

**CT-1 SIGNAL INJECTOR
OPERATION MANUAL**
JW FISHERS MFG INC

rev 610



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SIGNAL INJECTOR

FOR CABLE TRACKING

OPERATION AND MAINTENANCE MANUAL



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DO NOT

- Do not touch output posts or cable ends with power turned on (SHOCK HAZARD, IT COULD BE LETHAL).
- Do not operate if water is on the surface of the control panel or is inside of the Control Box. Should water splash on the control panel or get inside the Control Box, immediately turn off the power and unplug the power cord. Water on the control panel, or inside the Control Box, can be a SHOCK HAZARD AND COULD BE LETHAL.
- Do not let Signal Injector sit in hot sun for prolonged periods.
- Do not plug Signal Injector into any voltage other than 120 vac. Use a 220 to 120 vac transformer if operating from 220 vac.
- Do not allow the two output clips to short together. It may blow a fuse on the circuit board.
- Do not try to track metal pipes - it will not work. The conductor (the pipe) must be insulated from ground/water along its length.
- Do not connect the Signal Injector to any **LIVE** power cable.

DO

- Always turn the unit off before handling the output cable or touching the output posts on the control box.
- After reading this manual, check out the system using the test cable provided. See test and checkout in this manual.
- Before connecting the Signal Injector to any cable, insure the cable does not already have a voltage applied to it. Check between the cable and earth ground with a voltmeter.

SIGNAL INJECTOR SPECIFICATIONS

PERFORMANCE/DESCRIPTIONS:

- Input power 120 vac.
- Power consumption 10 to 75 watt.
- Output voltage 0 to 150 vac.
- Output current 0 to 500 ma.
- Output frequency (switch selectable) 25, 50, 60, 1,024 Hz.

DIMENSIONS/WEIGHTS:

- Signal Injector 13”L x 12”W x 8”D/20 lbs.

MATERIALS/COLOR:

- Signal Injector Urethane/Black

OPTIONS

- Custom frequencies available.
- 220/120 vac voltage transformer for Signal Injector (Europe).

INTRODUCTION

JW Fishers Cable Tracker Signal Injector is part of a cable tracking system that is specifically designed to locate and track buried power and communications cables. The complete system will locate cables buried on land or underwater. The complete system will not only locate and track cables, but also identifies faults or breaks in a cable. This manual deals with the Signal Injector, a separate manual deals with the Cable Tracker Probe.

CABLE TRACKER 1 SYSTEM

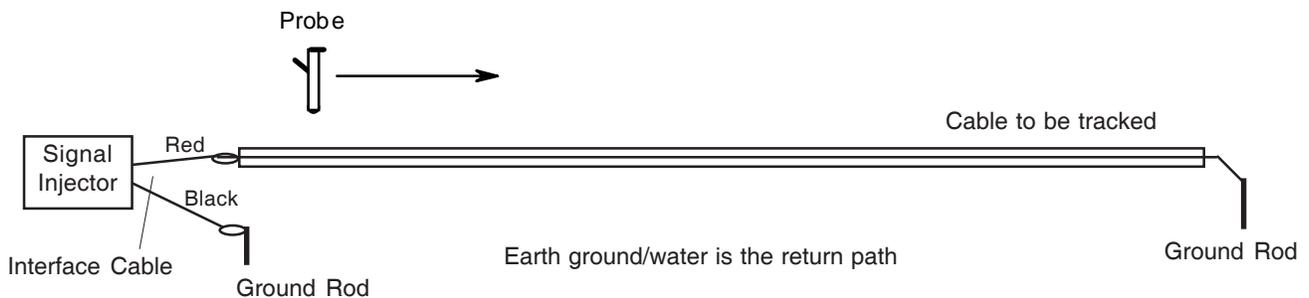


SIGNAL INJECTOR



CABLE TRACKER PROBE

The Cable Tracker 1 system consists of the Signal Injector control box and the Cable Tracker Probe. The Signal Injector is attached to an exposed part of the cable on land. A 25, 50, 60 or 1,024 Hz (operator selectable) signal is induced into the cable by the Signal Injector control box. The operator carries or swims with the Cable Tracker Probe along the length of cable receiving the transmitted signal. Typically the lower frequency 25 Hz signal is initially used to locate the cable as it can be detected from greater distances. Once the approximate location of the cable is determined the 1,024 frequency is used to precisely pinpoint the exact location of the cable. The 1024 Hz position is well away from the 50 or 60Hz overhead power lines that can cause interference. When searching for power cables it is generally not necessary to use the Signal Injector as the Probe can detect the 60 Hz (USA) or 50 Hz (Europe) frequency of an AC voltage line. When tracking live multiconductor communications cables the 1,024 position is used on the probe to pick up the communications signal (Signal Injector is not needed). A switch on the Probe allows the operator to select the frequency to be detected (25, 50, 60, or 1,024 Hz).



