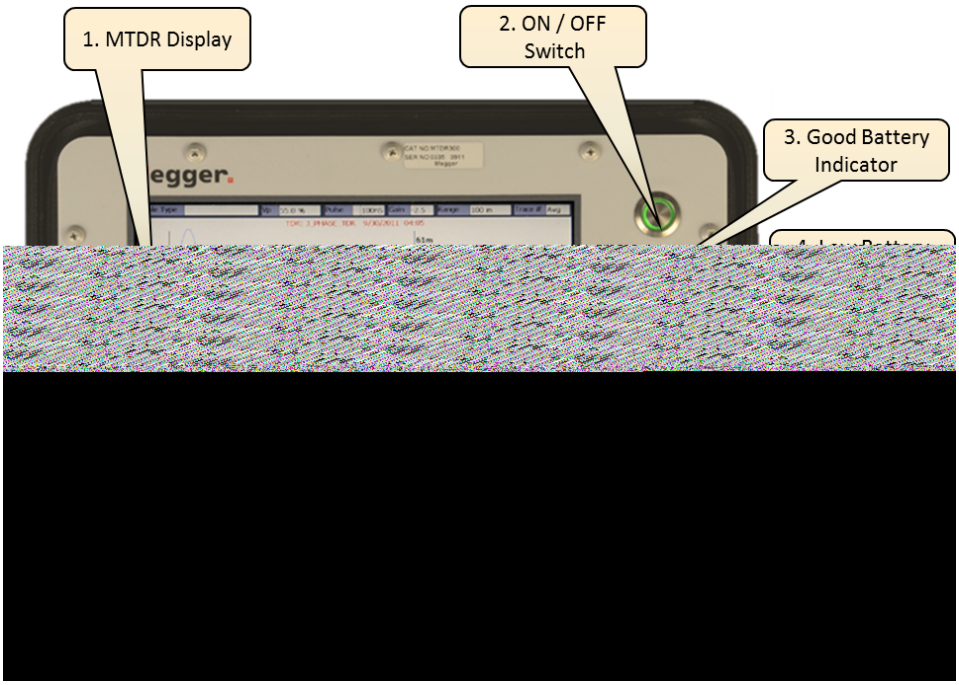
32. MTDR Display: Large 26mm (10.4") full XGA display. Displaying all parameters and the necessary information and traces to achieve rapid accurate fault location.

33. Pneumatic Lid Rams: Pneumatic support rams provide safe support whilst opening and closing the lid of the PFL22M.

34. USB Port: USB port to download/upload memorized traces including all parameters, and to upgrade system.

35. MTDR Jog Dial: With this jog-dial the operator sets all preferences, selects modes of operation and performs the fault analysis and fault pre-location.

MTDR300



1. **MTDR Display:** Large 26mm (10.4") full colour XGA display. Shows all parameters, and traces to achieve rapid accurate fault location.

2. **ON / OFF Switch:** Illuminated Push-Button ON / OFF Switch

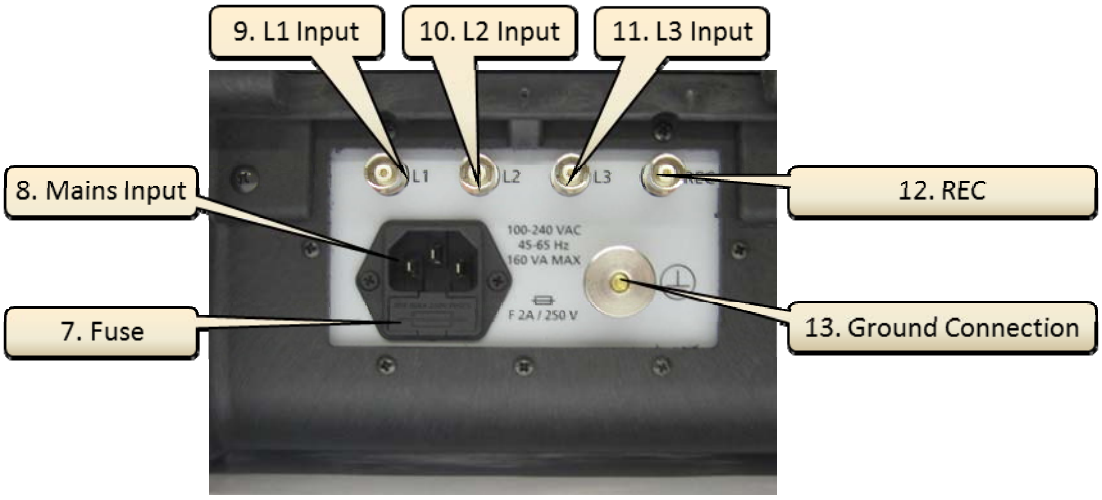
3. **Battery Indicator:** Green light indicates battery good or is being charged.

4. **Battery Indicator:** Red light indicates a low battery condition, and that the battery needs charging

5. **USB Port:** USB port to download/upload stored traces including all parameters, and to upgrade system.

6. **MTDR Jog Dial:** With this jog-dial the operator sets all preferences, selects modes of operation and performs the fault analysis and fault pre-location.

MTDR300

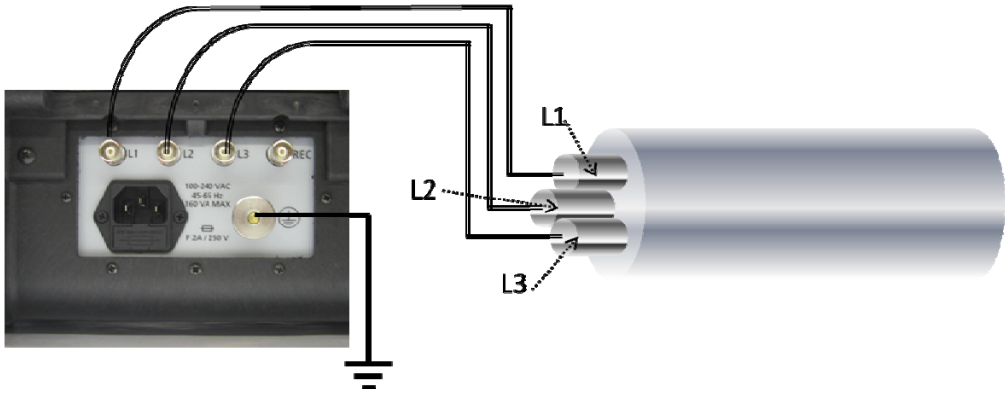


7. Fuse:	Instrument Fuse Holder 2A/250V Rating
8. Mains Input:	Instrument Supply Input. The MTDR300 will operate from an incoming a.c. supply 100 to 240Va.c. 45-65Hz. 160VA Max.
9. L1 Input:	Arc Reflection & Phase L1 BNC connector Input.
10. L2 Input:	Phase L2 BNC connector.
11. L3 Input:	Phase L3 BNC connector.
12. REC Input:	Input for Current Impulse (Impulse Current) and Voltage Decay.
13. Ground Connection:	Ground (Earth) connection. It is imperative for safe operation that the MTDR300 is connected to a good earth ground.

