

User Guide

# Megger Pinpointer MPP2000

**HIGH VOLTAGE EQUIPMENT**  
Read this entire manual before operating.

**Megger**®

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Megger MPP2000

Megger MPP2000 - Main

Setup Help

EM Level 1 0.00

EM Level 2 0.00

Acoustic Level 0.13

Time Delay 16.63 ms

Distance to Fault

Filter Off

Probe: ON

EM DETECTED

HOME

EM GAIN

ACOUS GAIN

Speaker icon

Directional keypad (up, down, left, right)

Settings icon

Memory icon

Green power button

**MPP2000**

**Megger Pinpoint Fault Locator**

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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.

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## **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. 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.

Low-energy exposure to high voltage may be harmless, such as the spark produced in a dry climate when touching a doorknob after walking across a carpeted floor.

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## ***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 is likely, 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.

## ***Introduction***

Thank you for purchasing the MPP2000 Pinpointer from Megger. This unit enables you to accurately and safely pin-point the location of faults on underground cables, using acoustic, electromagnetic and time difference methods.

The supplied probe/ground microphone used with the MPP2000 receiver detects and amplifies the acoustic emissions from a flashover at the point of fault, allowing the operator to actually “hear” the flashover. Typically this flashover is created by a surge generator (thumper).

The MPP2000 also detect the electromagnetic signals emitted by the flashover at the point of fault. The time difference between these two signals (acoustic & electromagnetic) are displayed in milliseconds with a graphical representation of the time between the two signals.

The MPP2000 provides a graphical display representing the relative distance to the fault.

Direction to the fault can also be determined measuring the relative strengths of the Electromagnetic fields.

This manual will list the specifications as well as the instructions on how to use the Megger MPP2000 Pin Point Locator.

If you find any discrepancies in the MPP2000 or have any comments please send them to Megger via fax, e-mail or phone.

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For more information please visit our web site at: [www.megger.com](http://www.megger.com)

# 1

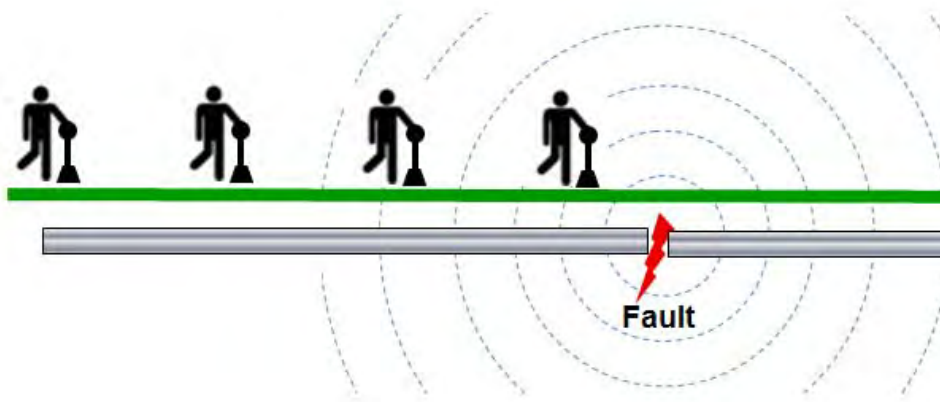
## SPECIFICATIONS

### OVERVIEW

The Megger MPP2000 pinpoints the location of faults in buried cables detected via a ground microphone. The receiver is housed in a robust lightweight, compact housing that can easily be carried “hands free” using the adjustable neck strap.

The ground microphone detects both the acoustic and electromagnetic pulses emitted from the flashover generated at the point of fault by a surge generator (thumper). These pulses are amplified and analyzed by the MPP2000 receiver.

The MPP2000 is suitable for use with any Megger PFL Power Cable Fault Locating system/surge generator (thumper) or similar equipment from other manufacturers.



The MPP2000 Pinpointer provides:-

- Detects and indicates the presence of both Electromagnetic and Acoustic signals.
- Displays the relative strengths of the Electromagnetic and Acoustic signals.

- Calculates and displays the “time difference” between the Electromagnetic and Acoustic signals.
- Calculates and displays the “relative distance” to fault.
- Displays Electromagnetic signal strength on two planes i.e. direction to the cable fault and alignment to the position of the cable.
- Clear, Concise and informative large backlit Display.
- Lightweight, rugged, ergonomic, field proven case.
- Background noise suppression using selectable filter band pass filters.
- Integrated loudspeaker, with volume control.
- Extremely lightweight Probe/Ground Microphone.
- Integrated noise protective collar on probe/ground microphone.
- Lightweight comfortable “neck” headphones.
- Small compact carry case suitable for storage and carrying of the complete system.