THEORY OF OPERATION

The Signal Injector is used to create a constant current electromagnetic field around the cable at any of the selectable frequencies (25, 50, 60, or 1,024 Hz). The Signal Injector (transmitter) is connected to the shore end of the cable and the Cable Tracker Probe (receiver), which is set for the same frequency, tracks the electromagnetic signal along the length of the cable.

The amount of current flowing through the cable determines the intensity (strength) of the electromagnetic field. The stronger the field, the further away the cable can be detected by the receiver probe. The output voltage/current of the signal injector is fully adjustable. The higher the Voltage/Current knob is adjusted the higher the current will be in the cable. Meters on the control panel show the voltage output (0 to 150 vac) and output current (0 to 500 ma). Once the Voltage/Current knob is adjusted for the desired current, the control box will maintain that current even though the load may be constantly changing. This current regulation insures that the receiver probe gives a steady readout.



SIGNAL INJECTOR

Most cable tracking can be done at 75 to 150 ma. Deeply buried cables, or heavily shielded cables, require more current to be detected and tracked by the Cable Tracker probe. As a general rule, use no more current than necessary to locate and track the cable; it makes pinpointing the cable easier. The amount of voltage necessary to get the desired current varies greatly depending on the size and length of the cable and ground conditions. Ground is used for signal return.

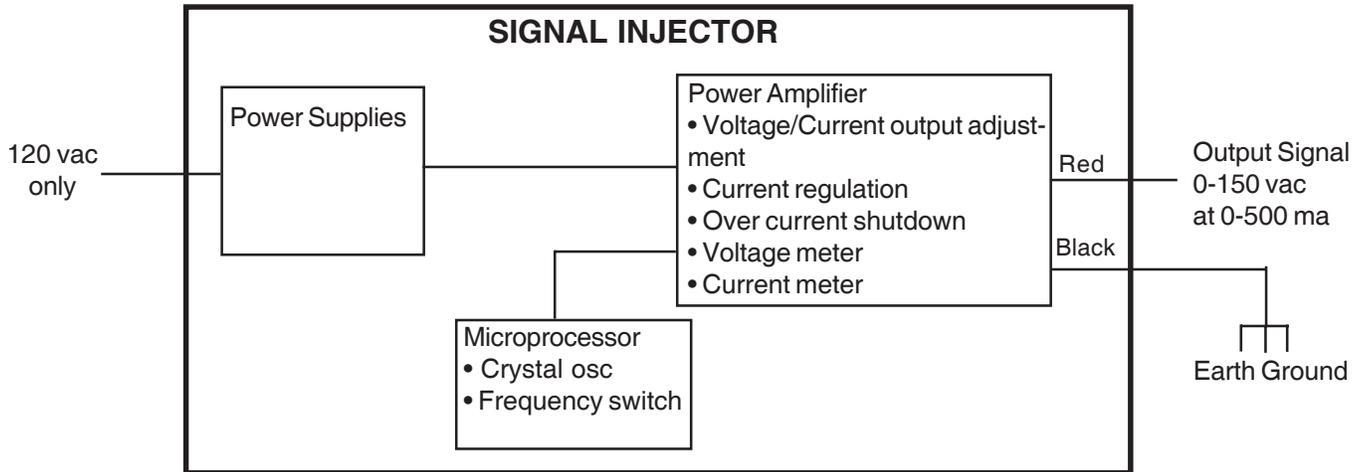
The most common frequency used to locate and track non-power cables is 1,024 Hz. The higher frequency is tuned well away from the 50 or 60 Hz that is common in overhead power lines and may cause interference. However, if the cable is buried deep, you may have problems detecting it with the higher frequency so the lower 25 Hz signal is used. If it is a power cable at 50 or 60 Hz chances are you can detect the cable with the Cable Tracker Probe without the Signal Injector.