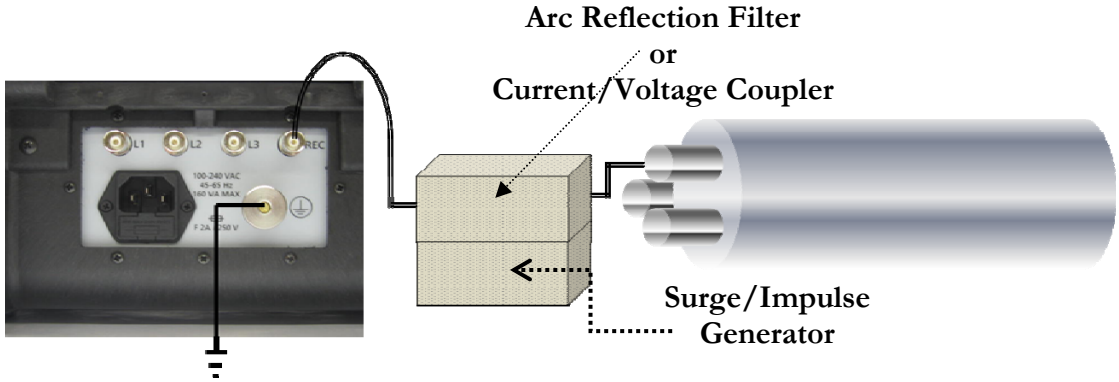
MTDR300

Connection Diagram

Low Voltage Modes



High Voltage Modes



Methods available on the MTDR100 & MTDR300

TDR / Pulse Echo

Reminder: TDR or Pulse Echo is a low voltage method of fault pre-location suitable for locating short and open circuits and other faults below approximately 300Ohms. It is not suitable for high impedance or flashing faults, where HV method should be used.

Arc Reflection

Reminder: Arc Reflection is the most widely used HV method of fault relocation. It is suitable for high resistance, flashing and other faults that can be ignited by a surge generator. A reference trace is taken without the arc, then a real-time trace is taken during the arc recorded and compared to the reference trace. The point of divergence indicates the fault position.

Arc Reflection Plus

Reminder: Similar to Arc Reflection but with the added advantage of being able to view multiple traces, all of which have been captured during the period of a single arc. This removes the need to adjust the triggering time, as all stages of the arc can be interrogated.

Differential Arc Reflection (DART)

Reminder: In Differential Arc Reflection mode unwanted and confusing reflection are removed leaving a clean trace with only the fault position being displayed by a negative pulse. This method is especially suited in locating high-resistance faults in complex cable systems. This differential arc reflection trace (DART) can be displayed at the same time as Arc Reflection Plus for even better and more confident fault analysis.

Current Impulse (ICE or Impulse Current)

Reminder: Impulse Current requires the most interpretation and is therefore not often used; however it is very suitable for long or wet cables. The fault is ignited and the resultant transients are recorded by the MTDR, which is acting as a transient recorder.. The trace displays impulses at both the point of the fault (low impedance) and also where the surge generator is connected to the cable. Do not use the first displayed impulse as this includes the "ionization delay" i.e. the time needed for the fault to flashover. The distance between the impulses is the distance to fault. For added accuracy try using more than one measurement and different voltages!

Loop-off / Loop-on

Reminder: In this method, which uses to standard Current Impulse techniques two traces are recording and compared. For this method to work there must be a good core available As in standard Current Impulse a flashover is created using the surge generator (thumper) and recorded on the MTDR. A bridge or "short" is then connected at the far end between the faulted core and a good core. (for convenience the bridge or short can be placed at the near end). The output of the surge generator is connected to both the faulted and good core and then a second flashover is created and the resultant trace recorded on the MTDR. These two traces are transposed and the point of change (divergence) is an indication of the fault position.

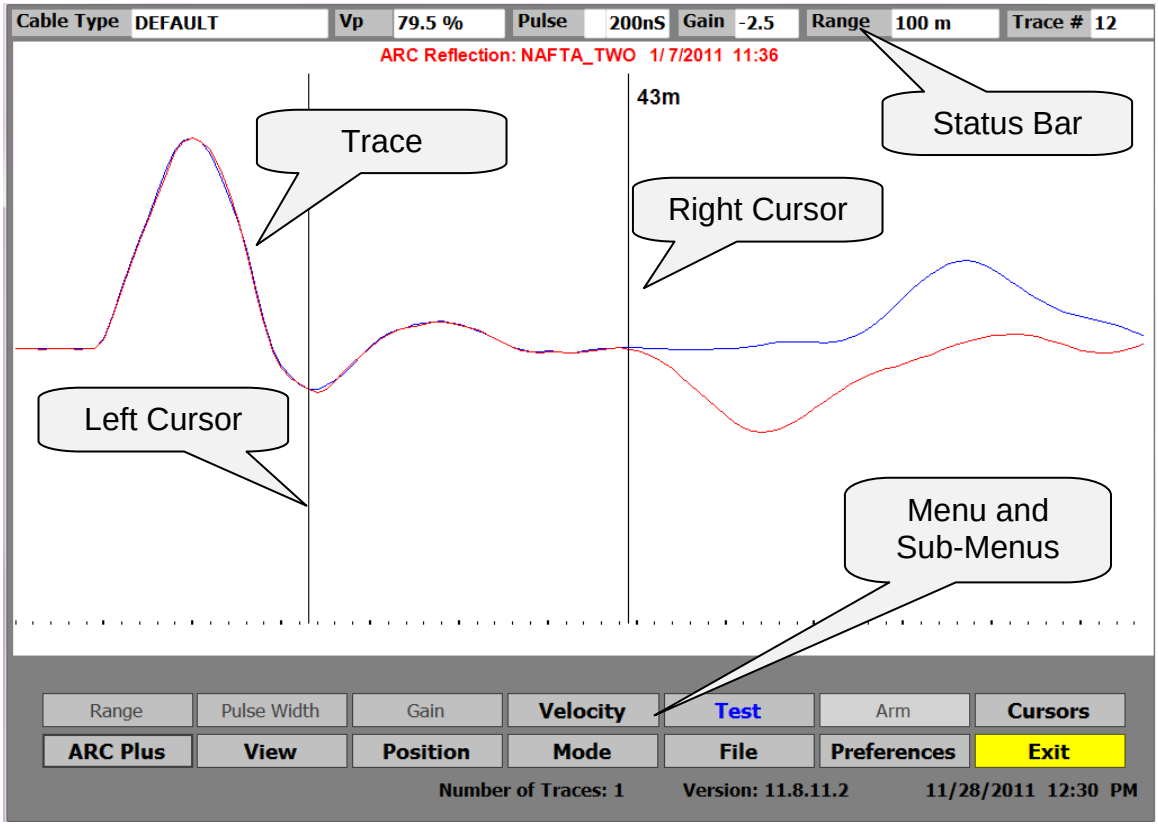
Voltage Decay

Reminder: Voltage Decay is only suitable for approximately 6 to 8% of cable faults, primarily those of extremely high resistance. This method uses the capacitance of the cable and a d.c source. The d.c. source is used to generate the breakdown with the resultant transients being recorded by the MTDR. The trace displays what can be deemed to be a "square wave". The distance to the fault is the distance of a whole cycle divided by two. As with the Current Impulse, do not use the first displayed impulse as this includes the "ionization delay".

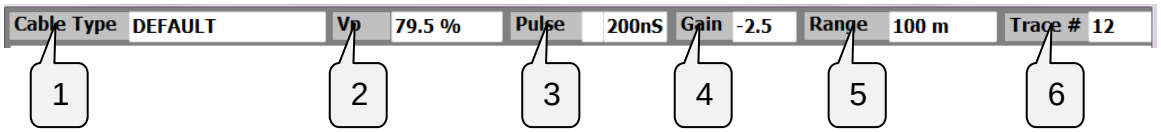
Display

The display of the MTDR100/300 is designed to be "user friendly", whereby all operator selection is via a series of menus and drop-down sub-menus.

