i5000™ Utility Locating System with Sheath Fault Locating Option

OPERATIONS MANUAL

VIVAX METROTECH

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ISO 9001 CERTIFIED

Metrotech has received ISO 9001:2000 Quality Management System Certification.

Metrotech adheres to the quality standard guidelines of ISO 9001:2000 and ensures quality in its design/development, production, installation, and servicing disciplines.

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1 INTRODUCTION

The Metrotech i5000^{TM} Utility Locator with Sheath Fault Locating (SFL) option is designed to detect and pinpoint sheath and other conductor faults that are in direct contact with the earth.

The i5000 SFL-2 offers these unique features:

- **Fault level measurement at the transmitter**
- **Simultaneous fault finding and line tracing**
- **LCD bar graph representing the A-Frame signal strength for judging the proximity to faults, comparing multiple faults, and detecting pinholes and "trees" in a power cable**
- **Detection of low and high resistance faults**
- **Automatic battery checking and low battery warning**
- **Non-polarized A-Frame**
- **Single-handed operation. No need to carry an i5000 receiver as well as an A-frame during fault locating**
- **Active SFL ohmmeter and voltmeter in the Transmitter**

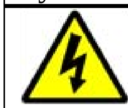
Operation of the unit is completely automatic. No operator adjustments are required. Both the Transmitter and Receiver are water resistant and built to withstand the rigors of field use.

2 GENERAL INFORMATION AND SAFETY

This manual contains basic advice for the installation and operation of Metrotech Utility Line and Sheath Fault Locators as well as accompanying accessories. The manufacturer is not liable for damage to material or humans due to non-observance of the instructions and safety advice provided in this manual. Therefore, this manual should be provided and reviewed by all personnel associated with the line and sheath fault locating equipment.

Symbols used in this manual

Important instructions concerning the protection of staff and equipment as well as technical safety within this document are labeled with one of the following symbols:

Symbol	Description
 WARNING	Indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury.
 CAUTION	Indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury or material damage.
	Notes have important information and useful tips on the operation of your equipment. Non-observance may result in incorrect measurement results.

Operating personnel

Metrotech utility line and sheath fault locators are intended for use by utility and contractor professionals.

Repair and maintenance

Repairs and service must only be done by Metrotech Corporation or authorized service departments of Metrotech Corporation.

2.1 SAFETY PRECAUTIONS

Observed safety practices

Familiarize yourself with all required safety practices of the local utility company, or other owner of the plant before entering an access area, or connecting a Metrotech transmitter.

Ensure that the line is de-energized and out of service, BEFORE connecting the transmitter directly to any conductor. NEVER make a direct connection to a live power cable.

Follow the appropriate safety procedures to avoid the risk of injury if using a clamp on energized electrical or control lines.

Pay special attention when using a locator in high traffic areas.

Intended application

Safe operation is only realized when using the equipment for its intended purpose. Using the equipment for other purposes may lead to human danger and equipment damage.

The limits described under the technical data section may not be exceeded.

Fire fighting in electrical installations:
Recommended extinguishing agent: carbon dioxide (CO_2)
Carbon dioxide is electrically non conductive and does not leave residue. It is safe to use in energized facilities as long as the minimum distances are observed.
It is essential to observe the safety instruction on the extinguishing agent.

WARNING

Dangers when operating with High Voltage (HV):
Special safety attention is needed when operating HV facilities, especially non-stationary equipment. The regulations VDE 0104 about setting up and operation of electric test equipment, i.e. the corresponding EN 50191 as well as country-specific regulations and standards must be observed.
Safety installations may not be by-passed nor deactivated.
Operation requires a minimum two people whereas the second person must be able to activate the emergency switch in case of danger.
To avoid hazardous electric charges of metallic parts in the vicinity, all metallic parts must be grounded.
To avoid drawing dangerous arcs, switching should only be done in a de-energized condition.
The equipment and all accessories must be connected according to applicable standards VDE, EN or DIN as well as country-specific regulations.

3 i5000 SFL-2 SHEATH FAULT LOCATOR QUICK START GUIDE FOR THE EXPERIENCED USER

1 Check Batteries Prior to Departing for the Field

Check the battery level in the Transmitter, Receiver, and A-Frame by powering up each instrument.

Maximum use of the Transmitter's **SFL** feature requires that the battery be fully-charged prior to field use. Metrotech recommends charging the battery to full capacity before locating faults.

Replace/recharge if necessary. Turn the instruments OFF.

2 Ensure All Conductors Are De-Energized

3 Lift Grounds

Lift Grounds (of all conductors in the circuit) at both ends of the faulted cable section.

WARNING

When the transmitter **SFL** is ON, the external OUTPUT JACK produces a high voltage. **Do not touch the jack! Electrical shock will result!**

4 Attach Transmitter to Conductor – Check Fault Resistance

1. Make sure transmitter is powered **OFF**.
2. Plug **Black** and **Red** conductive leads into the transmitter.
3. Stretch the **Black**-lead 180° away from conductor.
4. Push the ground rod into earth and clamp the **Black** lead to ground rod. Establish the best ground possible**. See Figure 3-1**

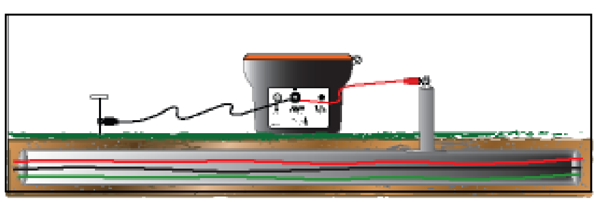


Figure 3-1: Clamping Black Lead to Ground Rod; Clamping Red Lead to Conductor

5. Clamp **Red** lead to target conductor sheath. See Figure 3-1

6. Push transmitter **SFL** key. Check measured fault resistance on transmitter display. **See Figure 3-2**

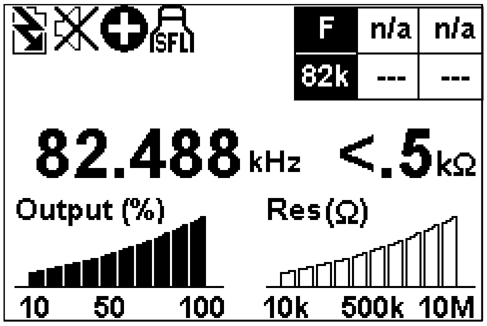


Figure 3-2: Transmitter display in SFL mode

Fault Severity Guide:

0-100 KΩ – Severe Fault

100 – 500 KΩ – Medium Fault

1 MΩ and above – Light Faults

7. Select frequency - 9.8KHz or 82KHz, pressing the ***f*** button on the Transmitter keypad.

5 Use the i5000 Utility Line Locator Receiver to Trace the Cable

Press the frequency softkey (**Freq**) on the receiver until the frequency selected on the transmitter is displayed. Trace and mark the cable as you proceed towards the fault.

6 Synchronize The A-Frame Receiver And Establish Reference Value Of Fault (A-Frame receiver has a one-color band above each spike (Black or White)

1. Hold the A-Frame Receiver so the spike with the **Black** band is about two (2) steps away from the ground rod and the spike with the white band is in-line with the targeted cable. The A-frame receiver **must be placed** as shown in **Figure 3-3** for synchronization and for unit to operate correctly. Push the A-Frame spikes firmly into the ground. Turn the A-Frame **ON.** Wait until the arrow flashes.