The Signal Injector is powered by 120 vac. A 220/120 voltage converter is available for operating from a 220 vac power supply.

THEORY OF OPERATION (Continued)

A block diagram of the Signal Injector is shown below.

BLOCK DIAGRAM OF SIGNAL INJECTOR

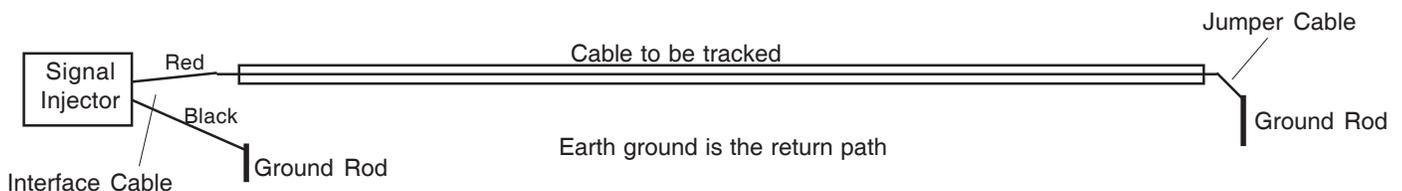


The Signal Injector contains a main logic board that has three main sections: Power Supply, Microprocessor, and Power Amplifier.

- Power Supply - Contains power supplies for the internal operation of the Signal Injector plus a high voltage supply to produce the 0 to 150 vac for the output. The power supply has a fuse on the front panel and has internal overcurrent protection.
- Microprocessor - CPU monitors the frequency selection switch and produces precise crystal controlled output frequencies to the Power Amplifier section.
- Power Amplifier - Under control of the Microprocessor, the Power Amplifier delivers the current to the output terminals at the selected frequency. Once the operator adjusts the desired current, the Power Amplifier automatically maintains the desired current even though the load may change.

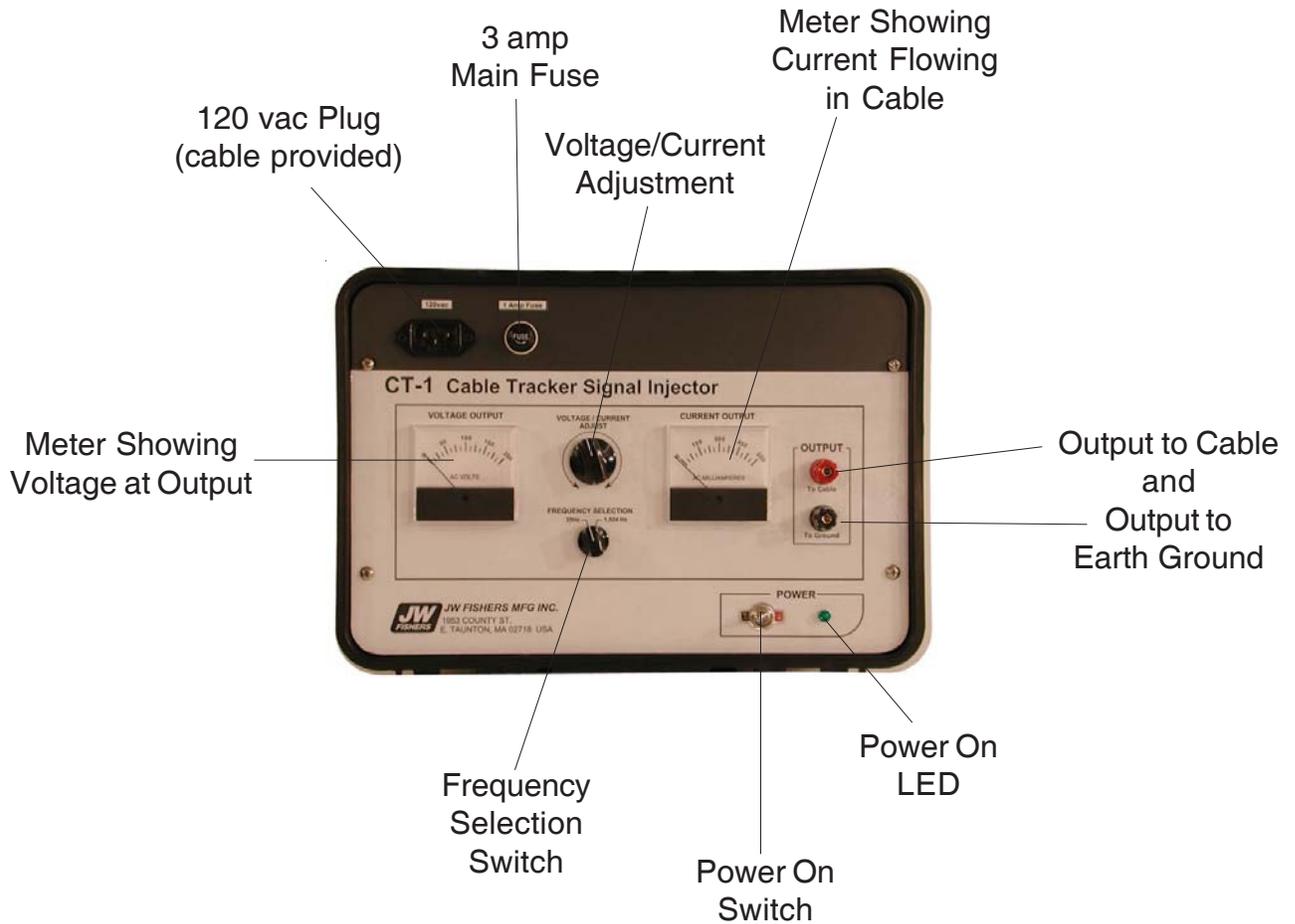
In case of a broken cable, where the broken end is exposed to water, the design of the Signal Injector eliminates “electrolysis” of the cable end while the system is in use.