Display: XGA 1024 x 768 (10.4" / 26.55mm)

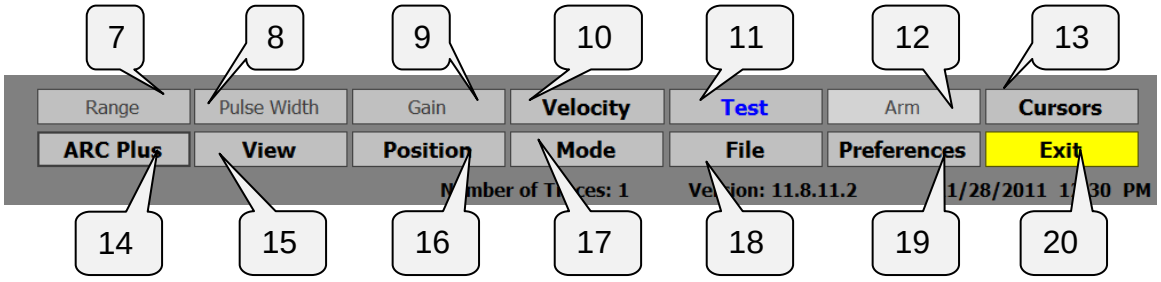


Status Bar



1. **Cable Type:** Selected from cable library, or custom cable put in by operator
2. **Vp:** Velocity factor, set by operator or by default setting in cable library
3. **Pulse:** Pulse width, either set automatically with range or manually by operator
4. **Gain:** Amplification applied to the trace
5. **Range:** Desired range of MTDR set by operator
6. **Trace #:** The reference number of the trace being displayed (when using Arc Reflection Plus).

Operator Menu Bar



7. **Range:** Allows operator to select required range.

   Note: In TDR & ARC Reflection mode with ***Auto*** *activated (by depression of jog-dial) the system will automatically set the right cursor over end of cable and set range. This should be seen as a guide only as spurious multiple reflections could cause incorrect positioning of cursor.*

8. **Pulse Width:** Manually set pulse width or select "Auto".

9. **Gain:** Set gain (amplification) to be applied to trace.

10. **Velocity:** Set velocity factor of cable (library or custom).

11. **Test:** Used to activate "constant sampling" in TDR/Pulse Echo modes.

12. **Arm:** Arms transient recorder for Arc Reflection, Current Impulse, Loop off/Loop on and Voltage Decay (Voltage Decay not available on PFL22M1500).

13. **Cursors:** Used to activate and move left and right cursors.

14. **Arc Plus:** Select Arc Reflection Plus (**ARP**) to view up to 1024 traces. (Range dependent)

15. **View:** Opens sub-menu to Zoom or Pan along trace.

16. **Position:** Allows the operator to move the trace vertically.

17. **Mode:** Sub-menu to select Arc Reflection, TDR, Current Impulse, Loop off / Loop on (Voltage Decay not available on PFL22M1500).

18. **File:** Access on-board file manager (save/upload/download).

19. **Preferences:** Access preferences sub-menu.

20. **Exit:** ***only on CAS-1 emulator software.***

Single Button Operation

Rotary Jog-Dial

Operation of either the MTDR100 or MTDR300 is undertaken via the rotary jog-dial. Selection of modes and setting of all user-defined parameters are easily undertaken with this single control.

Selection of the required parameter or settings is obtained by rotating the jog-dial, through the available menus and sub-menus.

The required parameter or settings is activated by depressing the jog-dial. The selected item will be highlighted on the display. Changes to the selected item can be changed either via the drop-down menus or by rotating the jog-dial.

To de-active a selection the jog-dial is depressed again.

The Operator can then continue to scroll through the menus and sub-menus as required.

Rotating the jog-dial = Select parameter, Menu or Sub-menu.

Depress the jog-dial = Activate or de-active the selected item.

3

SAFETY

Safety is the responsibility of the user

General Safety Precautions

Local Operating Company Safety Standards and Instructions should always be followed; the following are for guidance only.

The MTDR100/300 should only be used for its stated application. Any other application may render the safety features inoperative and expose the operator to dangerous levels of energy.

In the event of equipment malfunction, the unit should immediately be de-energized and returned to Megger for repair.

This equipment can be used with equipment that generates high voltages and high current, which can be lethal.

Operators must read and understand this entire User Guide prior to operating the equipment. Operator must follow the instructions of this User Guide and attend the equipment while the equipment is in use.

Only "**Competent**" or "**Authorized**" personal should operate the MTDR100/300.

Authorized Person: means a person recognized by an Authorizing Officer as having sufficient technical knowledge to perform certain duties in respect of defined electrical systems and equipment. An Authorized Person is normally appointed in writing by an Authorizing Officer.

Authorized Persons are those individuals who manage the Code and then ensure compliance with the Rules. The limit of responsibility may in general be different for each Authorized Person and must be detailed in writing. The level of responsibility will depend on the ability, experience, and the nature of the equipment under the control of the Authorized Person.

Competent Person: means a person having:-

- Adequate knowledge of electricity
- Adequate experience of electrical work
- An understanding of the system to be worked on and practical experience of that class of system
- An understanding of the hazards which may arise during the work, and the precautions which need to be taken
- The ability to recognise at all times whether it is safe for work to continue

Note:	*If persons are not competent to undertake particular work on their own, for example those who have not completed their training, then they must be accompanied and supervised by a competent person.*

- Observe all safety warnings on the equipment, and provided in this manual.
- Use this equipment only for the purposes described in this manual.
- Do not use the equipment in rain or snow unless in sheltered position.
- Do not operate the equipment whilst standing in water.
- All terminals of H.V. equipment are potential electric shock hazards. Use all safety precautions to prevent contact with energized parts of the equipment and related circuits.
- Use suitable barriers, barricades, or warnings to keep persons not directly involved with the work away from test activities.
- Never connect the test equipment to energized cables or use in explosive atmosphere.
- Use the grounding and connection procedures recommended in this manual.
- Personnel using heart pacemakers should obtain expert advice on the possible risks before operating this equipment or being close to the equipment during operation.

Safety in Using High Voltage Cable Fault Location Equipment

Always treat exposed conductors and connections as potential electric shock hazards.

The Cable under test is a source of instantaneously lethal levels of electrical energy.

- Do not use this equipment to locate faults on any cable that may be close enough to an energized cable to allow a burn-through of the insulation of the energized cable.
- Do not operate High Voltage test equipment if it has not first been stabilized and in an upright position.
- Remain a safe distance from all parts of the High-Voltage circuit, including all connections, unless the equipment is de-energised and all parts of the test circuit are earthed/grounded. Be aware that any voltage applied to the Cable Specimen will be present at the remote end(s) and at any other exposed part of the cable, often out of sight of the operator.
- Use the grounding and connection procedures. If other manufacturers' equipment is used with the MTDR100/300, the user is responsible for verifying that the grounding and interconnections between the systems comply with each Manufacturer's Instructions.
- Use Industry Accepted practices for making reliable, low-impedance connections, capable of carrying large surge currents.
- Maintain adequate air clearances between any exposed High-Voltage conductor and any adjacent grounds to prevent spark-over. An uncontrolled spark-over can create a safety hazard.
- Megger recommends the use of appropriately rated rubber gloves when connecting and disconnecting to the High-Voltage terminals.
- Where an interlock circuit is provided, its use is highly recommended, to enable the operator to safely control access to the complete high-voltage circuit.

4

PREPARING FOR TEST

IMPORTANT SAFETY WARNINGS

As applicable for use with any Megger Cable Fault Location Systems

WARNING

The surge return is isolated from chassis ground by a 2000ohm resistor. This limits current in the case of a failed concentric neutral.