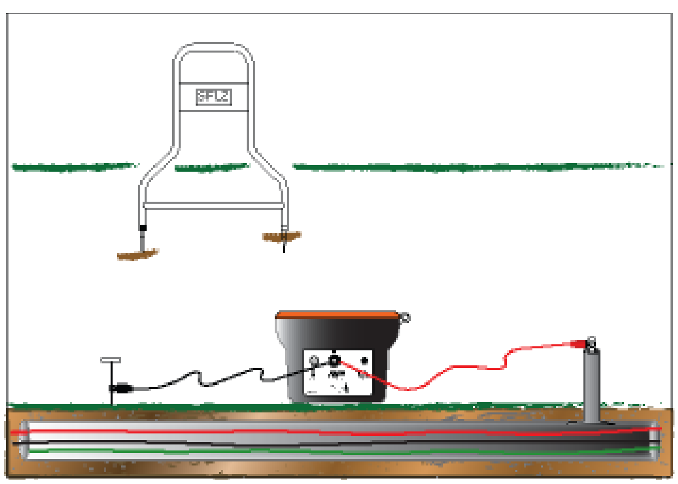


Figure 3-3: Positioning of A-Frame Receiver for Synchronization

2. Monitor bar-graph LCD display for arrow direction. If the arrow points AWAY from the ground rod, there is a fault.

3. If the arrow points TOWARDS the ground rod, there is no fault, and grounds and connections need to be rechecked.
4. The number of bars on the LCD indicates the potential gradient associated with the fault at the synchronization location.
5. The number of bars will decrease when you move away from the synchronization location and will increase when you get closer to the targeted fault. **See Figure 3-4**

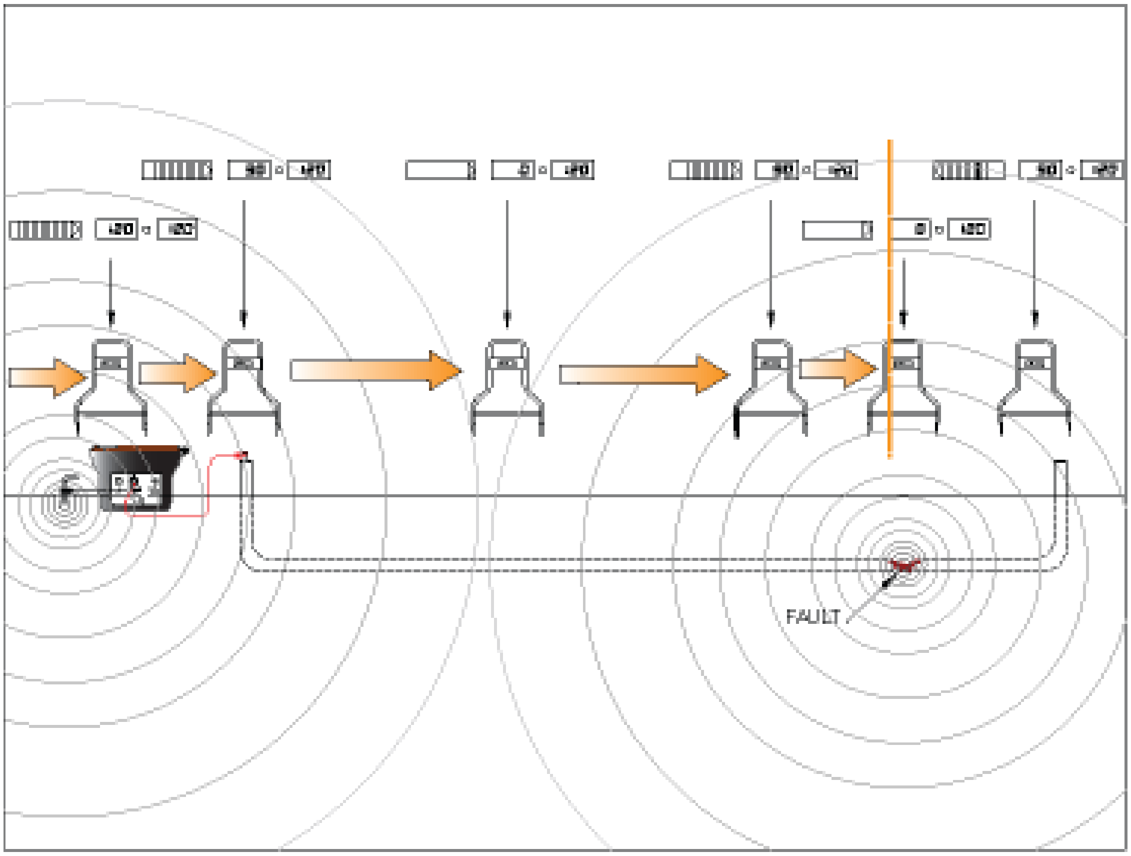


Figure 3-4 : Locating the Cable Fault with A-Frame Receiver

7 Pinpoint the Fault

1. Keep the A-Frame parallel to the target cable.
2. Insert the A-Frame firmly in the ground every 10’ – 20’ (3 -6 m). Follow the arrow.
3. When the arrow changes direction, the fault may have been reached or passed.

Look at the number of bars activated as well as the “Actual” LCD reading and compare them to number of bars you read at synchronization point as well as the “Reference” LCD reading. If the number of bars or the “Actual” and “Reference” readings are similar to the number of bars at synchronization point, you have located the main fault.

4. Backtrack.
5. Insert the A-Frame every 2’ (.5 m) until the arrow changes direction again.
6. Move the A-Frame across the cable until a slight movement causes the arrow to change direction. The fault is located at the center of the A-Frame.
7. Check entire cable for multiple faults. If more faults are present, check the “Active” LCD number at each fault site and compare it to the “Reference” number. The higher the “Active” number the larger the fault.

4 SFL-2 A-FRAME RECEIVER TECHNICAL SPECIFICATIONS

Metrotech offers two A-Frame models – logarithmic or linear. Selecting which model will depend upon the intended application.

4.1 LOG A-FRAMES FOR POWER UTILITIES:

Typically, operators looking for faults on power cables around 20 KΩ – 25 KΩ. The Log A-Frame is designed to have greater resolution within this range and therefore, able to differentiate the strength of several faults.

4.2 LINEAR A-FRAMES FOR TELECOM UTILITIES:

Telecom faults, however, are typically higher resistance faults than power. The Linear A-Frame provides greater sensitivity in the fault range of 100 KΩ – 10 MΩ to detect multiple faults in a cable.