The Signal Injector’s AC signal must have a return path for current to flow so the cable can be detected. In most cases this is accomplished by connecting the red output of the Signal Injector to a conductor (or the shield) in the cable to be traced, and the black output to a metal rod driven a short distance (if the ground is damp) into the ground. The other end of the cable (that the red output is connected to) is also connected to earth ground. A second conductor in the same cable cannot be used as the return path (electromagnetic field cancels itself out). An interface cable is provided to connect the Signal Injector output to the ground rod and the cable to be tracked. The interface cable has plugs on the Injector end and alligator clips on the other end.



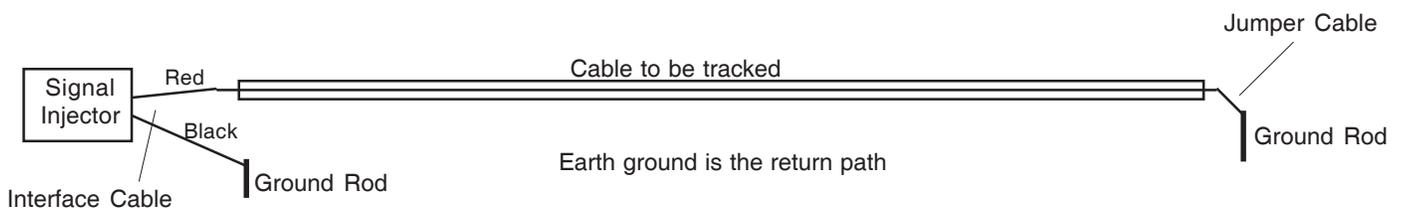
THEORY OF OPERATION (Continued)

The control panel contains all of the necessary switches and indicators necessary for operation and control of the unit.



The control panel switches and indicators are:

- 120 vac Plug (cable provided) - Input power for the system. Use 120 vac only.
- 3 Amp Main Fuse - The main fuse for the system. Other fuses are inside on the logic board.
- Power On Switch - Applies power to the system.
- Power On LED - Illuminates when power switch is on and Main Fuse is ok.
- Frequency Selection Switch - Selects one of four output frequencies (25, 50, 60, or 1,024 Hz).
- Voltage/Current Adjustment - Adjusts the output voltage/current (which determines the amount of current flowing in the cable).
- Meter Showing Voltage at Output - Displays the voltage that is present at the output plug.
- Meter Showing Current Flowing in Cable - Displays the current that is flowing through the cable.
- Output to Cable and Earth Ground - The Interface cable plugs into these two output posts. The other end of the Interface cable connects to a wire in the cable you wish to track and earth ground.