## ***Detailed Specifications***

<b>Modes</b>	Electromagnetic ; Acoustic ; Time Delay Distance to Fault (Relative)
<b>Range:</b>	0 – 99.9 mS, 0.1 mS resolution
<b>Electromagnetic Gain Adjustment:</b>	Manual >100dB
<b>Acoustic Gain Adjustment:</b>	Manual > 100dB
<b>Acoustic Pass Bands (Selectable):</b>	120Hz-800Hz BP 120Hz-1.8kHz HPF 260Hz-1.8kHz HPF : 500Hz-1.8kHz HPF
<b>Acoustic Pickup:</b>	Ground Microphone
<b>Volume:</b>	External Speaker
<b>Inputs:</b>	1 for EM/Acoustic pickup
<b>Output:</b>	1 jack for Stereo Headphones

<b>Enclosure:</b>	Weatherproof to IP54 Rubber armored case Self-contained protective cover (lid)
<b>Display:</b>	3.5" Color TFT LCD
<b>Power:</b>	8, AA alkaline cells
<b>Battery Life:</b>	≥ 24 hours with alkaline batteries, continuous use ≥ 30 hours with lithium batteries, continuous use > 150 hours, intermittent use
<b>Interface</b>	USB
<b>International Standards</b>	EN50081-1, EN50081-2 and EN50082-1 Meets IEC Requirements IEC61010

## ***Environmental***

<b>Operating Temp</b>	-20 to 50° C / -4 to 122 °F
<b>Storage Temperature</b>	-30 to 55° C / -22 to 131°F
<b>Humidity</b>	Up to 96% RH non-condensing (operating)

## ***Dimensions & Weights***

<b>Height</b>	Receiver: 78mm / 3.2 inch Probe/Microphone : 17.8cm / 7 inch (highest point) Carry Handle : 60cm / 24 inch
<b>Width</b>	Receiver: 203mm / 8 inch Probe/Microphone : 14.6cm / 5.75 inch (widest point)
<b>Depth</b>	Receiver: 148mm / 5.7 inch Probe/Microphone : 14.6cm / 5.75 inch (widest point)
<b>Weight (Total)</b>	Receiver: 0.98 kgs / 2.2lbs Probe/Microphone : 1.6kgs 3.5lbs

## ***Accessories***

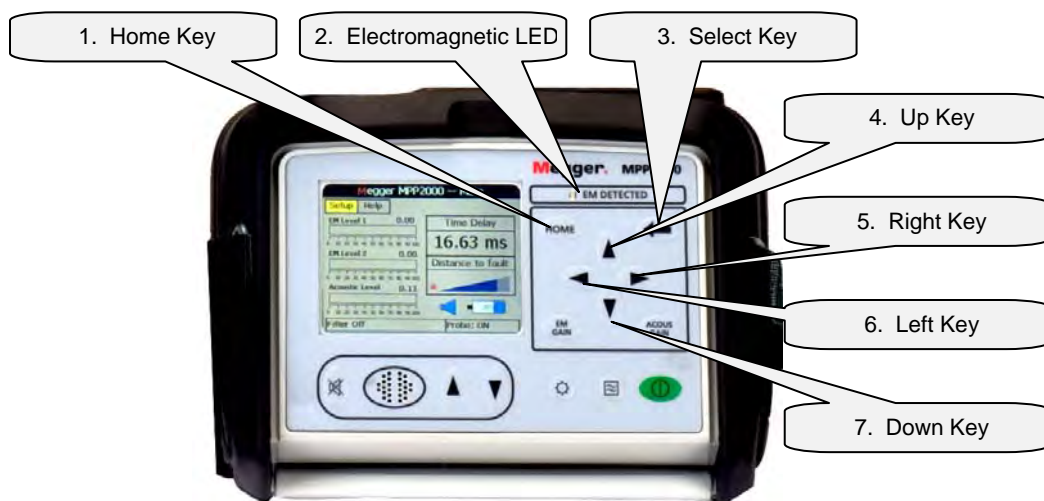
### **Standard (supplied with instrument)**

<b>Receiver</b>	Electromagnetic and Acoustic Receiver	MPP2000:
<b>Carry Strap</b>	Neck strap for carrying MPP2000 receiver	6220-780
<b>Headphones</b>	Behind-the-Head Headphones	90003-250
<b>Ground Microphone</b>	Lightweight Ground Microphone with Integral Wind Protection Collar. Complete with handle and connection cable	1001-809
<b>Batteries</b>	AA Batteries (8)	23415
<b>Manual</b>	MPP2000 User Guide	AVTMMPP2000-EN