4.3 TECHNICAL DATA

Frequency:	4.8 Hz Crystal Controlled
Input Sensitivity:	5 MV
Sensitivity Control:	Automatic
Active/Reference Signal Sensitivity	Logarithmic: 0 – 120 Linear: 0 – 999
Battery:	9 V NEDA 1604 or equivalent
Battery Life:	100 hr. continuous use
Battery Test:	Automatic at power ON for 3 sec.
Weight:	4.4 lb (2.0 kg)
Dimensions:	32” H x 22” W x 1” D (81 cm H x 56 cm W x 2.5 cm D)
Operational Temp:	-4° F – + 120° F (-20° C – + 50° C)

4.4 A-FRAME RECEIVER CONTROLS AND INDICATORS

See **Figure 4-1** for the location of the Receiver controls described below:

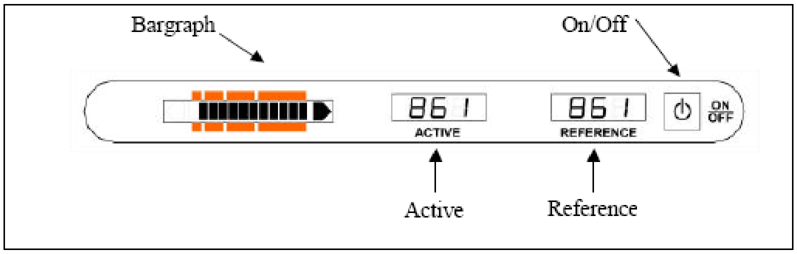
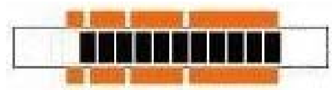


Figure 4-1: A-Frame Controls and Indicators

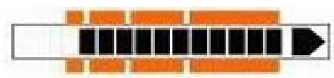
On/Off Button: Push and release to turn ON. Push and release to turn OFF.

LCD Bar Graph Display: The bar graph indicates three types of information:

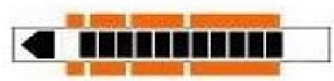
1 **Battery Status:** The solid bars indicate the battery level. If only one bar appears, replace the battery. The battery status is displayed for three (3) seconds at Power ON.



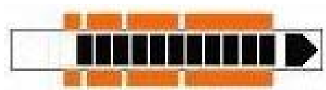
2 **Direction of Fault:** The flashing arrows will display the direction to the fault



or



3 **Magnitude of Fault** The bar graph consists of twelve (12) bars with each bar representing the magnitude of the fault(s) as described below.



Impedance (Ω)	Logarithmic Active/Reference	Linear Active/Reference	Bars
450	119	828	12
1K	118	694	11-12
5K	111	413	11
10K	104	302	10-11
20K	96	222	10
30K	91	182	10
50K	85	139	9-10
100K	77	90	8-9
327K	63	45	7-8
1M	50	21	6-7

4.5 ADDITIONAL A-FRAME RECEIVER FEATURES

4.5.1 Battery Access Plate

Located on the underside of Receiver control panel. Remove the two thumbscrews to release the plate. See Figure 9-1.

4.5.2 Conductive Pads

The A-Frame Receiver is shipped with two protective foam pads with large washers attached to the Receiver probes. These pads are used for tracing on dry, hard surfaces. Protect and save these conductive pads and washers.

5 PRINCIPLES OF OPERATION

5.1 FUNCTIONAL THEORY

Reviewing the basics of sheath fault locating is a valuable exercise before proceeding even for experienced users. This will improve the chances of finding the fault and saving time.

Comparing electrical current to water flowing through a pipe applies extremely well to fault locating. Just like trying to find a leak in a water pipe, you might seal off one end, pump water into the other, and look for water to appear near the leak. The principles of sheath fault locating are identical. The cable equivalent of sealing off the pipe is to lift all connections at both ends of the cable, creating a high resistance open condition. The "water" in this case is the current flowing through the cable towards the fault. We look for the current "leak" with an A-Frame.

Both ends of the cable must be disconnected from ground.

The SFL-activated transmitter applies a low frequency signal between an isolated conductor with an earth fault and another ground point. This 4.8 Hz signal is induced into the ground from the fault location. The A-Frame Receiver contact probes detect this signal pattern.

A typical hookup for locating a sheath fault, also called a shield-to-earth fault, is illustrated in **Figure 5-1**.

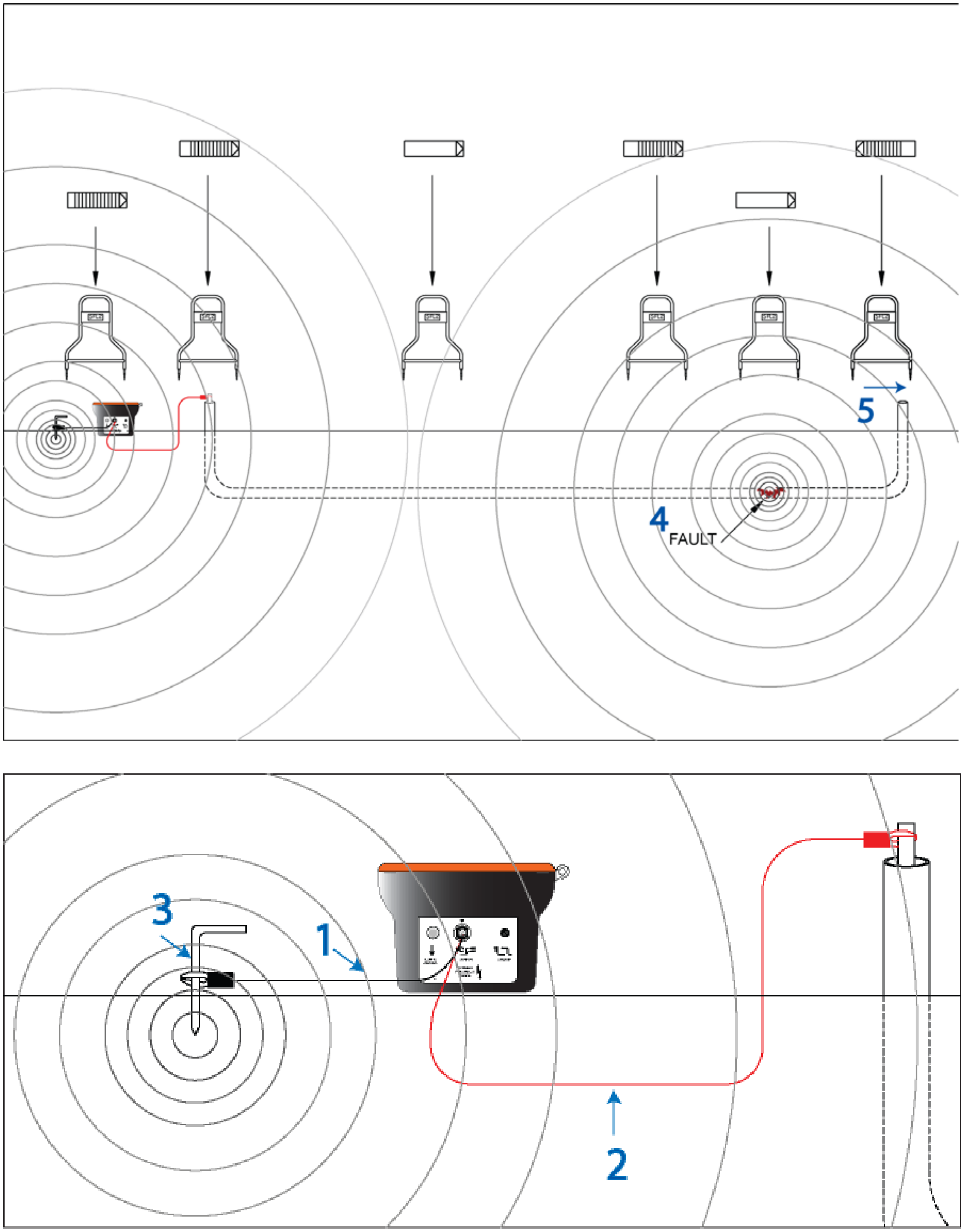


Figure 5-1: Typical SFL-2 Transmitter Connection

1. Black Lead
2. Red Lead
3. Ground Rod
4. Fault
5. Faulty conductor open on both ends

As current flows from the transmitter and through the fault, an earth voltage gradient field is created. Its center is at the fault. This gradient field has a pattern as depicted in **Figure 5-2**, like pond water ripples when you throw a rock in it or the rings of a tree stump.)