OPERATION

The only function of a Signal Injector is to inject an AC signal into a cable so that the cable can be tracked with a cable tracker receiver. The only operational decisions that the operator needs to make is: what frequency to select, and how much current to run in the cable?

Frequency - The operator can select any one of four frequencies: 25, 50, 60, or 1,024 Hz. The lower the frequency, the further it will travel through the ground. For deeply buried cables, or cables that are proving to be difficult to find, use 25 Hz. The drawback to the lower frequency is that it is a little more difficult to pinpoint the cable. Higher frequencies (1,024 Hz) are attenuated a greater amount through the ground, but it is very easy to pinpoint the cable. The higher frequency, 1,024 Hz, is the frequency of choice for most non-power line jobs. Always start with 1,024 Hz, turn up the power (up to 500 ma) if you have to.

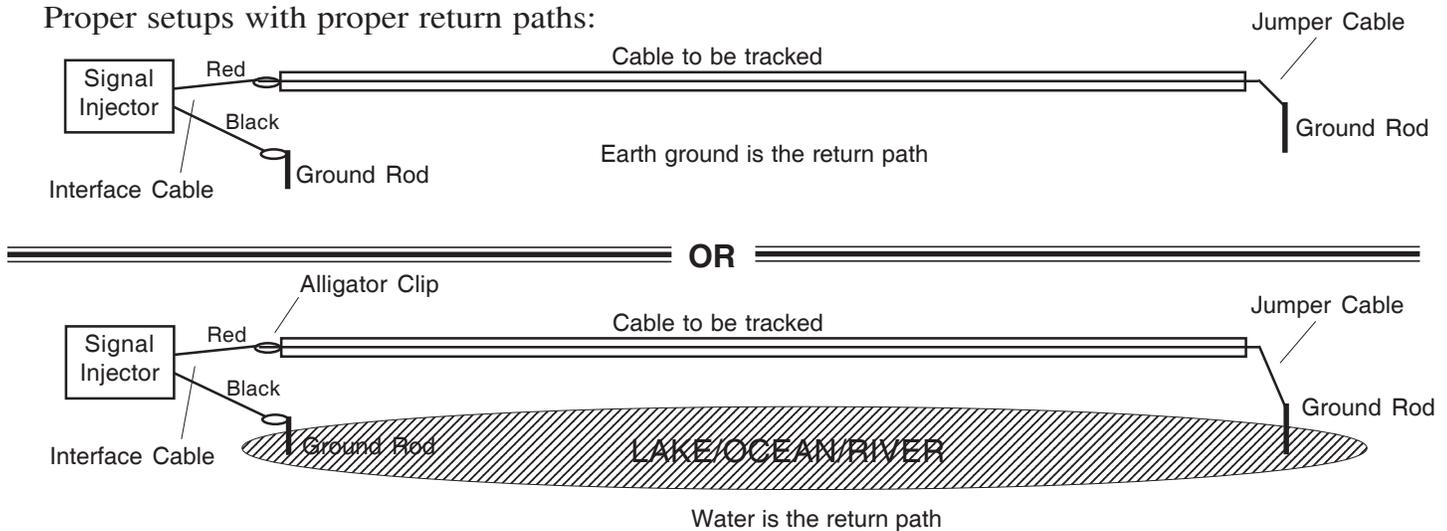
When tracking live power lines, at 50/60 Hz, the Signal Injector is not needed. The cable tracker probe (a receiver) picks up the live power cable. When tracking live multiconductor communications cables the 1,024 Hz position is used on the probe to pick up the communications signal (Signal Injector is not needed).

Current - The Signal Injector is capable of delivering up to 500 ma for deeply buried cables. In most cases 75 to 150 ma does an excellent job. The lower current doesn't "overpower" the receiver (diver probe) and makes pinpointing the cable easier. If the diver probe cannot detect the cable then "crank up the power" until the diver probe is close enough to the cable that it is getting very strong readings. At that point turn down the power so the cable can be easily pinpointed.

Return Paths (black lead from Signal Injector):

It is important to remember that there must be a return path **outside** of the cable that is being tracked. If a separate cable is being used for the return signal, it cannot be close (next to) the cable being tracked. Always try to use "earth ground" or water for the return path; it eliminates a lot of possible tracking problems.