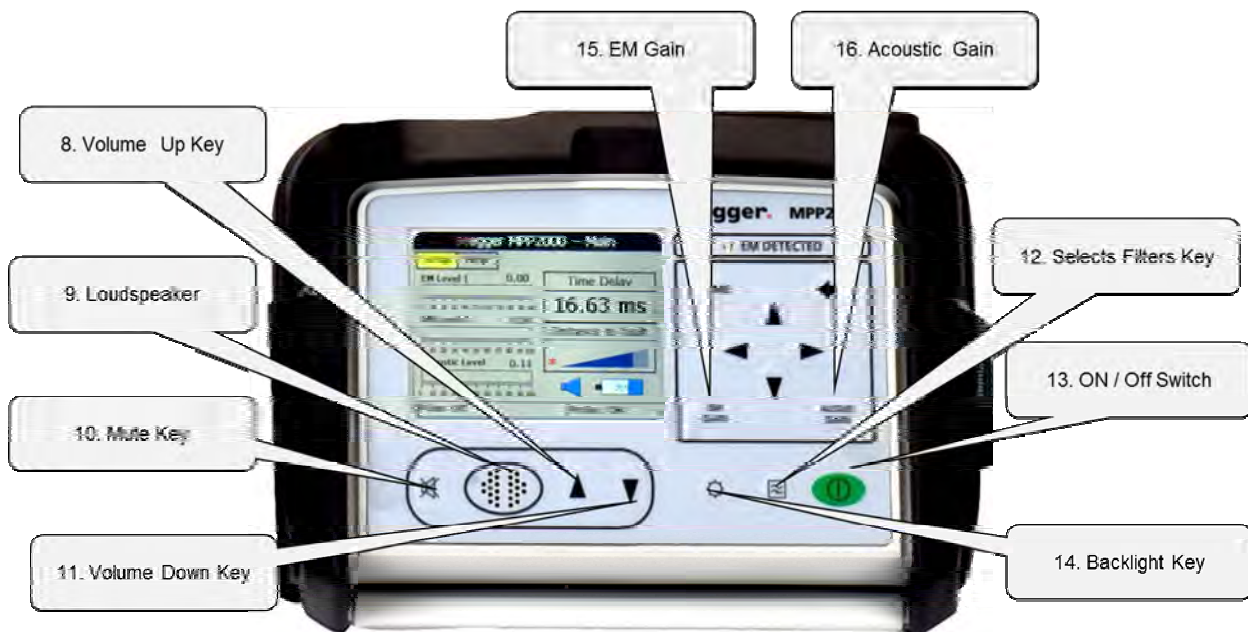
# 2

## GETTING TO KNOW YOUR MPP2000

### Controls

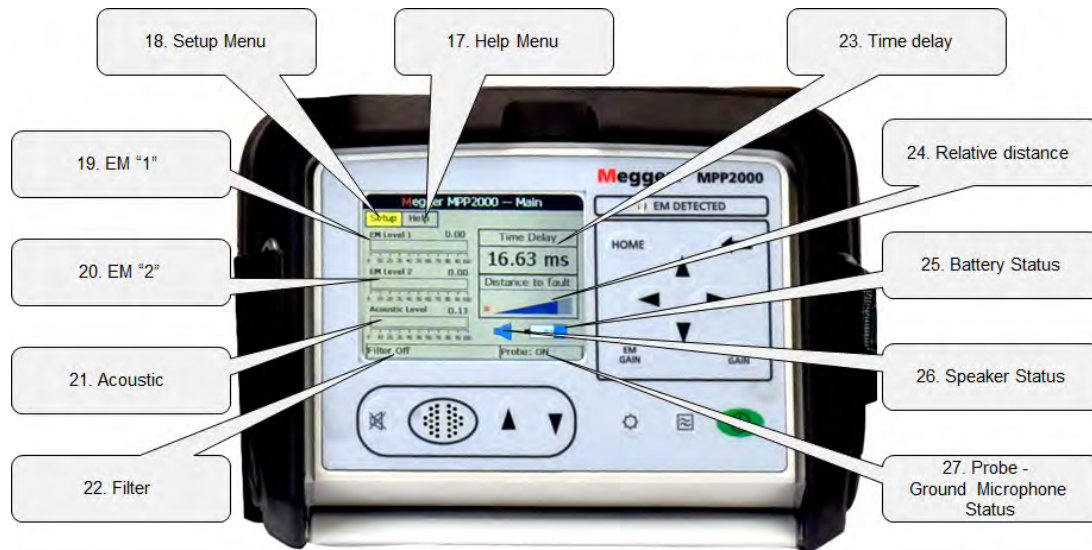


- |   |                            |   |
|---|----------------------------|---|
| 1 | <b>Home</b>                | Takes the operator back to “Home” screen.   |
| 2 | <b>Electromagnetic LED</b> | When illuminated shows the presence of Electromagnetic Signal                       |
| 3 | <b>Select Key</b>          | Allows the operator to select functions when in sub-menus                           |
| 4 | <b>Up Key</b>              | Allows the operator to increase values when in sub-menus                            |
| 5 | <b>Right Key</b>           | Allows the operator to step-through functions and increase values when in sub-menus |
| 6 | <b>Left Key</b>            | Allows the operator to decrease values when in sub-menus                            |
| 7 | <b>Down Key</b>            | Allows the operator to step-through functions and decrease values when in sub-menus |