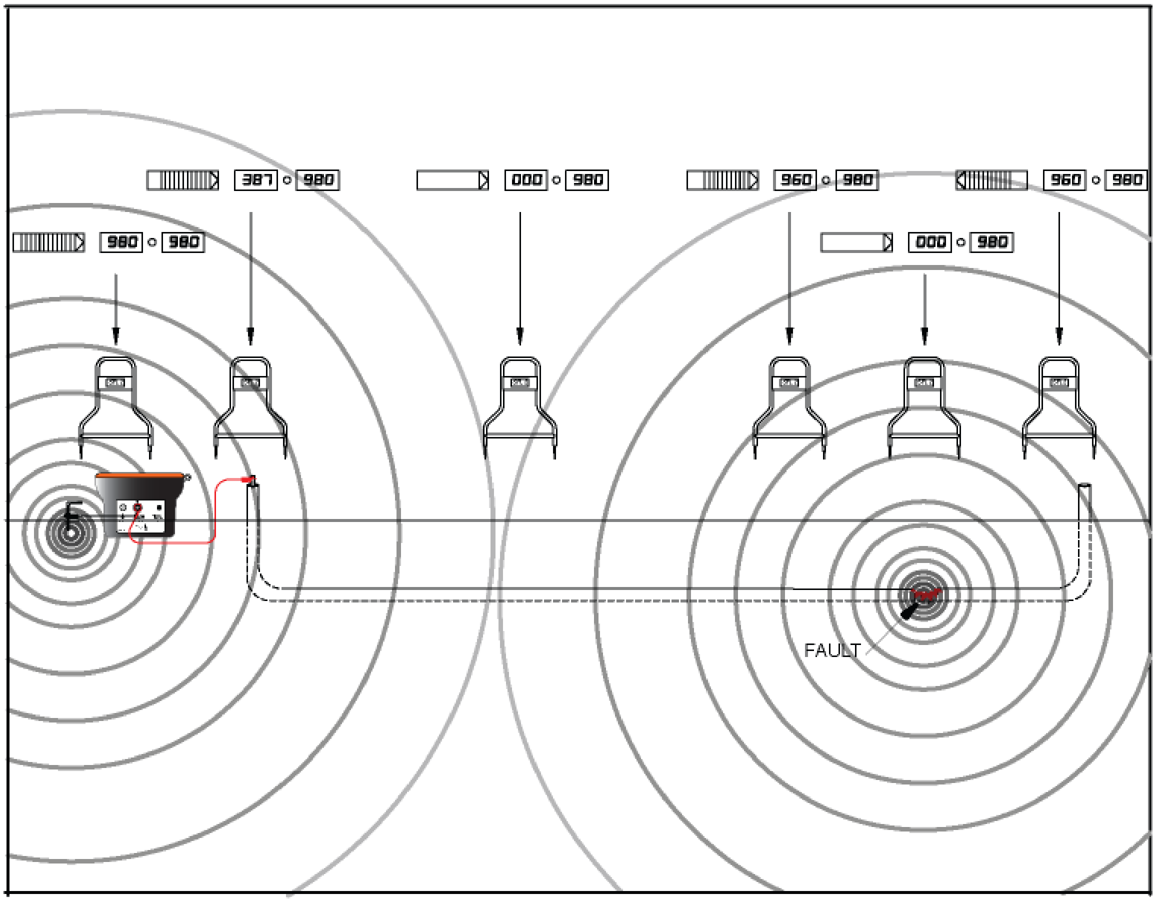


Figure 5-2: Signal Pattern Around Fault and Ground Point

The A-Frame Receiver compares the readings taken by the two probes and determines the direction and size of the fault. Directional blinking arrows guide the operator to the exact source of the fault. The A-Frame's bar graph and numerical active LCD display indicates the relative distance to the fault and it is size.

5.1.1 Earth Voltage Gradient

Note in **Figure 5-2** that the gradient pattern appears to be concentric circles near the fault. Properly interpreting this pattern is the key to successful operation of the i5000 SFL unit.

5.1.2 Equipotentials

The circles shown in **Figure 5-2** represent lines of equal voltage. The boxes show what the bar graph will display with the A-Frame in different positions. Thus, if the A-Frame were inserted so that both of the ground spikes were on the same circle, there would be no difference in voltage between them. The bar graph will show zero, the arrows will become erratic and the numerical active display will show a zero. One of these positions occurs when the fault is directly between the spikes.

This result can also occur midway between the ground spike and a fault and when the A-frame is exactly perpendicular to the fault. There is a return field around the transmitter ground spike. As you move toward the fault, the bars and the active numerical number will decrease until you reach the midpoint between the fault and ground spikes. At the half waypoint between the fault and ground spike, the signal strength is at it is absolute lowest. At this point the bar graph and active display will show zero and the arrows become erratic.

To determine if you are midway between faults or directly over a fault, move the A-Frame further from the transmitter and measure again. If the arrows tell you to continue in this direction, the zero point was a midpoint. If the arrows tell you to return toward the transmitter, the zero point was a fault. As you continue, they will increase until you reach the fault.

Nearly 70% of the signal exists within the last 1/3 of the distance between the ground spike and the fault. The amount of signal measured and displayed by the A-Frame is proportional to the number of field lines in **Figure 5-2** between the A-Frame spikes. Thus, the maximum signal point occurs when one A-Frame spike is directly above the fault.

By probing around the ground point, a user can learn what to expect at the fault from the A-Frame bar graph response. As shown in **Figure 5-2**, the signal pattern around the fault and ground point is identical (if there are no nearby conductors). This means that the A-Frame will react the same way around the fault as at the ground point.

As you move toward the fault, the bars and the active numerical display will decrease until you reach the midpoint between the fault and ground spike. As you continue, they will increase until you reach the fault.

5.1.3 Multiple Fault Patterns

The signal pattern created by two faults in a line is depicted in **Figure 5-3**. The two faults are shown without the ground point. Notice that from a distance the two faults will have the appearance of a single fault due to the equipotential circle around them both. As you get closer, the individual faults become apparent. There is an area between two faults where the A-Frame may give a false indication of another fault. This is caused by the two faults canceling each other. Errors can be avoided in this situation by following the procedure described in Section 7.7.

We recommend that multiple faults be attacked one at a time. Whenever a fault is positively located, it should be repaired before looking for the other faults.