The surge return cannot be used as a substitute system ground.

Failure to follow this procedure can result in serious injury or in the extreme, death of the operator and/or the destruction of the equipment.

WARNING

The operator is isolated from transient voltages along the surge return by the insulation system in the PFL and by the insulated jacket of the high voltage output cable. Tears or breaks in the insulating jacket of the High-Voltage output cable expose the Surge Return to the operator and poses a safety hazard and the cable should be replaced.

WARNING

DO NOT EXTEND the Surge Return lead of the HV Output Cable because this introduces excessive impedance in the Surge Return and could result in exposed hazardous voltages.

General Site Preparation

Choose a location that meets the following conditions:

- The vehicle (if used) can be safely parked. Set the brakes or block the wheels.
- The location is as dry as possible.
- There is no flammable material stored in the vicinity.
- The test area is adequately ventilated.
- Both the High-Voltage conductor and the Shield of the Cable Specimen are accessible. Be sure all equipment is de-energized. Identify the faulted cable, obtain access to both ends, and erect safety barriers to protect the operator from traffic hazards and to prevent intrusion by unauthorized personnel. Beacon Warning lights are recommended.
- Verify that the station ground is intact and presents an acceptable low resistance to earth/ground.

Making Connections

Before operating any HV CFL equipment the following connections and safety procedures need to be followed.

- Ensure the cable to be tested is Earthed/Grounded and de-energized.
- Connect the Earthing/Grounding cable of the HV equipment to a suitable Earth/Ground point and the Earth/Ground stud of the equipment.
- Connect the supply cord to the HV CFL equipment and suitable supply.
- Connect any HV Interlock blanking plug.
- Connect the HV cable to the HV CFL equipment.
- Connect the Sheath of the HV cable to the cable under test.
- Connect the HV connection of the HV cable to the cable under test.
- Cordon off a safety zone around instrument and all exposed cable terminations.

Earth (Ground) the Instrument

Prior to operating any HV CFL equipment or making any other connections the instrument has to be Earthed/Grounded.. If in doubt use an Earth/Ground Tester to confirm status of Earth/Ground. It is not sufficient just to rely on the supply earth/ground as this may not exist.

Incoming Supply Lead/Cord

The appropriate (Country specific) supplied power lead/cord should be inserted into the HV CFL equipments receptacle, and connected to a suitable stable supply, as required by the equipment. Do not use extension leads, unless suitably rated.

Sheath / Concentric connection

Before undertaking this connection you should check to ensure that the cable under test is Earthed/Grounded, if unable to do so it is dangerous to make any connection to it.

The Sheath / Concentric connection of the HV Cable is connected to the sheath/concentric connection of the cable under test.

High Voltage Cable connection

Before undertaking this connection you should check to ensure that the cable under test is Earthed/Grounded, if unable to do so it is dangerous to make any connection to it.

The HV Core connection of the HV Cable is connected to the core of the cable under test.

Safety Zone

As High Voltages are present when undertaking cable testing and cable fault location any area of potential danger needs to be cordoned off to protect people from possible "electrical shock". This includes the cable terminations, point of connection and other areas of potential hazard.

Switching On

Once all connections have been made and a safety zone established the HV CFL equipment can be turned on.

5

OPERATION OF THE MTDR100 AND MTDR300

NB: Some features differ between models and configuration

Enabling the MTDR (When Integrated with PFL system)

NOTE: Any reference to item #numbers refer to PFL22M1500 user guide.

On the PFL ensure the rotary Voltage Control knob (item 21) is set to the "Zero Start" (item 9) position.

Unless using HV methods of Pre-location the Voltage Range switch (item 20) can be set to any range. If using HV methods of Pre-location this Voltage Range switch (item 20) is to be set to the desired range either 8 or 16kV. At this stage the Status Bar (item 1) will glow "Red".

The Mode selector switch (item 19) is set to the TDR, Arc Reflection Group.

- To select **TDR Mode**: Depress the TDR mode Pushbutton switch (item 16).
- To select **Arc Reflection Mode**: Depress the Arc Reflection mode pushbutton (item 15).

NOTE: The selected mode pushbuttons will illuminate.

Initial Set-up

All models MTDR300 & MTDR100

Important:	*When you receive your instrument or following an update you will be asked if it is an MTDR100 or MTDR300. Please answer as appropriate as this will select the correct settings.*

When you receive the instrument it will have certain parameters pre-set as the "default". To change these defaults and set up the instrument to satisfy individual requirements follow the following procedure.

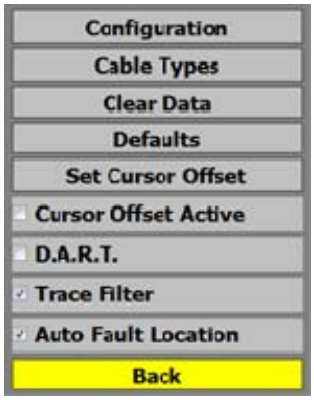
NOTE:	*All menus and submenus are accessed by turning the jog-dial until the desired menu item is highlighted and then depressing the Jog-dial to select the required item or sub-menu*

Rotating the jog-dial = Select parameter, Menu or Sub-menu

Depress the jog-dial = Activate or de-active the selected item

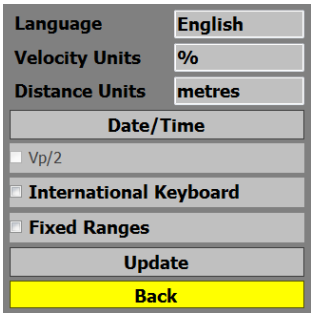
- Select and activate **"Preferences"** by turning the jog-dial and depressing when over the menu.

- You will then see the following sub-menu options.



- Scroll up to **Configuration** and select by depressing jog-dial.

You will then be presented with the following options:



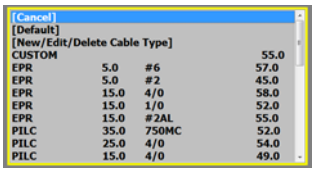
- **Language:** Allows the operator to select the operating language from those installed.
- **Velocity Units:** The operator can select from: % ; ft/µS ; m/µS. The Distance Units are automatically changed to the appropriate unit of measurement.
- **Distance Units:** The operator can select from Feet or Meters. **Date/Time:** Set the date/time format and set the local time.
- **Vp/2*:*** Allows the operator to set personal preference on whether they want Velocity Factor set as Vp or Vp/2. Check the box to select Vp/2.
- **International Keyboard:** When selected the system will use a keyboard with local language specific characters.
- **Auto-Range on Start-up:** When selected, on "turn-on" the unit will automatically auto-range when TDR & Arc Reflection modes are initialised.

Warning:
This setting overrides any "default settings".

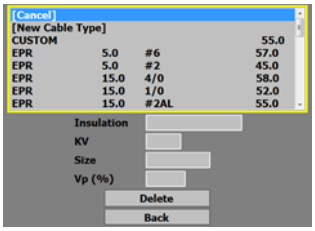
- **Fixed Ranges:** Allows the operator to select from "fixed ranges" or variable ranges that will be dependent on velocity factor setting. Check the box to select "fixed" ranges.
- **Update:** Updates to the software can be implemented via the USB slot. By selecting update the MTDR will automatically search the USB for any updates and start to download and implement. Updates must be in a folder named "Update".
- **Back:** Exits the operator out of the Configuration menu.
- From **Preferences** scroll up and highlight **Cable Types** and select by depressing jog-dial.