- |                             |   |
|-----------------------------|---|
| <b>8 Volume Up Key</b>      | Increases Loudspeaker volume  |
| <b>9 Loudspeaker</b>        | Instrument Loudspeaker. Allows operator to hear the acoustic signals without the use of the headphones. |
| <b>10 Mute Key</b>          | Allows the operator to Mute the loudspeaker   |
| <b>11 Volume Down Key</b>   | Reduces the loudspeaker volume  |
| <b>12 Filter Select Key</b> | Allows the operator to select filters on or filters off   |
| <b>13 ON / OFF</b>          | When depressed turns the MPP200 ON or OFF   |
| <b>14 Backlight Key</b>     | Toggles between backlight-on or backlight-off   |
| <b>15 EM Gain Key</b>       | Access the EM Gain sub-menu   |
| <b>16 Acoustic Gain Key</b> | Access the Acoustic Gain sub-menu   |





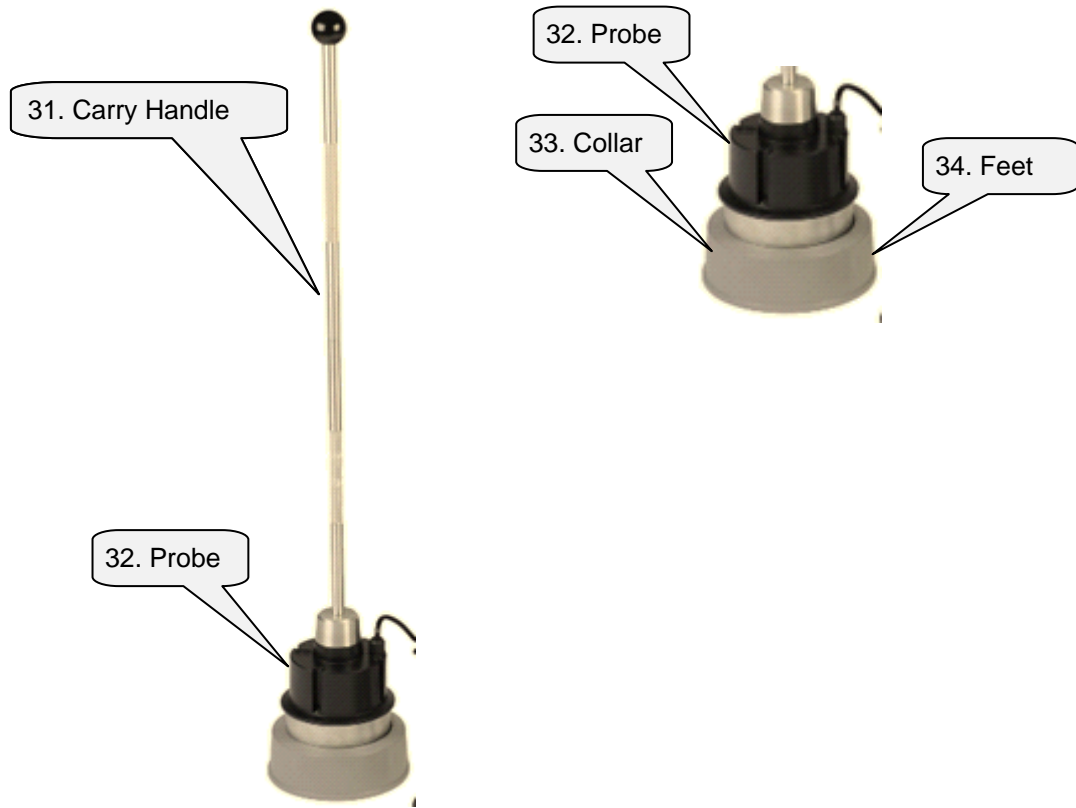
- |   |  |
|---|--|
| <b>17 Help</b>                                    | Access the help screens  |
| <b>18 Setup</b>                                   | When highlighted allows the operator to access the setup sub-menu.   |
| <b>19 E.M. "1"</b>                                | Displays the strength of electromagnetic signal "1"  |
| <b>20 E.M. "2"</b>                                | Displays the strength of electromagnetic signal "2" i.e. Alignment to Cable  |
| <b>21 Acoustic</b>                                | Indicates the strength of the acoustic signal  |
| <b>22 Filter</b>                                  | Indicates to the operator whether filters are ON or OFF, as well as the selected band of frequencies if turned ON. |
| <b>23 Time Delay</b>                              | Shows the time delay between the electromagnetic and acoustic signals.   |
| <b>24 Relative Distance</b>                       | Displays the "Relative" distance to fault.   |
| <b>25 Battery Status</b>                          | Indicates the status of the battery by showing percentage remaining  |
| <b>26 Speaker Status (ON/OFF)</b>                 | Shows whether the speaker is turned-on or turned-off   |
| <b>27 Probe Ground Microphone Status (ON/OFF)</b> | Indicates if the probe is active or inactive. When the unit is lifted from the ground the probe becomes inactive.  |