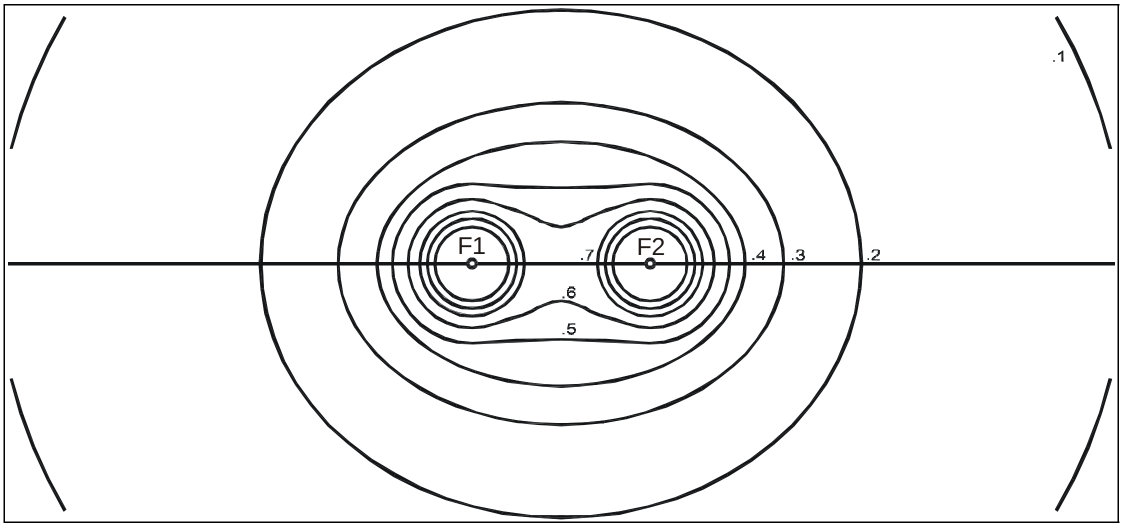


Figure 5-3: Multiple Fault Signal Patterns

5.1.4 Distortion Due to Adjacent Conductors

Whenever a non-insulated adjacent conductor lies between a fault and the ground return point, the return current tends to concentrate on the conductor instead of flowing through the earth. This situation can shrink the signal pattern near the fault, which would tend to reduce the detectable signal away from the fault. Possible distortion problems such as the described situation can be avoided by first tracing the faulty conductor and looking for adjacent conductors prior to fault locating.

6 Calibration Test Procedure

Perform this instrument test procedure on a lawn prior to field site use. If grass or dirt is not available, indoor carpeting may be used.

1 Check the Batteries

Turn the transmitter **ON**. The transmitter LCD will display the battery capacity level. Ensure the transmitter battery is fully charged for optimal operation. Turn the transmitter **OFF**.

Turn the A-Frame Receiver **ON**. The solid bars indicate the battery level. If only one bar appears, replace the battery (1 each, 9V). The battery status is **ON** for 3 seconds at turn on.

2 Connect the Test Cables

Connect the **Black** and red connection leads to the transmitter OUTPUT JACK. See **Figure 6-1**.

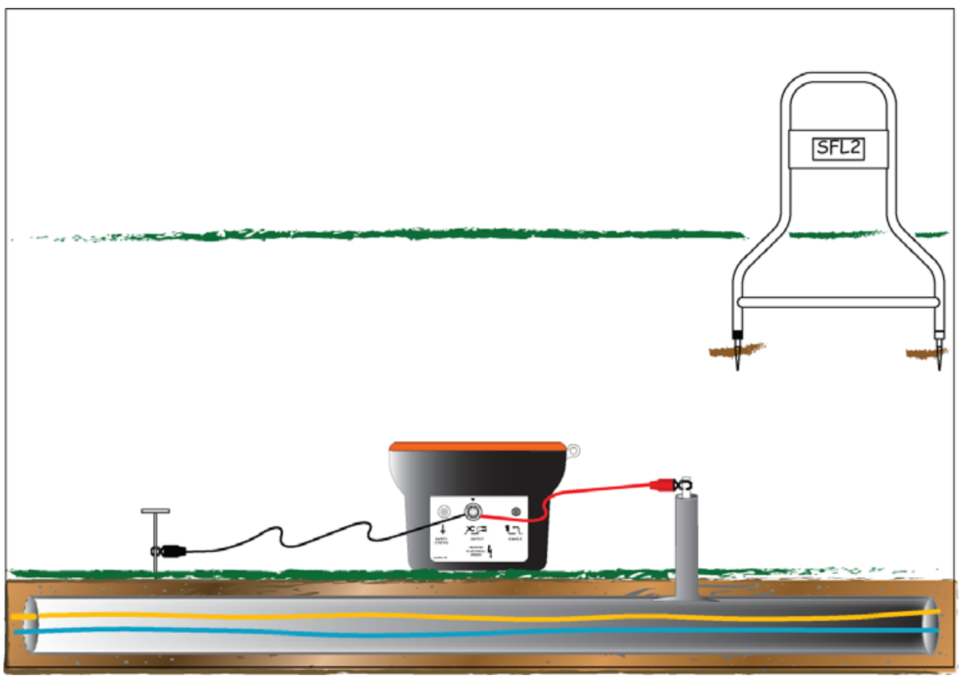


Figure 6-1: Checkout Test Set-Up

3 Spread the Test Leads as Far Apart as Possible

Insert the ground spike and attach the **Black** cable. Insert a screwdriver into the ground and connect the **Red** cable to it, creating a simulated fault.
This test can also be done by pushing the metal end of the clamps directly into the ground so that they make electrical contact. When using a carpet in this checkout procedure connect test cable clamps directly to the carpet.

4 Push the SFL transmitter button on the keypad

Wait for the SFL high-voltage output to be generated and observe the fault resistance transmitter display.

5 Synchronize the Receiver

Hold the A-Frame so the black spike is closer to the ground connection. Push the A-Frame firmly into the ground.

6 Push the Receiver On/Off Switch to ON

The A-Frame Receiver will repeat its battery test. After the battery test, the arrow facing the simulated fault (**Red** test clamp) flashes and a potential gradient number is shown on the Active and Reference LCD display.

7 Rotate the A-frame 180°

Note that the arrow now facing the red test clamp flashes. As the A-Frame is moved around the fault the arrow closest to the simulated fault should flash.

7 OPERATION

7.1 CHECK THE BATTERIES PRIOR TO GOING INTO THE FIELD.

Follow the transmitter battery check procedures provided in the i5000 Utility Locating System operating manual.

Turn the A-Frame Receiver **ON**. The solid bars indicate the battery level. If only one bar appears, replace the battery (1 each, 9 volt). The battery status is displayed for 3 seconds at turn on.

7.2 ENSURE ALL CONDUCTORS IN THE FIELD ARE DE-ENERGIZED

7.3 LIFT THE GROUNDS

Lift the grounds (of all conductors in the circuit) at both ends of the faulted cable section. Occasionally, the very experienced fault locators see evidence (i.e. tripped circuit breakers at transformer) that the fault is so severe that no signal will travel beyond the fault. In these cases, it is not necessary to lift the distant ground.

7.4 ATTACH THE TRANSMITTER TO THE CONDUCTOR AND CHECK THE FAULT RESISTANCE.

1. Turn the transmitter **OFF.**
2. Plug the **Black** and **Red** test leads into the transmitter.
3. Clamp **Red** lead to target conductor sheath. Make sure the red clamp does not make contact with any leaves, grass, or dirt. This could create false reading.

WARNING

When the transmitter is set to “SFL” the external OUTPUT JACK produce up to 1200 volts. Do not touch these jacks, electrical shock will result!

CAUTION

Do not place a shorting bar across external Output Jacks, or connect the two leads together. Damage to the transmitter may result.