Proper setups with proper return paths:



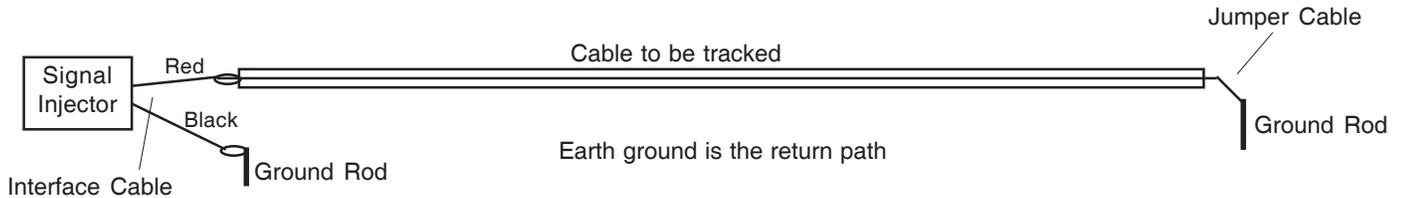
NOTE: Because water is a better conductor than earth ground, water as a return path allows higher currents to be put in the cable. However, since we need only 75-150 ma for most cables, earth ground works well in most cases. When earth ground doesn't do the job because the ground is very dry, a longer ground rod (deeper in the ground) can help.

OPERATION (Continued)

Main Path (red lead from Signal Injector):

The red lead from the Signal Injector is connected to a wire in the cable to be tracked. The other end of the same wire to be tracked must be connected to earth ground for the return path to the Signal Injector. Some comments regarding cables to be tracked:

- The wire must be insulated from ground along the full length to be tracked.

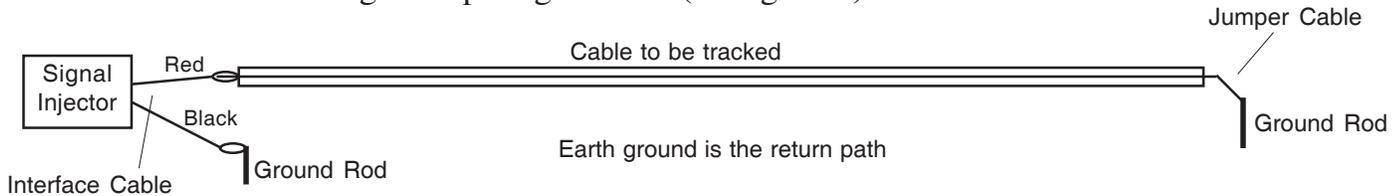


- Metallic pipes cannot be tracked unless they are insulated from ground.
- When a cable, including fiber optics cable, has no wires but has a metal shield, the cable can be tracked by inserting the signal on to the metal shield. This is done by disconnecting the shield from ground at the Signal Injector end. For this to work, the shield must have an outer jacket that insulates it from ground along its length.
- When tracking a broken cable the broken end of the cable must be exposed to ground to have a return path to the Signal Injector. If the broken end is not exposed to ground, the cable cannot be tracked (current meter will show zero current).
- When tracking a broken cable, whose end is exposed to ground, the cable can in most cases be tracked up to 20-25 foot from the break. At that point the return signal is so close to the cable being tracked that pinpointing can no longer occur. Keep Signal Injector current to a minimum as you reach the end of a broken cable.

OPERATION (Continued)

Operation of the land-based Signal Injector is very straightforward:

- Before proceeding to apply voltage/current to any cable, use a voltmeter to check the cable to insure that the cable does not already have a voltage on it. You are checking to insure it is a “dead cable”. After checking for voltage, make an ohmmeter check to insure it is not a dead short between the cable wire and ground. Even a short cable should measure a few ohms.
- With the Signal Injector turned off, plug the short interface cable into the Signal Injector control box. The red plug goes onto the red jack and the black plug goes into the black jack.
- Connect the red alligator clip to the conductor (wire) to be tracked.
- Connect the black alligator clip to a ground rod (earth ground).



- Select the desired frequency, 1,024 Hz is the most commonly used.
- Turn the Voltage/Current control to minimum (ccw).
- Plug the Signal Injector power cable into 120 vac only. See next page for other power inputs.
- Turn on the Power switch.

DO NOT TOUCH THE OUTPUT POSTS OR HANDLE THE ALLIGATOR CLIPS WITH POWER ON - LETHAL VOLTAGES ARE PRESENT.

- The Power On LED should immediately illuminate.
- Slowly turn up the voltage while watching the voltmeter and current meter. The voltage and current should move up together. If you have a general idea of the location where the cable is running set the current at 75-150 ma.

Note: The more current, the further you can detect the cable, but the more difficult it is to pinpoint the cable as you get closer to the cable (it overwhelms the receiver).

Note: The longer the cable, or the smaller the diameter of the wire, the more voltage it will take to provide the desired current.

Problems:

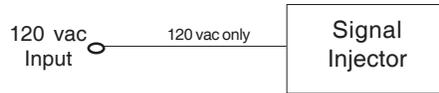
- If only the voltage (no current) goes up (it will max out at 150 vac), then there is not a complete electrical path for the signal (see above drawing). This could be caused by a poor ground connection or the wire is broken and the broken end is not exposed to ground. This cable cannot be tracked with this setup.
- If the current quickly goes to your desired 75-150 ma with almost no voltage shown on the meter, then the cable is very short, or a short exists at the input connection, or at a very short distance down the cable. Depending on the location of the short determines whether the cable is trackable to the short.

OPERATION (Continued)

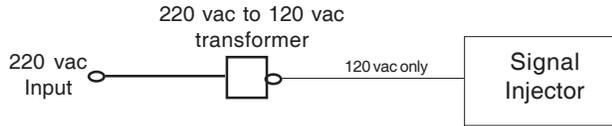
Input Power:

NOTE: the Signal Injector **must only be powered by 120 vac**. If your input power is 220 vac or 12 vdc , see below for hookup.

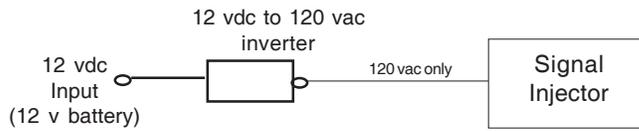
For 120 vac:



For Optional 220 vac:



For Optional 12 vdc:



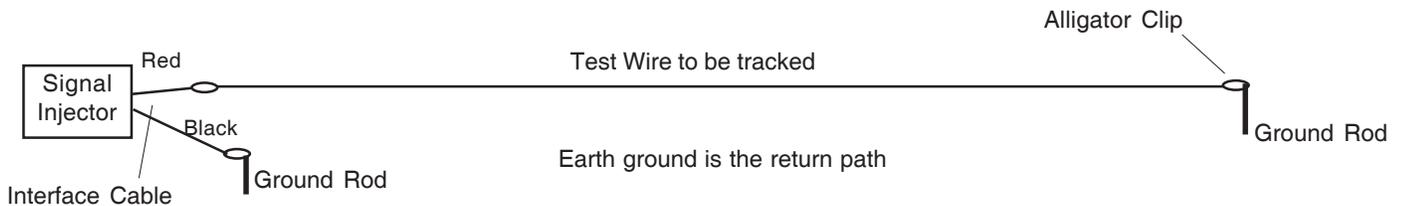
TEST AND CHECKOUT

Before proceeding with checkout of the system, read the Theory of Operation and Operation sections of this manual. The procedure that follows assumes that you understand how the system works.

Your system was shipped with 100 foot of test wire that we will use for testing the system. If the ground rods you are using are short they can only be used if the ground is moist. If the ground is very dry then use longer grounding rods or go near the waters edge where you would normally be working with the Signal Injector.

Test setup:

- 1) Stretch out the spool of wire so that the bare end on the spool of wire ends up where the control box will be.
- 2) Be sure control box Power switch is turned off.
- 3) Connect the Signal Injector as shown below (see page 10-12 for detailed information).



- 4) Select the desired frequency (1,024 Hz is the most commonly used.)
- 5) Turn the Voltage/Current control to minimum (ccw).
- 6) Plug the Signal Injector power cable into 120 vac only. See page 14 for other power inputs.

DO NOT TOUCH THE OUTPUT POSTS OR HANDLE THE ALLIGATOR CLIPS WITH POWER ON - LETHAL VOLTAGES ARE PRESENT.

- 7) Turn on the Power switch. The Power On LED should immediately illuminate.
- 8) Slowly turn up the voltage while watching the voltmeter and current meter. The voltage and current should move up together. Check to see that you can adjust to any current from 0 - 500 ma.
Note: If you cannot get the full 500 ma, the most likely cause is dry ground which is a poor conductor for the return path.
- 9) Try switching frequencies. You should be able to make the same voltage/current adjustments.

This completes the checkout of the Signal Injector. If you also purchased the Cable Tracker Probe, set the Signal Injector frequency at 1,024 Hz, the current at 75-100 ma, and test out the probe.

TROUBLESHOOTING

The Power On LED does not illuminate when the Power Switch is turned on.

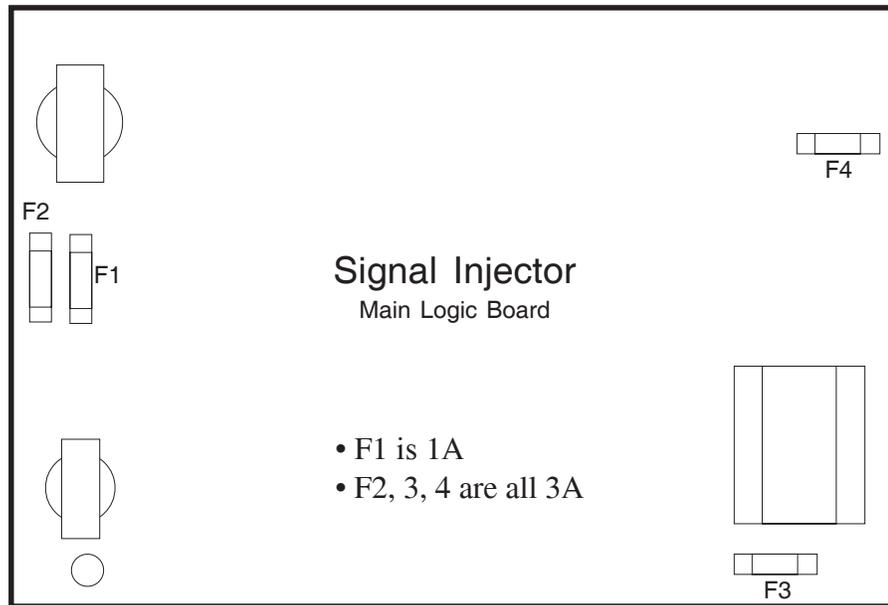
- 1) Check to insure you have 120 vac at the input power plug.
- 2) Check 3A Main Fuse on control panel.
- 3) Check 1A (F1) fuse on Main Logic Board.

The Power On LED does illuminate, but the Voltage meter does not go up when Voltage Adjust knob is turned up.

- 1) Check the four fuses on the Main Logic Board (see below).

CAUTION: UNPLUG CONTROL BOX POWER. SHOCK HAZARD, IT COULD BE LETHAL

BACK OF CONTROL BOX



Only the Voltage meter goes up (it will max out at 150 vac). The Current meter does not move.

- 1) There is not a complete electrical path for the signal (see page 12). This could be caused by a poor ground connection or the wire (that is being tracked) is broken and the broken end is not exposed to ground. Cables cannot be tracked without current flow.

Current quickly goes to your desired 75-150 ma with almost no voltage shown on the meter.

- 1) The cable is very short, or a short exists at the input connection, or at a very short distance down the cable. Depending on the location of the short determines whether the cable is trackable to the short.

CALL THE FACTORY IF ANY QUESTIONS - see front cover for contact information.

LIMITED WARRANTY

The Warranty on the Signal Injector is for two years from date of purchase and is limited to the electronic portion of the unit. The Warranty does not include broken, damaged, or lost equipment. Should service be required, contact us explaining the nature of the problem. Most problems can be isolated over the phone and correct replacement parts sent to you. In some cases, we may have you return an assembly for checkout. In almost all cases, the Signal Injector is field repairable.

Should water splash on the control panel or get inside the Control Box, immediately turn off power and unplug the power cord. Water on the control panel, or inside the Control Box, can be a **SHOCK HAZARD AND COULD BE LETHAL**. With the power cord unplugged, lift the control panel and check for water. If there is salt water on the electronics board, flush the board in fresh water and allow to completely dry outside of the housing. Rinse out the inside of the control box housing in fresh water if it has been flooded. Do not reinstall the electronics in the control box. Contact the factory for instructions. See cover page for contact information.