## ***Rear of Instrument***



- |                            |   |
|----------------------------|---|
| <b>28 Probe Socket</b>     | Receptacle for Probe/Ground Microphone connection cable |
| <b>29 Headphone Socket</b> | Headphone Socket  |
| <b>30 USB Socket</b>       | USB Socket. Can be used to upgrade software.            |

**Probe / Ground Microphone**



- |                        |  |
|------------------------|--|
| <b>31 Carry Handle</b> | Two piece carry handle   |
| <b>32 Probe</b>        | Lightweight Probe or Ground Microphone                         |
| <b>33 Collar</b>       | Noise deadening collar. Helps remove external noise like wind. |
| <b>34 Feet</b>         | Three stabilizing feet   |

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# 3

## PREPARING THE UNIT FOR OPERATION

This section will describe in a step by step manner how to prepare the received MPP ready for operation..

### ***Battery Installation***

The MPP2000 requires 8 AA batteries. If the unit is used in areas with temperatures in the range of 0°C to +50°C then Energizer E2 AA batteries are recommended. For areas with temperatures outside this range, Lithium AA batteries are recommended.

1. Remove the battery cover, by removing screw on battery compartment lid.



2. Insert 8 x AA batteries as shown. Then re-install the battery cover.



## ***Assembling the Ground Microphone***

This section of the manual will describe how to assemble the probe/ground microphone assembly and make all the necessary interconnections..

1. Screw the two sections of the carrying handle together
2. Insert the carry handle into the top housing of the probe/ground microphone.
3. Optional: When required remove the screw from the base of the probe/ground microphone and screw in the optional spike.

### **Connections**

At the rear of the MPP2000 receiver there are two connectors / receptacles



4. Connect the probe/ground microphone connection cable to the 8-way circular connector.
5. Plug the headphone into the headphone jack.

### **Special attention on use of the Probe/Ground Microphone**

The probe/ground microphone of the MPP2000 has a special feature provided to enhance operator comfort. .

When the probe/ground microphone is lifted off the ground the movement lifts the top of the probe/ground microphone allowing light to be detected by a light sensor. Once detected the probe/ground microphone is effectively switched off and no signals will be amplified by the receiver. This means that the operator will not be subjected to spurious annoying noises picked up by the probe/ground microphone when it is lifted and being moved from position to position. The status of the probe is indicated on the MPP2000's display in the bottom right-hand corner.

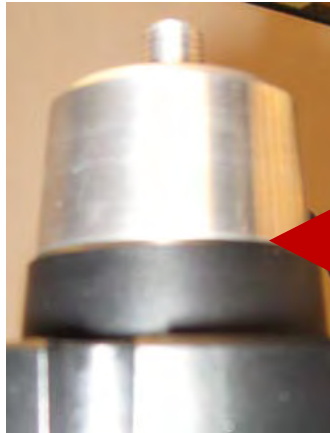
**Probe : OFF**



When the probe/ground microphone is placed on the ground the top of the probe/ground microphone drops and shuts out any light from being detected by the light sensor. At this stage the probe/ground microphone and associated receiver circuitry will be active, and all parameters will be displayed on the MPP2000 LCD.

For operator convenience this feature can be seen in the bottom right-hand corner of the MPP2000.

**Probe : ON**



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# 4

## OPERATION OF THE MPP2000

### To Turn-On the unit

To turn-on the unit depress the green ON/OFF button (item 13)



The Red Electromagnetic LED will flash and then extinguish (item 2)



The MPP2000 operating screen will be displayed.



### To Access the Settings Menu

(Some items may differ dependent on software version)

Press the Select Key (item 3)



The operator will now have access to the Settings Menu



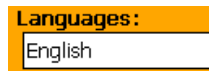
Using the Up/down Right/Left Keys highlight the parameter to be change/set (items 4,5,6,7)



Once selected the parameter can be changed by using the Select Key (item 3)



Language once highlighted toggle to required language.



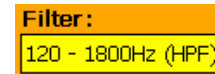
To exit press Home Key (item 1)



To select idle/shut-down time select Auto off and the operator can select from shut-down times from 10 to 60mins.



The operator is able to select from 1 x Acoustic (BPF) and 3 x High-pass filters (HPF), or turning the filter off. The filter function is used to help cancel environmental/traffic noise conditions.



Here the operator is to able to turn the speaker on or off, this is in addition to the Mute Key (item 8) on the top panel



Allows the operator to select their preference of having the measurements shown in “feet” or “metric”



To exit the settings menu press the Home Key (item 1)

After a period of inactivity the unit will default back to the main operating screen.