4. Stretch **Black** lead 180 degrees away from the Conductor.
5. Push grounding rod into the earth and clamp the Black lead to the grounding rod. Establish the best ground possible.
6. Turn the i5000 transmitter **ON** and push the “SFL” key to switch the transmitter into SFL operating mode. Check transmitter battery status.
7. Check the fault resistance on transmitter display. Severe faults read in the 0-100 KΩ, medium faults will read in the 100 KΩ – 500 KΩ, and light faults will read 1 MΩ and up.

   To switch between 82KHz and 9.82KHz frequencies for line tracing, push the ***f*** (frequency) button on the transmitter keypad. In SFL mode, the transmitter will simultaneously generate a 4.8Hz low frequency fault locating tone as well as 9.8 Hz or 82kHz cable tracing frequency.

7.5 SYNCHRONIZE THE A-FRAME RECEIVER

By synchronizing, the A-Frame memorizes the phase of the transmitter signal. This allows it to recognize the reverse phase signal coming from the fault and direct you to it.

Resynchronize the Receiver every 45 minutes to maintain optimum calibration. You may do this near the ground rod or near a fault. At the ground rod, the black A-Frame spike must be nearer to the ground rod with the white spike facing toward the fault. At a fault, the white A-Frame spike must be nearer to the fault.

1 Hold the A-Frame so the black spike is closest to the ground rod.
2 Push the A-Frame spikes into the ground.
3 Switch the Receiver **ON**. Wait until the arrow flashes on the bar graph.
4 If the arrow points away from the ground spike, there is a fault.
5 If the arrow points towards the ground spike, there is no fault. Recheck the grounds and connections if a fault is wrongly given. **See Figure 7-1.**

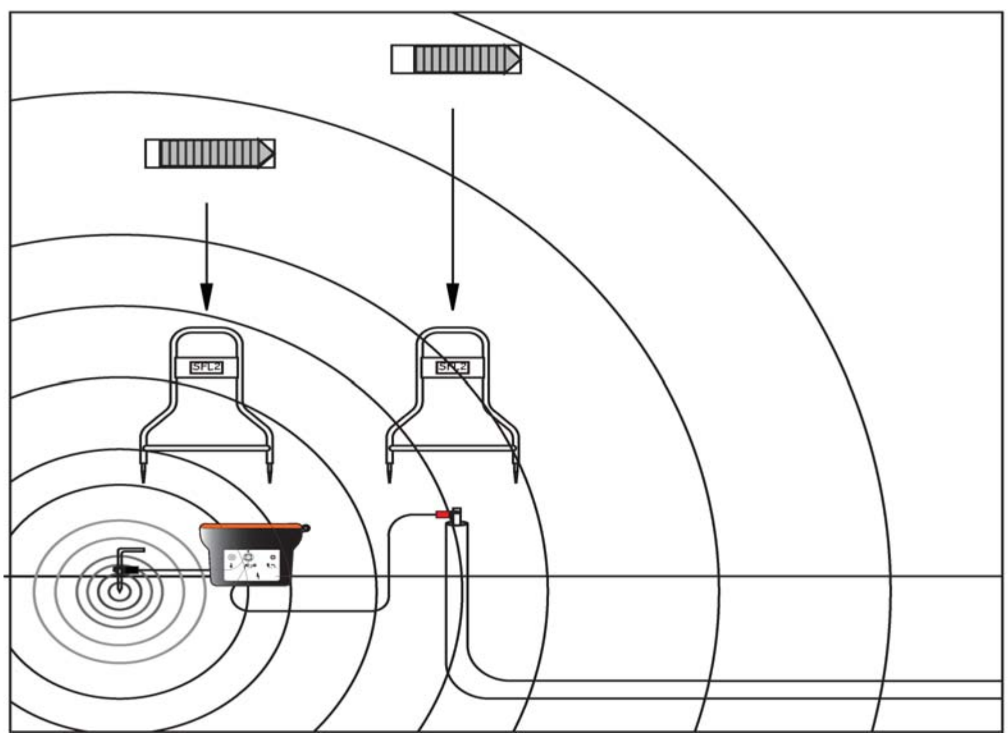


Figure 7-1: Synchronizing The A-frame

7.6 CONFIRM THAT A FAULT EXISTS

1 Remove the A-Frame from the ground.

2 Rotate it 180° and re-insert it into the ground. The arrows should reverse directions and point away from the ground spike.

7.7 TRACE THE CABLE WITH THE I5000 RECEIVER

The i5000 Utility Line Locator allows you to trace the line and search for the fault at the same time.

1 Check the i5000 Receiver for cable tracing frequency. Aim the Receiver at the **Red** lead and cycle through the Receiver frequencies – 9.8KHz or 82KHz, to confirm that the selected tracing frequency is being received.
2 Trace and mark the cable as you proceed towards the fault.

7.8 PINPOINT THE FAULT

1 Keep the A-Frame parallel to the target cable
2 Insert the A-Frame every 10' – 20' (3 - 6 m). Follow the arrow and monitor the active number.
3 When locating with the A-Frame, make sure that the probes are inserted well into the ground. A good physical ground connection is needed to receive strong signal.
4 When the arrow changes direction, back track. Check the "Active" LCD number and compare it to the "Reference" LCD number. If both active and reference numbers have the same or similar value, you have found the major fault.
5 Insert the A-Frame every 2' (50 cm) until the arrow changes direction again, then turn it 90 degrees. Check for obvious causes where a fault is suspected, such as recent excavation.
6 Continue to move the A-Frame across the cable until a slight movement causes the arrow to change directions. When this happens, the fault is located at the center of the A-Frame.

7.9 VERIFY THE FAULT

1 Move slightly off to one side of the cable.
2 Insert the A-Frame into the ground at various positions around the suspected fault site (like the hands of a clock).
3 The arrow should always point toward the fault.
4 Place the other spike in the ground at the fault site and repeat the process. The arrow should always point inward, toward the fault. **See Figure 7-2**.

Place the other spike in the ground at the fault site and repeat the process. The arrow should always point inward, toward the fault.

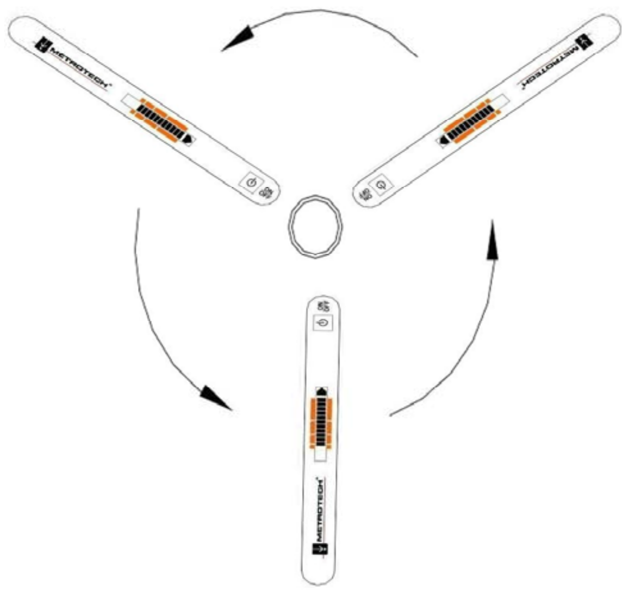


Figure 7-2: Fault Confirmation

8 ADVANCED TECHNIQUES

8.1 FAULTS UNDER INACCESSIBLE SURFACES

When the faults exist beneath a paved or other inaccessible area, the fault may be located using one of the following methods.