You will then be presented with the following options:

- The MTDR comes with a standard data-base of "typical" cables. These can be selected by scrolling down and clicking/selecting the one desired. This will then automatically set the cable type and velocity factor for all measurements taken on that setting. The Default cable type may also be set.



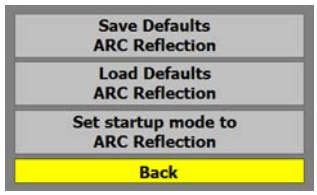
- In the event of a specific cable not being in the database, you can add a cable type by selecting (New/Edit/Delete Cable Type) and then (New Cable Type) in the sub-menu. Fill in the information fields by using the Keyboard and the new cable type will be added to the table. Unwanted cable types may also be deleted from the table using this menu.



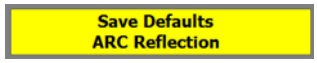
- **Cancel :** Takes the operator out the Cable Type sub-menus back to Preferences menu.

- **Clear Data:** Clear Data, removes all traces from TDR screen, and returns operator back to main menu.

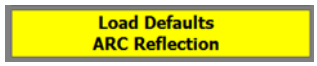
- **Defaults:** Allows Operator to load and save default settings for; TDR, Arc Reflection, Current Impulse, Loop Off / Loop On, and Voltage Decay. Displayed default sub-menu is dependent on Mode setting.



- **Save Defaults:** In this submenu you save the default settings for the selected Mode. These settings are then used as the "default" for that Mode.

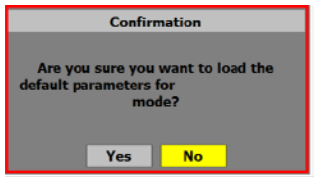


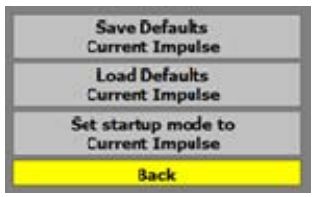
- **Load Defaults:** By selecting this you will load your saved "default" settings for the current Mode.



- **Set Startup mode:** When selected, the MTDR will start-up in the current Mode every time it is turned on.

NOTE: For security the operator will be promoted Yes or No before setting the defaults

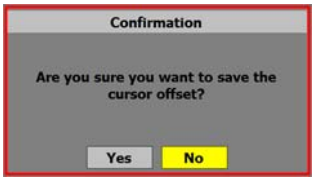




- **Set Cursor Offset:** Allows the operator to "null out" the instrument's output cable. When "nulled out", the left cursor will be placed at the start of the test piece. If selected, this will be set as a default until reset !

NOTE: DO NOT use this option in Current Impulse or Voltage Decay.

As this affects the default setting the following screen will be displayed asking for confirmation.



- **Cursor Offset Active:** Allows the operator to select whether the offset is used or not. Depress jog-dial to activate. When Cursor Offset Active is on, the left cursor will be locked.

- **D.A.R.T. (Differential Arc Reflection):** The operator can choose whether the DART function is active or not. Depress jog-dial to activate.

- **Trace Filter:** Filters or averages the captured traces when activated. Depress jog-dial to activate. This feature is automatically activated when "Find End of Cable" is active.

- **Auto Fault Location:** When selected and in Arc Reflection mode the MTDR will automatically position cursor over the fault position. Depress jog-dial and check the box to activate.

NOTE: This should be seen as a "guide" only, as further investigation of the trace using Arc Plus and/or DART may be necessary.

- **Back:** Takes the operator out of the "configuration" sub-menu and back to "preferences" menu tab.

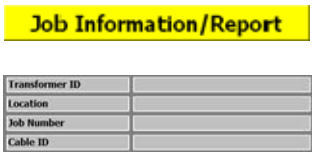
- Scroll to **File"** select by depressing jog-dial, you will then be presented with the following sub-menu options:

- **Save:** Allows the operator to save current trace with its parameters to internal memory. If "new" selected operator will be presented with a virtual keyboard allowing entry of new name and other pertinent information.

- **Load:** From here the operator can recall any previously saved trace from the internal memory.

- **Delete:** Allows the operator to delete any saved traces from the internal memory.

- **Job Information:** Allows the operator to enter additional information which will be saved and loaded along with the trace data.



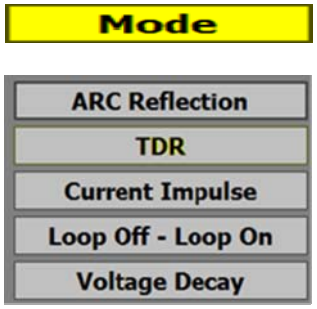
- **Copy to USB:** Allows the operator to copy trace data from the MTDR internal memory to an external USB device.

- **Copy from USB:** Allows the operator to copy recorded data from an external USB device to the MTDR internal memory.

- **Back:** Takes the operator out of the File sub-menus back to the "File" tab.

To select Mode (Method)

- Scroll to **"Mode"** (also known as method), to configure the MTDR. Select the desired mode by rotating the job-dial until "Mode" is highlighted. Then by depressing the jog-dial, you will then be presented with the following sub-menu options:

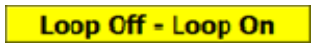


- **Arc Reflection:** Use to select Arc Reflection method of pre-location on the MTDR.

- **TDR:** To select standard Pulse Echo method.

- **Current Impulse:** Select for Current Impulse (Impulse Current).

- **Loop Off – Loop On:** Select to use Loop Off – Loop On method.



- **Voltage Decay:** To select Voltage Decay method (not available on PFL22M1500)

- When the **TDR mode** has been selected the operator menu bar will change to display the "Traces" option.

- **Traces:** Allows the operator to select which traces he wants to view, and which trace is active.

- **Show Traces**: the operator can choose between the three available traces. Check to activate. You are then able to compare any of the three phases. By using the vertical control (see later) you can overlay each of the traces to look for any deviations.

- **Select Trace #:** Once the traces to be viewed have been selected. You can then select which trace is active.

  Once selected use "Back" to return to the main menu options.

- **Back:** Takes the operator out the File sub-menus back to the "Traces " tab

- **Test:** Activates the TDR to start taking Pulse Echo measurements. To deactivate (cancel) depress jog-dial again.

- **Position:** Allows the operator to set the Vertical Position of the displayed traces. Select by depressing jog-dial, you will then be presented with the following sub-menu options:

- Select either the Blue, Red or Green Trace by depressing the jog-dial, to move the selected trace either up or down

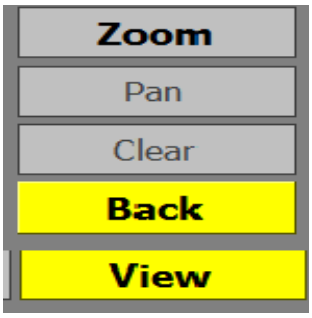
- *Note: If in Arc Reflection mode with DART selected in "preferences" the Green trace will be designated "Black" which is the DART trace.*

- **Reset:** Returns all traces to their original positions.

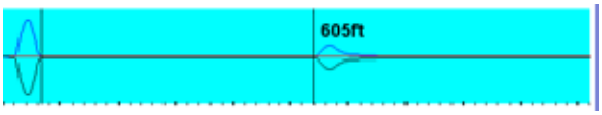
- **Back:** Takes the operator out the Position sub-menus.

- **View:** to access the display viewing options. Select by depressing jog-dial.

You will enter the Zoom Mode and will be presented with the following sub-menu options:



- **Zoom:** Allows the operator to zoom in to a particular section of the displayed trace. Zoom defaults to the right cursor position.



- **Pan:** Allows the operator to view (pan) along the total length of the displayed trace.

- **Clear:** Exits the Zoom Mode.

- **Back:** Takes the operator out of the View sub-menus.

Arc Reflection Plus

only available following initial Arc Reflection measurement.

- In **Arc Reflection Plus**, the operator is able to scroll through up to 1028 (dependent on range) Arc Reflection traces, taken during the arc period.

The selected trace is shown on the top status line as:

Different traces can be selected by rotating the jog-dial.

- **Range:** Select by depressing jog-dial.

Allows the operator to set the MTDR to the desired range (TDR 100m to 55km) (Transient 100-200km). *It is recommended that a higher range than the anticipated length of the cable is used.*

- **Pulse Width:** Select by depressing jog-dial.

Allows the operator to set the pulse width of the outgoing pulse from 50ns to 10µS or select Auto whereby the pulse width is automatically selected as determined by the range.

- **Gain:** Select by depressing jog-dial.

Allows the operator to adjust the amount of gain to be applied to the displayed trace.

- **Velocity:** Select by depressing jog-dial.

Allows the velocity factor to be selected. This is an ***important factor*** as this determines the electrical speed of the cable, hence any measurements are made based on this parameter. Units will be as determined in preferences.

NOTE:	*If the Cable length is known, then Velocity can be verified. Place the left cursor at the start of the cable and the right cursor at the Cable end and adjust the Velocity. When the Distance shown for the right cursor matches the known Cable length, the velocity is set to its correct value.*

- **Test: S**elect by depressing jog-dial.

When activated turns the MTDR into real-time pulse echo mode, with continual sampling.

Realtime sampling is cancelled by depressing jog-dial

- **ARM:** Select by depressing jog-dial.

Required in: Arc Reflection; Surge Impulse; Loop off / Loop on; Voltage Decay modes to arm or initiate the transient memory required for these methods. The following message to show that the TDR is waiting for a trigger will be displayed at the top centre of the TDR screen.

NOTE: *You will be unable to capture any traces with the above methods unless you* ***ARM*** *the transient memory function first.*

- **Disarm:** Selected by depressing jog-dial.

- **Cursors: S**elect by depressing jog-dial.

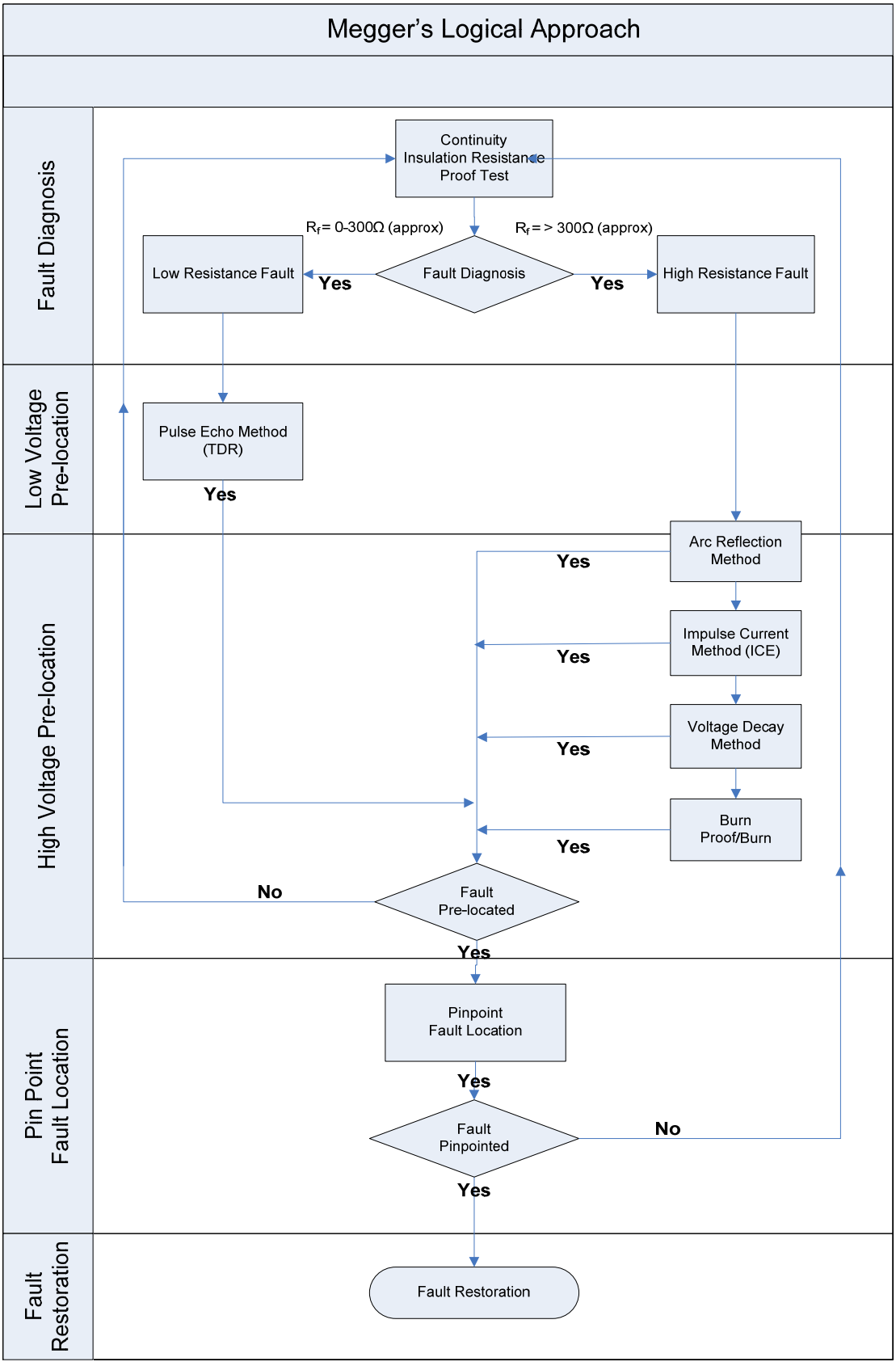
- Allows the operator to move the "right" or "left" cursor. Active cursor will appear as a "dotted" line on the TDR display.

Note: *if Cursor Offset is active, only the Right Cursor can be selected.*

Addendum

Cable Fault Location

Applications Guide


Megger's Logical Approach
Fault Diagnosis
Continuity
Insulation Resistance
Proof Test
R_f = 0-300Ω (approx)
R_f = > 300Ω (approx)
Low Resistance Fault
Yes
Fault Diagnosis
Yes
High Resistance Fault
Low Voltage Pre-location
Pulse Echo Method (TDR)
Yes
High Voltage Pre-location
Arc Reflection Method
Yes
Impulse Current Method (ICE)
Yes
Voltage Decay Method
Yes
Burn Proof/Burn
Yes
No
Fault Pre-located
Yes
Pin Point Fault Location
Pinpoint Fault Location
Yes
Fault Pinpointed
No
Yes
Fault Restoration
Fault Restoration

A-1

Appendix

Remember !

"It's your fault if you don't find the fault"

and

"It's <u>your</u> Fault if you do"

Typical Fault Locating Strategy

The most important aspect of locating a cable fault is the development of a strategy that will allow the fault location to be safely and positively identified.

This is achieved by following the Megger **"Logical Approach to Fault Location"** See previous flowchart.

1. Use only suitably rated, equipment, making sure that all company and equipment manufacturers' safety guidelines are followed.

2. Positively identify the faulted cable. After isolation and Earthing/Grounding of all of the suspect cables and cores, this can be done by either using an Insulation Continuity Tester, to determine the condition of each of the cables and cable cores, or by using a TDR to see if all of the cores appear to have the same characteristics, i.e. (splices, joins, transformers, etc., at approximately the same distance.

3. If all circuit elements appear to be equal, determine if the electrical length of the circuit elements agree with the known physical length of the circuit. If it does not agree, adjust the TDR propagation velocity accordingly.

4. If the TDR data is inconclusive, use the d.c. (Proof/Dielectric Test) function to positively identify the faulted phase. Separately bring each phase up to a test voltage as agreed by "local" conditions or regulations. Note the breakdown voltage from the faulty phase or phases.

    a. After the faulted phase (or phases) has been positively identified, begin pre-location by engaging the Arc Reflection method and

configuring the MTDR and PFL for Arc Reflection. Apply a test voltage as defined by the breakdown voltage noted during the previous step. Increase the test voltage slowly, noting that the longer the cable, the greater the cable capacitance, hence the Arc Reflection breakdown voltage can be higher than the breakdown voltage. If the fault appears to be unstable, try increasing the discharge voltage slightly.

b. If the fault does not consistently breakdown, or is unstable, at the maximum allowable voltage, select the Proof/Burn function on the PFL. Raise the voltage to either the maximum allowable voltage or until the fault breaks down in a relatively stable manner as indicated by stable current and voltage. Continue this proof/burn function until the discharge current is stable. After a few minutes of stable discharge, return to Arc Reflection. Do not use proof/burn excessively as you could create a "dead short" to earth/ground that would be extremely difficult, if not impossible to pinpoint using acoustic methods.

c. Another effective method of HV Prelocation is the Impulse Current method also known as Impulse Surge, or Voltage Surge. This method is effective for pre-locating high-resistance faults (arc resistance greater than 200**Ω**) where the Arc Reflection method does not work effectively. The Impulse Current method is similar to the Arc Reflection method in that both methods send high energy pulses down the cable which are used to break down the fault. When using the Impulse Current method, a current coupler is switched into the surge return circuit and is used to measure the high frequency transients, seen as a series of spikes each separated by the time taken for the transients to travel from the fault back to the PFL.

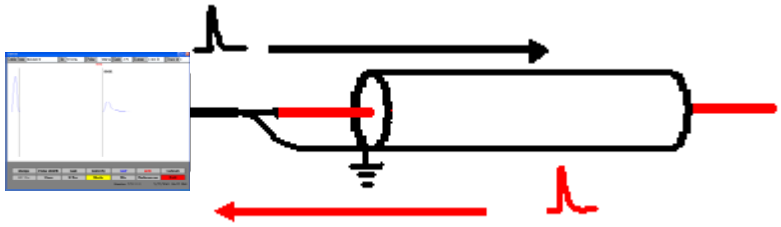
   It should be noted that the first displayed pulse includes the "ionisation delay" and should not be used for measurement. In general the second or third pulses can be used, later pulses can distort the measurement as they have been attenuated by the cable during the multiple reflections.

d. Once the fault has been pre-located by using any of the above methods, the fault can be pinpointed either by acoustic or electro-acoustic methods. Set the PFL to Impulse Current and set the discharge voltage to a voltage similar to that used previously. Note: The lowest possible voltage should be used (as long as it is high enough to ignite the fault and create a flashover) as this ensures that the maximum energy is available, making pinpoint location easier. Set the discharge rate as desired and use the MPP2000 pinpoint receiver to pinpoint the exact location of the fault.

Overview of Fault Prelocation Methods

Description of TDR or Pulse Echo techniques

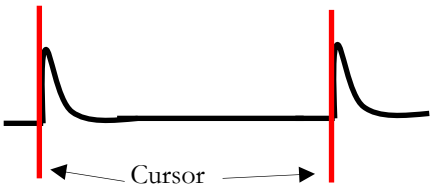
TDR also know as Pulse Echo or radar methods of fault location use low-voltage pulses to locate changes in impedance along the length of the cable.



From these low-voltage pulses, a small amount of energy is reflected back to the TDR from a change of impedance and is displayed on the MTDR screen, as either a positive going or negative going pulse, depending on the impedance characteristic (negative pulse for low impedance to shield faults and positive pulse for high resistance faults).

With Pulse Echo. The time which the pulse needs to travel from the Instrument to the end of cable and back is measured by means of a cursor which is positioned at the beginning of the reflection.

Mathematical representation: **L = v . t**

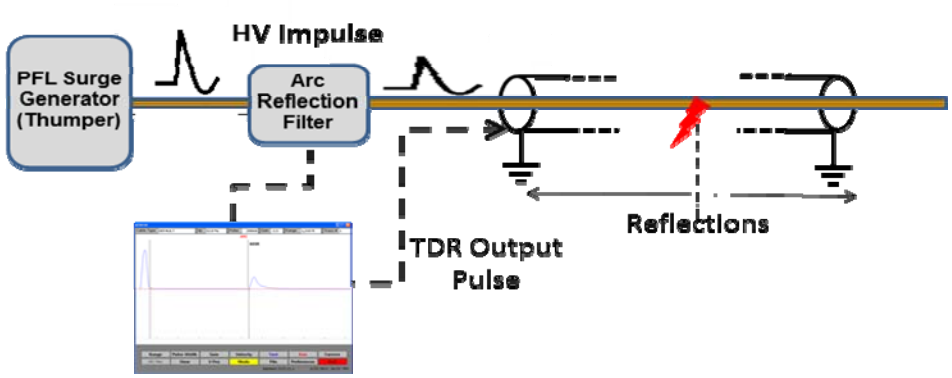


With Pulse Echo, the output pulse travels twice the distance of the cable. i.e. from the output of the TDR to the change of impedance and the returning reflection back to the TDR., so the length to the impedance change is shown as**:**
L_x = v.t/2 = v/2.t

Where: v = Propagation velocity; L = Measured length; t = time measured

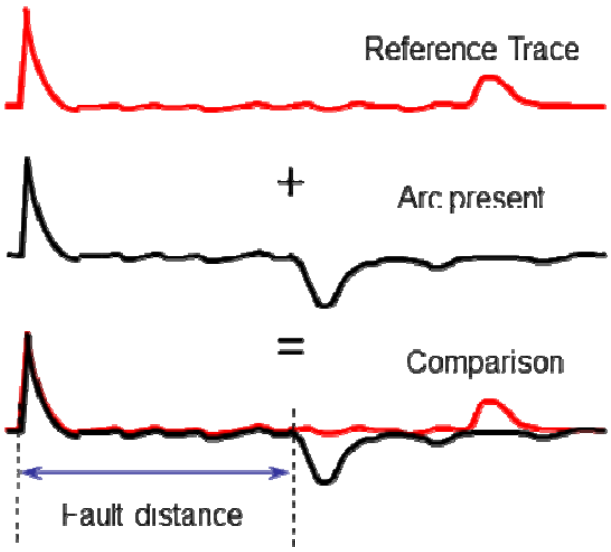
Description of Arc Reflection

The Arc Reflection method uses standard pulse echo techniques to pre-locate high resistance faults, which are not identifiable using pulse echo.



In Arc Reflection we use an Impulse Generator, Arc Reflection Filter and the MTDR100. The operator takes a standard pulse echo trace which is automatically saved as a reference file. Then a HV impulse is applied to the cable, the impulse going through the Arc reflection filter. This arc reflection filter "stretches" in time, the outgoing pulse which then ignites the fault, creating a temporary bridge to earth/ground. During this period the MTDR sends out LV TDR pulses into what is in effect a short circuit. This trace is then memorised and compared to the original trace. The point of divergence is the point of fault.

Typical Traces

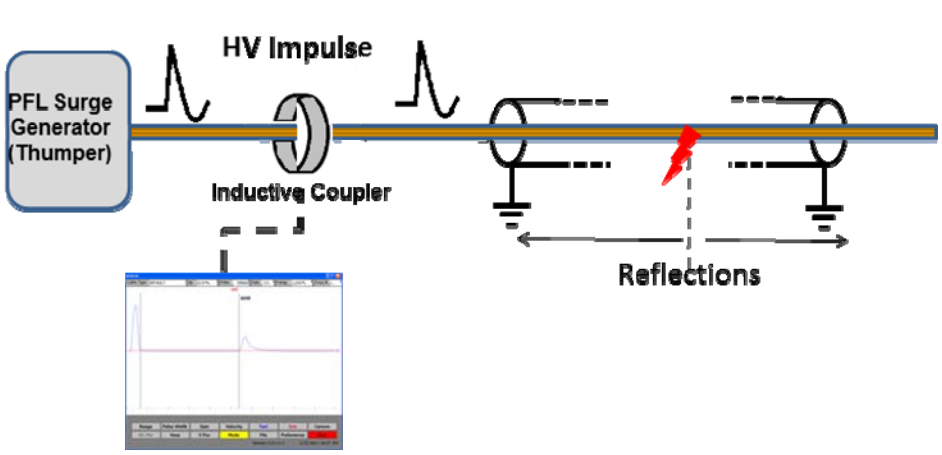


This method is extremely effective and easy to interpretation.

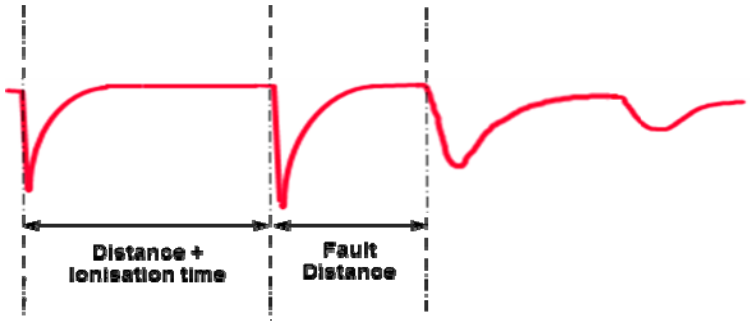
Description of Current Impulse (Impulse Current)

Impulse current also known as ICE is probably one of the oldest methods of fault pre-location using "transient analysis". This method allows the pre-location of high resistance and flashing faults.

In Impulse Current we use an Impulse Generator, Inductive Coupler (C.T.) and the MTDR which acts like a transient recorder. The surge generator creates a flashover at the point of fault and the resultant transients are reflected back and forward between the fault and the impulse generator. These transients are picked-up by the Inductive couple and fed to the MTDR where they are subsequently displayed.



Typical Trace

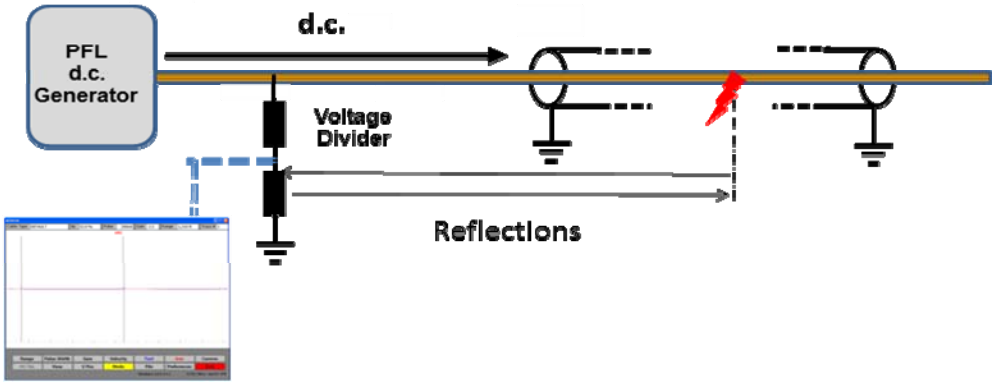


Description of Voltage Decay

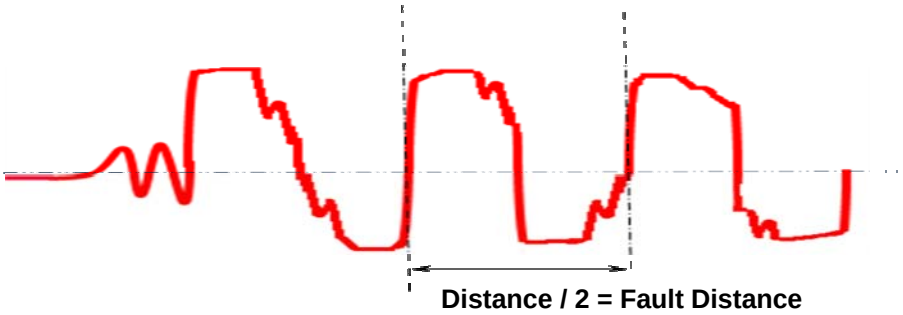
Voltage Decay is probably only used around 8% of the time, but it is especially useful when a fault breaks down and then reseals itself. This can be termed a "flashing or pecking" fault. Voltage decay can also be used where the voltage required to breakdown the fault cannot be achieved with the surge generator.

In Voltage Decay we typically use a High Voltage d.c. source, a voltage divider and the MTDR which is operating as a transient recorder.

HV DC is applied and the voltage increased until the fault breaks down, and a flashover occurs. During this flashover (the point of fault) the resultant transients are reflected back and forward between the fault and the dc source. These transients are detected by the voltage divider and fed to the MTDR where they are subsequently displayed.



Typical Trace



MTDR EC Certificate

Megger

EC Declaration of Conformity

We certify and declare the listed product and found that it conforms to the applicable portions of the **EMC** Directive 2004/108/EC based on the following specifications applied:

Standards ► **EN61326-1:2006 Clause 7.2**
(CISPR11 Edition 4:2003) Group 1, Class A

EN61326-1:2006 Table 2
For use in Industrial Locations

Product Approved ► **MTDR300 Time Domain Reflectometer**

Date of Approval ► **March 29, 2012**

Authorized manufacturer representatives:

Quality Assurance Manager ► **Robert Runta**

Engineering Manager ► **George Esmet**

Certificate No ► **EMCR300**

Valley Forge Corporate Center
2621 Van Buren Avenue
Norristown, PA 19403-2329 USA
T 610-676-8500
www.megger.com
Registered to ISO 9001:2008

Form MegSC11-09

KEMA

Affiliate with the N.V. KEMA in The Netherlands

CERTIFICATE

Certificate Number: 110006.01

The Quality System of:

Megger®
2621 Van Buren Ave
Norristown, PA 19403
United States

Including its implementation, meets the requirements of the standard:

ISO 9001:2008

Scope:
Design, manufacturing and marketing of electrical, electronic and mechanical measuring instruments and systems.

This Certificate is valid until:	February 13, 2013
This Certificate is valid as of:	February 13, 2010
Certified for the first time:	January 1, 1995

H. Pierre Sallé
President
KEMA-Registered Quality

The method of operation for quality certification is defined in the KEMA General Terms And Conditions For Quality And Environmental Management Systems Certifications.
Integral publication of this certificate is allowed.

Experience you can trust.

KEMA-Registered Quality, Inc.
4377 County Line Road
Chalfont, PA 18914
Ph: (215)997-4519
Fax: (215)997-3809

Accredited By:
ANAB