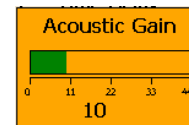


## To Access the Acoustic & EM Gain settings

To access the “Acoustic” gain menu press Acoustic Gain Key (item 16)



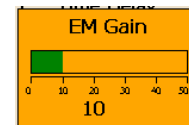
Once the Acoustic gain sub-menu is displayed the amount of gain applied to the received signal can be adjusted using the UP/DOWN or Right/Left arrow keys



To access the “Electromagnetic gain menu press EM Gain Key (item 15)

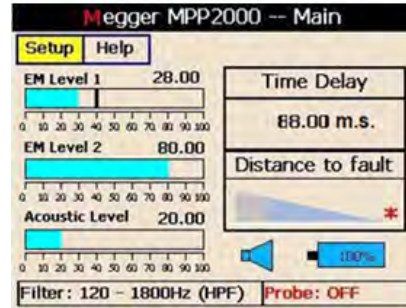


Once the Electromagnetic gain sub-menu is displayed the amount of gain applied to the received signal can be adjusted using the Up/Down or Right/Left arrow keys



## Pinpoint Fault location

The MPP2000 detects and indicates the presence and strength of both Electromagnetic and Acoustic signals, emitted from a flashover, created by a surge generator (thumper), at the point of fault.



From these signals it will calculate and display the “time difference” between the Electromagnetic and Acoustic signals and “relative distance” to the fault.

By utilizing the two Electromagnetic signals it is able to advise the direction to the fault and also the operators’ alignment to the cable route.

1. Assemble the Ground Microphone probe and attach it to the MPP2000 receiver as previously described.
2. Place MPP2000 around neck, using the supplied neck-strap.
3. Press the Power ON button. The display should illuminate and the EM Detected LED should be blinking in approximately ½ sec. intervals. This is an indication that the unit is alive and powering up. Power up time is approximately 20-secs.
4. Stand over the cable and place the Probe on the approximate cable line.
5. Rotate the arrow on the Probe cap parallel to the cable path. (see application note appendix).
6. Ensure that a repetitive HV surge (thump) is being applied to the cable under test.

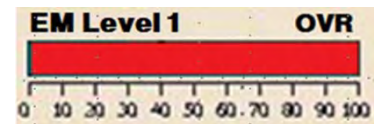
*Note: Please remember the strength of the flashover (thump) is dependent on the amount of energy (Joule). Hence use the most appropriate voltage range, which may not be the highest, that will give you the most energy (Joules)*

7. Ensure that the EM LED is blinking, this indicates the presence of an EM signal. The EM LED should blink at the same rate as the output of the HV surge.. If not check that the surge generator is actually surging/thumping into the cable.

*Note: If the EM LED stays on, this indicates that the EM level is too high, and needs to be reduced using the EM Gain control.*

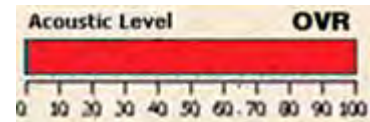
8. Once an EM signal has been detected, as indicated by the regular blinking of the EM LED, adjust the EM gain to obtain an optimum level on the EM1 signal strength bargraph, typically 50%.

*Note: If the EM gain is too high the following will be displayed, indicating that the signal being detected is "Over Range". The gain needs to be reduced using the EM Gain control to obtain an optimum level of approx. 50%*



9. Observe the EM2 level, this should be approximately 1/2 or 1/3 of EM1's Level, when the operator is aligned to the route of the cable. Observe the same warning as for EM1.
10. When an Acoustic level is detected this is displayed on the Acoustic level bargraph, you should strive for maximum strength at this stage. As a guide the previous strength level is shown so a strength comparison can be made. i.e. is the signal stronger or weaker than the one previously displayed. This advises the operator whether he/she is getting closer or further away from the fault.

*Note: If the Acoustic GM gain is too high the following will be displayed, indicating that the acoustic signal being detected is "Over Range". The gain needs to be reduced using the Acoustic Gain control to obtain an optimum level of approx. 50%.*



11. Once Acoustic and Electromagnetic signals are received the MPP2000 will indicate the Time Difference, between the two signals in milliseconds, and the "relative" distance to the fault.
12. The objective is to get both these figures to a minimum or as near zero as possible. When this is achieved the operator is above the actual fault.
13. Adjust the EM Gain where EM1 is at its maximum and EM2 is at its minimum. This indicates that the operator is facing the direction of the fault and is aligned to the cable under test

# 5

## TROUBLESHOOTING

This section of the manual shall describe some possible problems, there causes and fixes.

Description	Cause	Correction
Unit will not turn on.	Dead Batteries	Replace AA Batteries in MPP2000
No Sound from Headphones	MUTE button ON	Depress MUTE button on MPP2000
No Sound from Optional Noise Cancelling Headphones	AAA Batteries dead	Replace AAA Batteries
EM1 Level and EM2 Level Bar graphs not moving	Probe not over or too far away from cable line EM gain is set too low Faulty Probe	Make sure Probe is on or near the cable line Turn up the EM gain Replace Probe
No Acoustic sound or level	Fault is not in range Acoustic gain set too low	Move closer to suspected fault Turn up acoustic gain
Inconsistent Acoustic Reading	Probe not flat on surface	Use Spike on Bottom of Probe
Can't hear fault due to background noise	Environmental or traffic noise	Turn on the BPF or HPF filters whichever gives the best results

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# 6

## SPARE PARTS

This section of the manual lists the parts numbers for all the accessories for the MPP2000. All parts and accessories except the AA batteries need to be purchased through Megger.



Description	Part Number
Pin-Pointer	MPP2000
Strap for Unit	6220-780
Probe/Ground Microphone Complete	P1001-809
Headphones	90003-250.
AA Batteries	23415
Unit Carrying Case	2002-119
MPP2000 Manual	AVTMMPP2000-EN

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# Megger Quality System Certificate



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
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**EMC TEST REPORT**

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**Manufacturer:** Megger  
2621 Van Buren Avenue  
Norristown, Pennsylvania 19403

**Product:** MPP2000 Pin Pointer

**Model:** MPP2000

**Testing Commenced:** Nov. 3, 2011

**Testing Ended:** Nov. 3, 2011

**Summary of Test Results:** Page 3

**Directive:** EMC Directive (2004/108/EC)

**Deviations (if applicable):** N/A

**Standards:**

- ❖ EN 61326-1:2006 - Electrical Equipment for measurement, control and laboratory use – EMC Requirements - Part 1: General requirements
  - EN 61000-4-3:2006, inc. A2:2010 - Electromagnetic Compatibility-Part 4: Testing and measurement techniques – Section 3: Radiated, radio-frequency, electromagnetic field immunity test
  - EN 55011:2009, inc. A1:2010 - Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio frequency equipment

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# Appendix

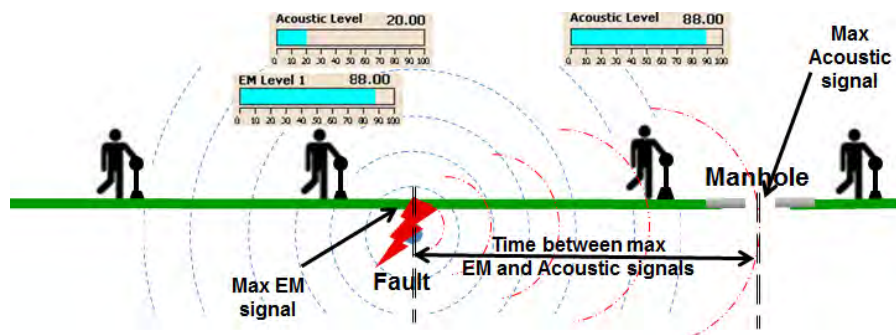
## *Applications Note*

Megger.

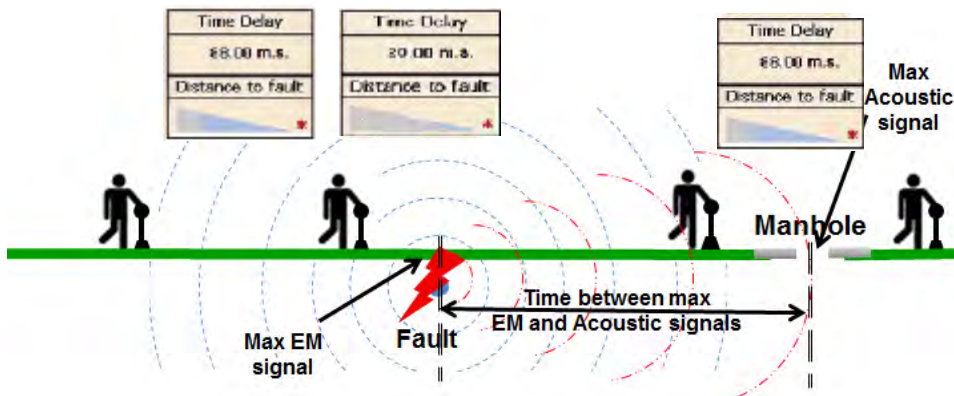
## Application

The MPP2000 pinpoints faults while the cable is being surged by a surge generator, or “thumper.” To detect these signals a probe / ground microphone is used.

Where cable fault is in a duct or conduit, the loudest acoustic emission will be detected either at the conduit end or the conduit's actual breaking location. When pinpointing over pavement, the loudest sound may be at a crack, seam or end of a pipe, trunking or conduit. In these situations the sound can travel in several directions (away from the actual fault position), here the MPP2000 becomes especially useful.



The receiver displays the time delay between the electromagnetic surge and acoustic event. As the detector is moved closer to the fault, the acoustic signal strength increases while the time difference between surge and acoustic emission decreases. When directly over the fault, the time difference is at a minimum and the acoustic level is at a maximum. .



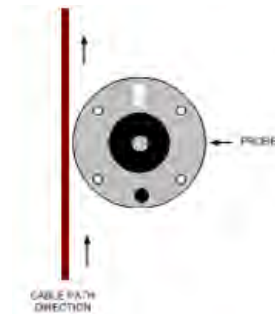
The receiver's display also provides the level of the electromagnetic surge, a measurement of the volume of the acoustic emission, and the time difference between the two events.

## Test Scenarios

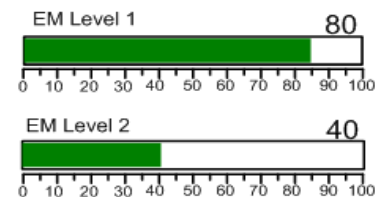
### Finding and staying on the cable route

The user normally has a general idea of the cable route with respect to the point where the connections to the cable are made, even if the location of the fault is unknown.

1. Place the MPP2000 Probe/Ground microphone on the ground approximately 10-15meters (33 – 49 feet) away from the surge generator (thumper). This avoids the signals generated by surge generator (thumper) swamping the amplifiers of the MPP2000.
2. The probe/ground microphone should be set on the ground with the direction arrow on the top of the cap pointing in the direction of and parallel to the cable route.
3. The operator then needs to Increase the EM Gain to approximately 25dB.



- a) If the user is parallel and nearly on top of the cable line, the user should see something similar to the picture shown.
- b) The relative signal levels of EM Level 1 and EM Level 2 indicate that the MPP2000 probe is perfectly aligned to the cable path.
- c) The user should adjust the EM Gain where EM Level 1's signal level is maximum and EM Level 2's signal level is minimum.



Generally, EM Level 2's signal level should be  $\frac{1}{2}$  or less that of EM Level 1's.

The relative signal levels between EM1 and EM2 should remain fairly consistent IF the user remains on the cable path.

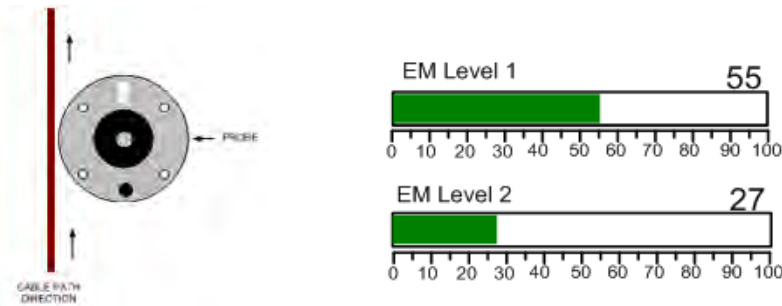
The user should adjust the EM Gain such that the bar graphs stay in the higher  $\frac{1}{4}$  of the quadrant. However, very weak EM signals with maximum EM Gain may only register in the first quadrant.

**NOTE:** Care must be taken not to adjust the EM Gain where it saturates the electronics. If both EM1 and EM2 signal level bar graphs are both at maximum, turn the EM Gain down until the levels fall into the upper  $\frac{1}{4}$  of the quadrant.

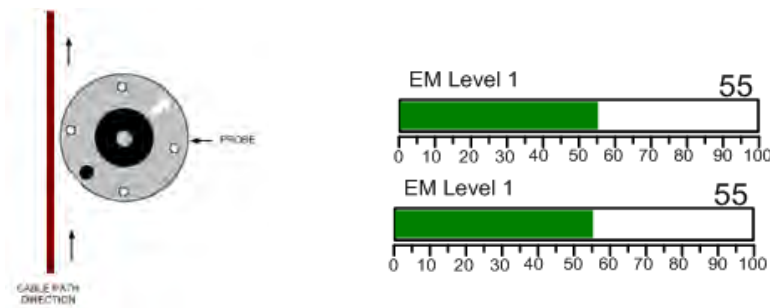
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## How do I know I am straying off the cable path?

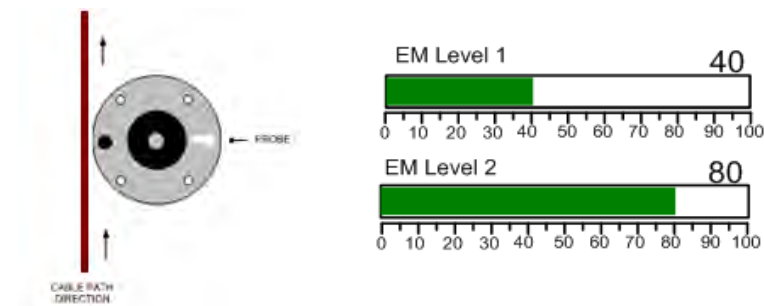
1. If the direction arrow on the MPP2000 Probe cap is moving at right angles to the cable path, the user should see a proportional decrease in EM 1 and EM 2's signal levels.



2. If the directional arrow on the MPP2000 Probe cap is moving at 45° angles to the cable path, both EM 1 and EM 2 signal levels will be near equal.



3. If the directional arrow on the MPP2000 Probe cap is moving at 90° angles or perpendicular to the cable path, EM 2's signal level will be 2x or more that of EM 1's signal levels. As the user continues to walk perpendicular to the cable path, the signals will continue to grow much weaker.



**Megger.**