8.1.1 Perpendicular Method

Carefully trace the location of the faulty conductor. Hold the A-Frame parallel to the cable path. As you move away from the ground rod the bar graph and the active number will gradually decrease until reaching the midpoint. It will then increase until reaching the fault. When the A-Frame center passes a line perpendicular to the sheath fault, the directional arrow indicators will rapidly change positions and the bar graph and active number will drop to zero. See **Figure 8-1**.

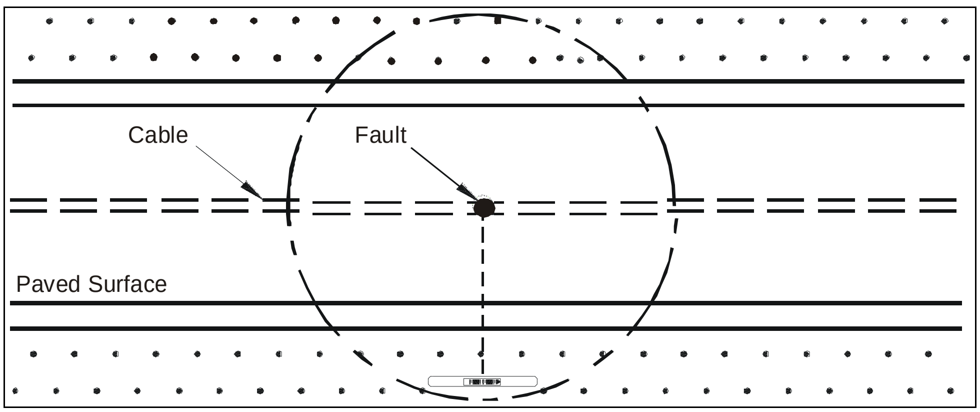


Figure 8-1: Perpendicular Method

8.1.2 Triangulation Method

As shown in **Figure 8-2**, (the point where the signal strength is a minimum) if the A-Frame is positioned exactly on an equipotential circle, a perpendicular line from the center of the A-Frame will pass through the fault. The intersection of any two such perpendicular lines defines the fault location.

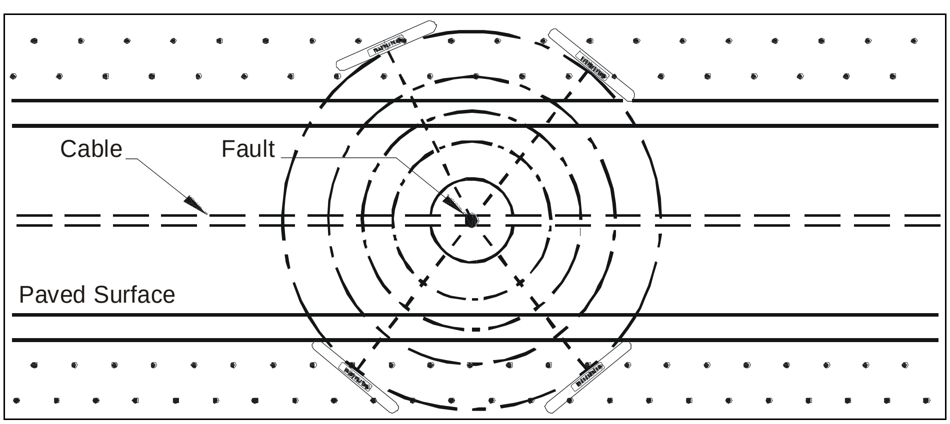


Figure 8-2: Triangulation Method

To find an equipotential circle (**see Figure 8-3**) insert the A-Frame into the ground and pivot around one spike. Rotate the A-Frame back and forth until the exact point is found where the flashing arrows change direction. The A-Frame is now on an equipotential circle and is perpendicular to the fault. By marking this line and repeating the process with the A-Frame at another nearby location, the two lines will intersect or cross at the fault.

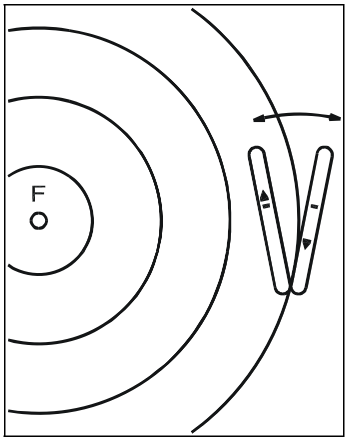


Figure 8-3: Locating an Equipotential Circle

8.2 FAULTS UNDER PAVEMENT

Faults under pavement or other slightly conductive surfaces can be found using the foam pads supplied with the unit. Saturate the pads with water and insert the A-Frame spikes into the pads. Locate the fault as you normally would. Be sure to keep the pads as moist as possible, but do not let the water form a continuous puddle between the pads as this will short out the signal.

8.3 LONG DISTANCE TRACING

As the distance to the fault increases, the signal picked up by the A-Frame is proportionally reduced. This condition can lead to problems if the signal levels are reduced to the point that they can no longer be detected by the A-Frame.

Whenever working with weak signals due to long distance faults (or other reasons), increased sensitivity can be obtained by extending the distance between the A-Frame spikes using the extension cable. This extension method can be applied to any of the previously discussed methods including the conductive foam pads. When working with very long distances, as in fiber optic runs, the sensitivity can be increased even further using a longer insulated wire to extend the A-Frame span. See **Figure 8-4**.

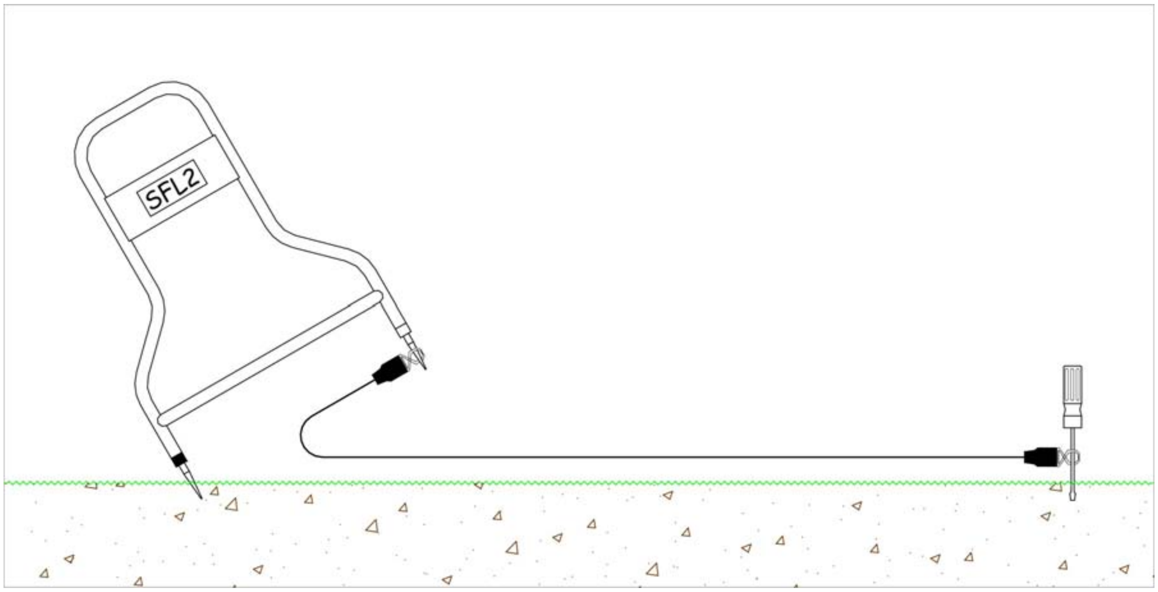


Figure 8-4: Fault Location Using Extension Cable for Increased Sensitivity

8.4 HIGH AND LOW IMPEDANCE FAULTS

Before beginning a fault search it is a good idea to know the severity of the fault. This is measured in terms of its resistance or impedance to ground. Faults where the ground is wet and/or a very large piece of the insulation is missing are found at the low end of the range (<500 Ohms). Conditions where the ground is very dry and/or the actual fault is a small pinhole where the conductor has a very small ground contact area are found at the high end of the fault range (>1-3 MΩ).

A low impedance fault is the easiest to find since there is more signal to detect. Generally, the more bars and a higher number displayed at synchronization, the larger the fault.

A high impedance fault is more difficult to locate. Characteristically, the A-Frame Receiver may not detect the signal after moving a short distance away from the ground point. The higher the impedance of the fault, the closer you must be to detect it.

For Example.

If the A-Frame only reliably points away from the ground connection within 20’ (3 m), then the A-frame will only detect the fault within about 20’ (3 m). Outside this distance the signal is too weak to reliably detect.

For this reason we highly recommend tracing and marking the line before searching out high impedance faults.

8.5 MULTIPLE FAULTS

Locating multiple faults is the most difficult and confusing fault situation. It is especially important in this case to accurately trace the faulty conductor before beginning the fault search. Stay exactly above the line if possible and verify each suspected fault by monitoring the active number to see which fault has the higher number. Remember that a very strong or low impedance fault will mask the detection of a weak or high impedance fault. The safest and best way to find multiple faults is to repair each fault as it is positively identified and then continue the search. See **Figure 5-3**.

9 MAINTENANCE

9.1 RECEIVER BATTERY REPLACEMENT.

Loosen the two thumbscrews located on the underside of the Receiver housing. Gently pull out battery door. Be careful not to pull on the battery wires. Remove battery from battery holder and disconnect battery. Reverse procedure for installing new battery.

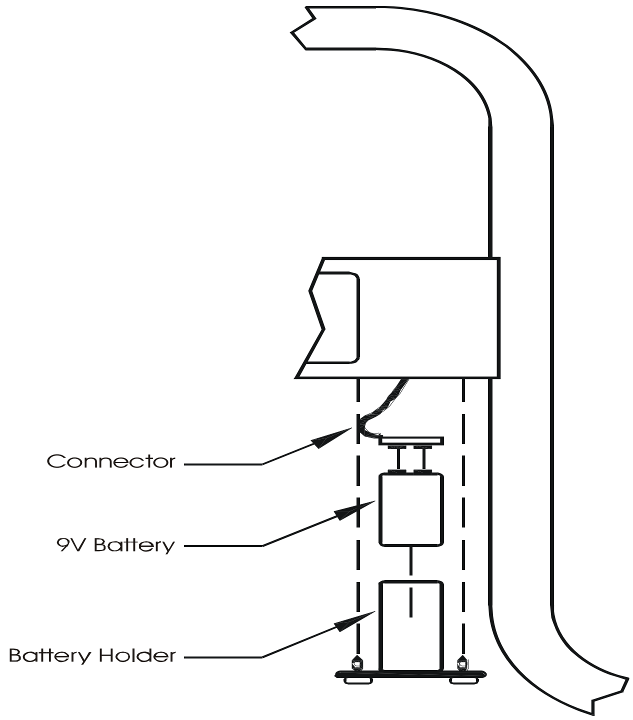


Figure 9-1: Receiver Battery Replacement

9.2 SERVICE CENTERS

If the instrument does not function properly, replace the battery as described above. If the equipment still malfunctions, contact one of our Metrotech Customer Service departments for assistance:

Vivax-Metrotech Corporation
3251 Olcott Street,
Santa Clara, CA 95054, USA
Website : www.vivax-metrotech.com
Sales & Sales Support:
T/Free : +1-800-446-3392
Tel : +1-408-734-1400
Fax : +1-408-734-1415
Email : sales@metrotech.com

Application Support:
T/Free : +1-800-624-6210
Tel : +1-408-454-7159
Fax : +1-408-743-5597
Email : applications@metrotech.com

Service & Repairs:
T/Free : +1-800-638-7682
Tel : +1-408-962-9990
Fax : +1-408-734-1799
Email : service@metrotech.com

All Other Department:
T/Free : +1-877-330-1647
Tel : +1-408-734-3880
Fax : +1-408-962-9993

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Vivax Canada Inc.
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Tel : +1-289-846-3010
Website : www.vivax-metrotech.com
Email : CanadianSales@vivax.biz

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Tel : +49-9544-680
Fax : +49-9544-2273
Website : www.sebakmt.com
Email : service@sebakmt.com

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Fax : +61-2-9972-9433
Website : www.sebakmtaus.com
Email : sales@sebakmtaus.com
service@sebakmtaus.com

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Shanghai, China 200336
Tel : +86-21-5187-3880
Fax : +86-21-5168-5880
Website : www.leidi.com
Email : info@leidi.cn

Or call the factory for the nearest authorized Metrotech repair station.

Additional Metrotech Instruments: Pipe and Cable Locators, Dual Frequency Locators, Magnetic Locators, Fiber Optic Cable Locating System, Leak Detectors, Valve Box Locators, and High Power Locators.

10 APPENDIX

A1 APWA Marking Colors - The following color markings have been established by the American Public Works Association (APWA):

Conductor	Color
Electric power lines, cables, or conduits	Red
Communication lines, cables, conduits, CATV	Orange
Gas, oil, petroleum, or other gaseous materials	Yellow
Sewers, storm and sanitary, drain lines	Green
Water, irrigation, or slurry lines	Blue

If you have any questions regarding marking requirements or procedures in the United States, please call your local One Call Center. International customers: please check with your local regulatory authorities or utility companies required color markings may vary between different countries.

11 COPYRIGHT NOTICE

12 WARRANTY

THERE ARE NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY, BEYOND THOSE STATED HEREIN.

Metrotech warrants it is equipment to be free from defects in workmanship and material under normal and proper use and service for one year from date of purchase by original user. Metrotech assumes no obligation to repair or replace equipment which has been altered or repaired by other than a Metrotech-approved procedure, been subject to misuse, misapplication, improper maintenance, negligence, or accident; has had it is serial number or any part here of altered, defaced ore removed; or been used with parts other than those approved by Metrotech. Warranty does not include batteries. Expendable items such as fuses and lamps are excluded.

Any detection product proved defective under this warranty will be repaired or replaced free or charge at the Metrotech Corporation factory or approved Metrotech repair station. The equipment should be returned to our factory by prepaid transportation after requesting and receiving return authorization from our Service Department.

Metrotech's obligations are limited to repair or replacement of broken or defective parts, which have not been abused, misused, altered, or accidentally damaged, or at the option of Metrotech, to refund of the purchase price. Metrotech assumes no liability for removal or installation costs, consequential damages, or contingent expenses of any other nature.

Part #: