A Quick Course on Magnetic, Cable and Pipe Locating

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Chapter

1

Cable and Pipe Locating Basics

Applying the Signal

There are three methods of applying signal with a transmitter:

- Conductive method
- Inductive method
- Inductive Clamp method

With any method of applying signal, frequency choice is important to get the "most" signal on the cable. Any signal applied to an insulated, buried cable or pipe leaks off to ground; as it gets farther away from the transmitter, the signal gets weaker and finally disappears. How fast it leaks off is determined by:

- Cable diameter,
- wet or dry soil conditions, and
- signal frequency.

Since you do not have any control over the first two conditions, the Transmitter offers more than one frequency choice:

Low (<1 kHz): These frequencies usually provide the most accurate locate in congested areas (the lower the frequency, the better). They are best for tracing over long distances and do not couple easily to other buried conductors. These frequencies are too low to be used with Inductive clamp or inductive methods and so the conductive method should be used.

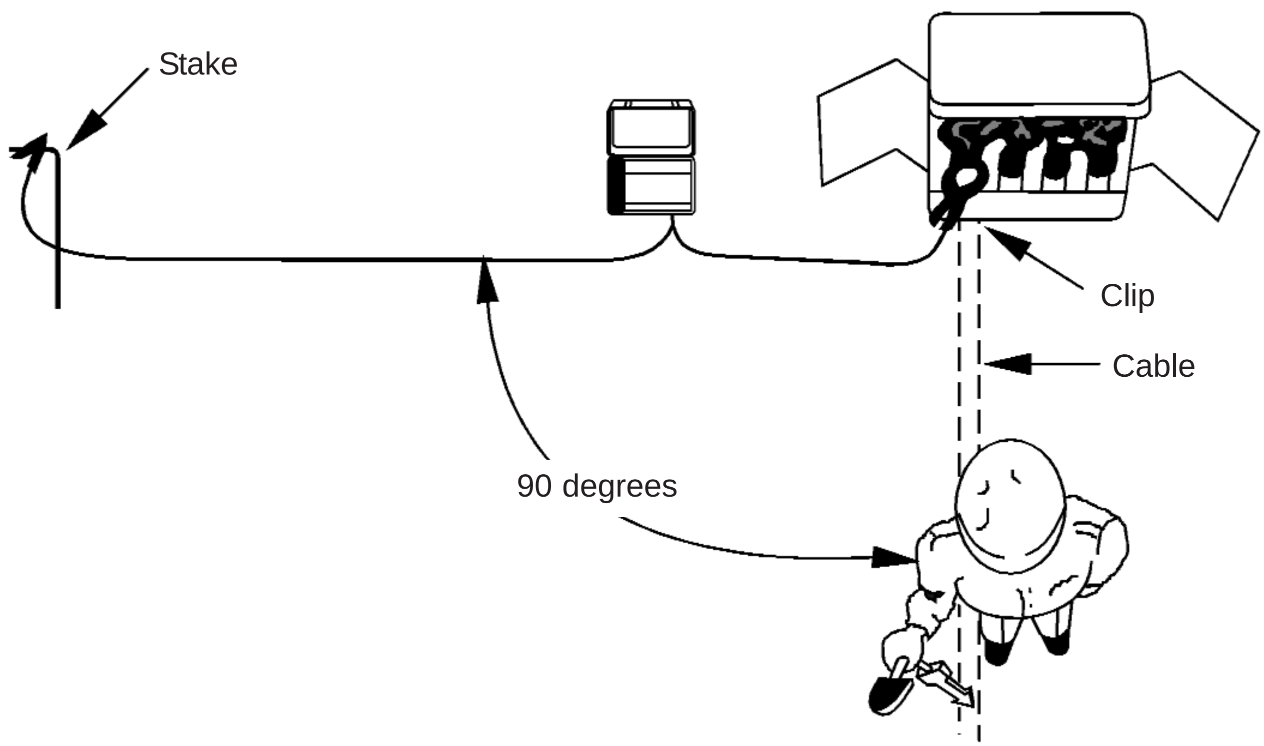
Medium (1 kHz - 10 kHz): Medium frequencies are the most useful general-purpose signals. They allow the use of the Inductive clamp method. Although they will couple to other nearby cables, medium frequencies do not do so as strongly as high frequency. Medium frequencies travel less far than low frequencies but farther than the high frequencies. They are best when the Inductive clamp method is used (when the conductive method cannot be used) and the tracing distance is one mile or less. These frequencies may not be high enough to induce a strong signal on small diameter lines like telecom cables.

High (10 kHz - 100 kHz): High frequencies attenuate over shorter distances than low or medium frequencies. They travel well on small diameter conductors (CATV and Telecom). High frequencies will couple strongly to other nearby conductors. They work best with inductive clamp and induction methods. If the receive signal is weak at the beginning of the trace, try a higher frequency.

Very High (100 kHz and higher): These frequencies attenuate rapidly with distance and so are intended for shorter runs. They couple strongly to other nearby conductors and will couple across non-conductive gaps such as cable breaks and insulated pipe joints. They work best with Inductive clamp and induction methods. Very high frequencies are best for sweeping a large area to locate all buried cables and pipes.

The Conductive Method

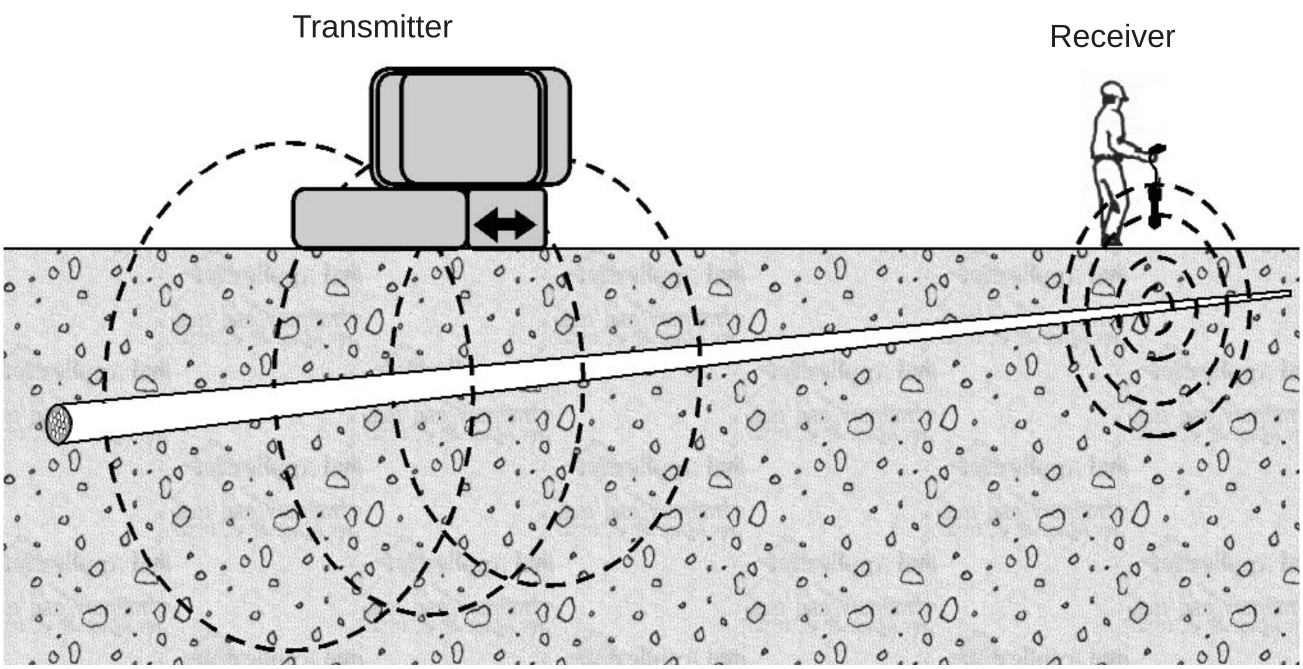
Connecting a signal directly to the cable or pipe you want to trace is the most accurate method of cable locating. Connecting the Transmitter directly isolates the signal to one cable or pipe.



Use the low frequency (575 Hz) so that signal will not couple to other grounded cables. This frequency will travel farthest down the cable.

Grounding can "make or break" a trace when you are using the Conductive method. The Transmitter connects electrically to the cable or pipe and conducts a signal current through it. The signal goes to ground at the far-end, and returns to the Transmitter through the ground stake. If the conductor is not well grounded at the far-end, or if the Transmitter connection to the ground stake is poor, the signal will be weak and not detectable. The better the ground; the stronger the signal. Place the Transmitter ground stake as far from the far-end ground and as far from the trace path as possible. In general, this means placing the ground stake at a ninety-degree angle to the suspected path. If necessary, you can extend the ground lead with any insulated wire.

The Inductive Method



The simplest way to put signal on a buried cable or pipe is with the inductive method, where you merely set the Transmitter on the ground directly over the cable with the arrow parallel to the conductor. Of course, you have to have some idea where the conductor is buried. When the Transmitter is turned on, a signal current is induced into any parallel conductor within range. It is important to place the unit directly over the target cable with the arrow parallel to the cable path, as shown above. The effectiveness of this method decreases rapidly if you place the Transmitter even 5 or 10 feet to either side of the path.

In congested situations where services such as gas or water pipes, cable TV, and lawn-watering control circuits are all buried nearby, you should not use the inductive method because the signal will be applied to all nearby conductors causing confusion during the trace.

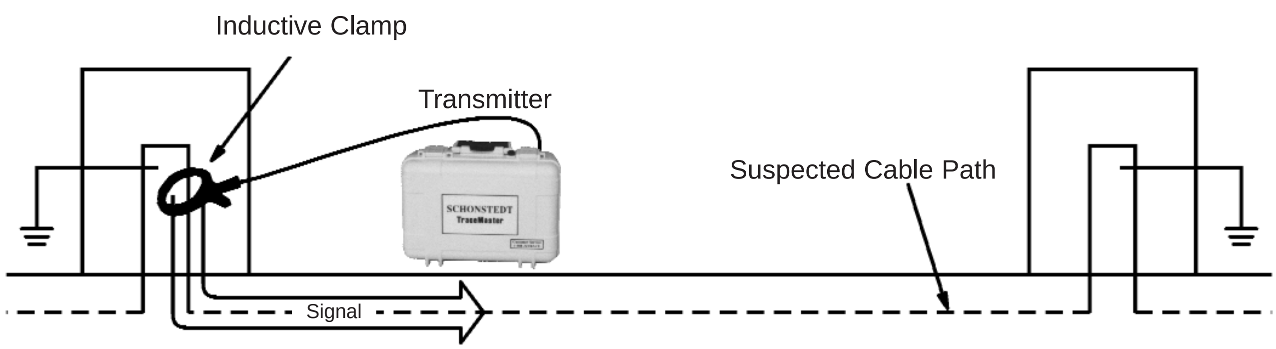
The strength of the induced signal depends on three things:

- The Transmitter frequency,
- how well the conductor is grounded,
- and how deep the conductor is buried.

When using the inductive method, the high frequencies (82 kHz or 455 kHz) should be used. Both of these frequencies will couple to the nearest conductors. Keep in mind that 455 kHz will definitely put signal on conductors other than the one you are tracing.
The Receiver can pick up signal from the Transmitter through the air from 40 feet away, even if no cable exists between them. For best results, keep the Receiver away from the Transmitter by at least that distance.

The conductor must be well grounded at both ends to produce a good locate. In all methods, the better the ground to the conductor, the stronger the signal.

The Inductive Clamp Method



Another way to put signal on a cable is the Inductive clamp method. When the clamp's jaws close around a cable or pipe, the clamp inductively couples the Transmitter signal onto it. The clamp jaws must fully close for signal transmission. As with the other methods, the cable or pipe must have a far-end ground to form a complete circuit path for the signal to follow. When you apply the Inductive Clamp between grounds, signal will be only on the section between the grounds.

You can find detailed instructions for using the Inductive clamp in specific applications in later sections of this manual.

Passive Power Frequencies

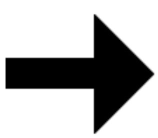
In the Passive mode the transmitter does not produce any signal and the receiver searches for 50 or 60 Hz signals.

An energized cable carrying AC power produces a 50 or 60 Hz signal. Although these are relatively low frequencies, they can still couple into other conductors buried nearby. You can detect the conductor because of the signal, but identification is impossible. The signal could be coming from a power cable, a nearby pipe, or concrete reinforcing bars. However, the knowledge that these conductors exist is useful.

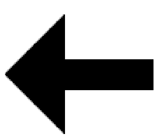
Most energized power cables are easy to detect unless they are designed to minimize the strength of radiated signals so that the 'out' and 'return' current fields cancel each other, (this is the case with power cords we use everyday for lamps, computers, etc.). These cables are difficult to detect particularly with three-phase cables. The fundamental frequency normally cancels in a three-phase installation but the 9th harmonic of 60 Hz (540 Hz) reinforces, generating a stronger signal to trace. To locate 50 Hz power cables, the receiver is factory set to detect the 11th harmonic (550 Hz).

Trace Mode

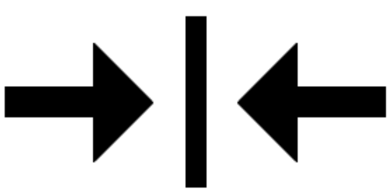
The Receiver will exhibit a peak response. The pitch of the sound from the Receiver's speaker increases to a maximum as the antenna crosses the cable. It diminishes as the antenna moves away from the cable path. The numeric strength indicator also increases to a maximum. A Peak mode Receiver can trace a cable path rapidly until the cable direction changes. The speaker pitch falls off quickly if the Receiver handle is not in line with the cable path. In such a case, a sharp turn or bend in the path is indicated. To find which direction leads back to the cable path, use the direction indicating arrows on the display.



Right Arrow: Move Receiver to the right to get closer to cable path.



Left Arrow: Move Receiver to the left to get closer to cable path.



Both Arrows and Bar: Receiver is directly over the target. This is also accompanied by a beeping sound.

When all three arrow elements are OFF, the signal strength is not adequate to make a directional determination. Keep searching based on the signal strength indication (you may need to increase the gain) and the audio feedback, until one of the arrows comes ON. **Directional indication is not available at 455 kHz.**

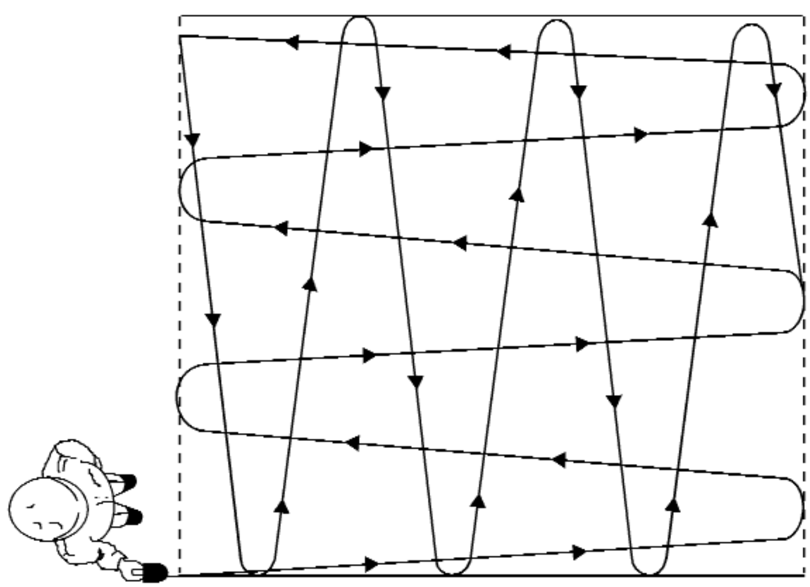
Adjusting the Gain

The Receiver gain setting determines the sensitivity to a signal. It is an important adjustment. Too little gain and the signal may be lost - too much gain and accuracy is lost or worse the wrong conductor is traced. The receiver has the ability to operate in manual or automatic gain control modes (AGC). There is also a numerical signal strength indicator to help in setting the gain. Always adjust the Receiver gain only when you are over the target cable. As you trace cables away from the transmitter, the signal becomes weaker and it may be necessary to manually adjust the gain.

When the gain control is in the fully CCW direction, the gain is set automatically. The operator has the option to set the gain manually by rotating the control in the CW direction, beyond the "click". As the control is rotated in the CW direction, the gain increases. As a guideline, always operate at the minimum gain that shows a clear "peak" over the target. It is not important what the signal strength number is at the peak, as long as it clearly decreases on each side of the target. It is NOT necessary to operate with a signal strength close to 99, in fact, if "99" appears on the numeric display, the signal is saturating the amplifiers and the gain should be reduced. For best results keep between 20 and 80.

Sweeping

Sweeping an area allows you to locate all buried conductors in the area. Use the Inductive method to apply the highest Transmitter frequency available so that all conductors in the area carry signal. Walk in a grid pattern over the area as shown, and cover the area from two directions. Stop the sweep when there is a response. Move the transmitter to the spot of the response and trace it until you are out of the area. Mark the path using spray paint or surveyor's flags. After tracing the cable, resume the sweep.



Walk the grid again using the Passive Power. You should now have identified and marked any continuous metal pipe and/or cables, and properly installed tracer wire on plastic/vinyl/PVC pipe within the area.

Tracing

To get the most accurate results when tracing a cable, signal should be isolated to the individual cable. This means using either the Conductive or the Inductive clamp methods of applying signal. If surface access is not possible, then use the induction method. Trace the cable at a slow walk while moving the Receiver in a side-to-side motion. Periodically mark the path. As tracing proceeds, remember that the most powerful signal is near the Transmitter. As the Receiver gets farther away from the Transmitter the signal strength drops off. It will be necessary to readjust the gain periodically to be sure there is adequate signal for the Receiver to operate.

Chapter

2

Telephone Cable Locating Techniques

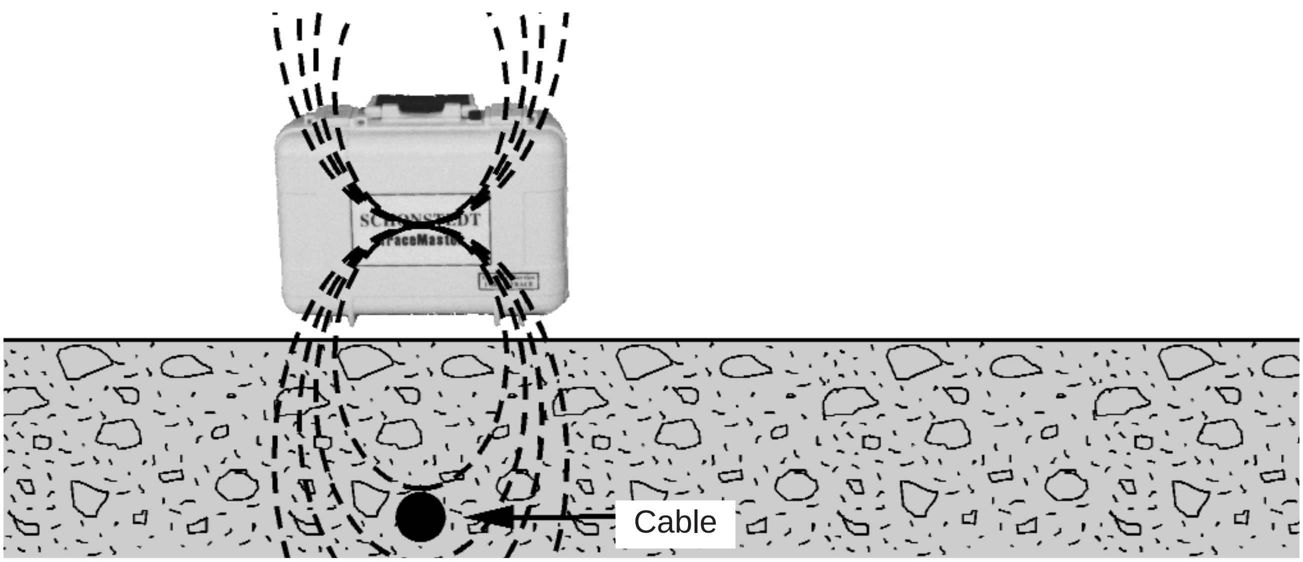
Introduction

Read Chapter One of this manual to learn more general information about each of the following signal application methods. The following paragraphs provide specific instruction on applying signal for telephone cable locating.

Applying Signal to Telephone Cables:

Inductive method

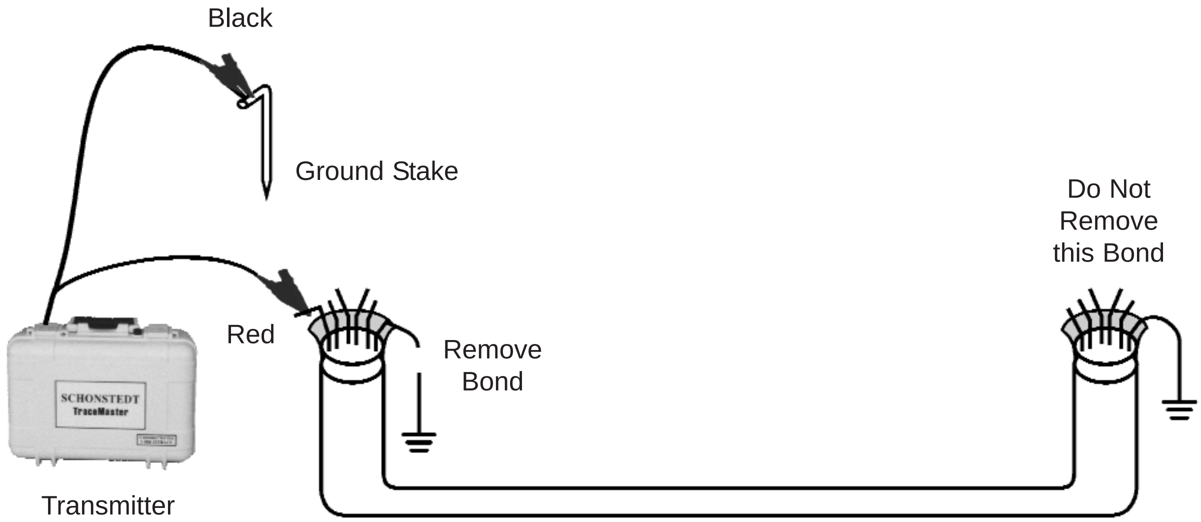
The Inductive method broadcasts signal into an area. No access to the cable is necessary. Use this only when no other buried conductors are present, or when locating all buried services in a general area.



Place the Transmitter on the ground over the cable to be located. The Transmitter arrow should be in line with the cable path, as shown above. Turn the Transmitter on and select the 82 kHz frequency. To be certain that the Transmitter is directly over the cable, use the Receiver to find a good clean peak about 50 feet down the cable. Move the transmitter to this spot. Confirm that this is the target line by backtracking with the receiver to the first site of the transmitter. This procedure of leapfrogging the transmitter is also a good method for extending the tracing range on electrically poor or leaky lines. If the Receiver has trouble picking up the cable path, switch to the higher frequency.

Conductive Method

Use the conductive method for locating a specific cable among other cables, and to find a complete break. You can use this method to trace a single cable or a line for distances up to 5,300 feet. A good electrical contact between the clip and the conductive portion of the target line is essential. You must remove any rust or paint to ensure a good electrical connection. Electrical contact must also be made by driving the ground stake into the ground as far off to the side of the line as the cable will permit. The low frequency 575 Hz signal will not travel beyond a cable break and will not bleed off onto adjacent cables/lines and pipes.



The Conductive method requires access to the cable shield. Disconnect the shield bond at the near-end where the Transmitter is connected. Do not disconnect the far-end shield bond since this supplies a far end ground.

Connect the Conductive connectors to the cable shield and to the ground stake. Connect Red to the shield and black to the stake.

Place the ground stake as far away from the cable path as possible (90 degrees from the suspected cable path). Never ground to water pipes or other services in the area. The returning signal on these services may mislead the trace.

Insert the Conductive cable into the Transmitter jack. Turn the Transmitter on and choose the lowest frequency to get the greatest signal distance down the cable. The trace signal will be on the sheath between the Transmitter and the far end ground.

Observe the OUTPUT POWER LED for a rough indication of the circuit quality the transmitter is hooked to:

If the LED is GREEN, the circuit is very good, which typically means the impedance is below 2 k ohms;

If the LED is alternating between GREEN & RED, the circuit is of medium quality, which typically means the impedance is between 2 and 4 k ohms.

If the LED is RED, the circuit is poor, which typically means the impedance is higher than 4 k ohms.

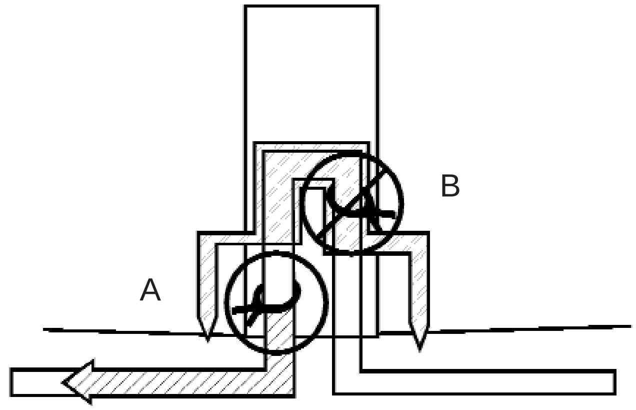
If the indicator is RED or alternating GREEN & RED, you should try to improve the connection (check the cables, the clips, the ground stake, wet the ground, clean rust or dirt, etc.). However, you may not be able to improve the connection. This does not mean that you won't be able to locate. It just means that there is a smaller amount of current circulating in the circuit and you may have to increase your receiver gain, or not be able to trace the signal as far as you would with a higher current.

Inductive Clamp Method

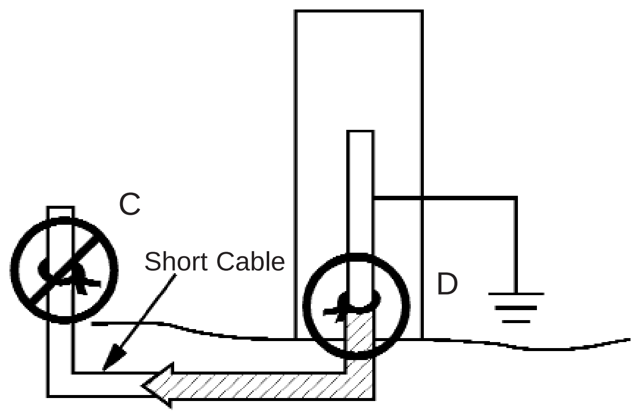
The Inductive clamp puts signal selectively on a cable by clamping around it. This eliminates the need to disconnect the cable. The Inductive clamp puts signal on a cable between grounds, so where you place it is important.

Insert the plug into the transmitter jack BEFORE TURNING THE POWER ON, open the jaws of the clamp and place it so that it completely encircles the desired cable. Make sure the clamp can fully closed.

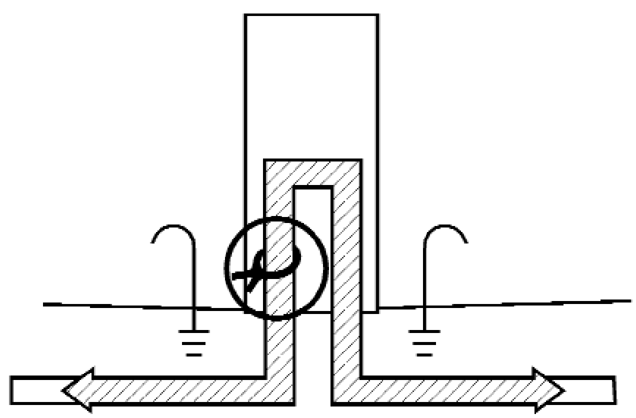
Place the Inductive clamp on the cable between the ground bonding and the point where the cable enters the earth as shown (A). Don't place the clamp above the bond (B); the signal travels to ground, and not onto the cable.



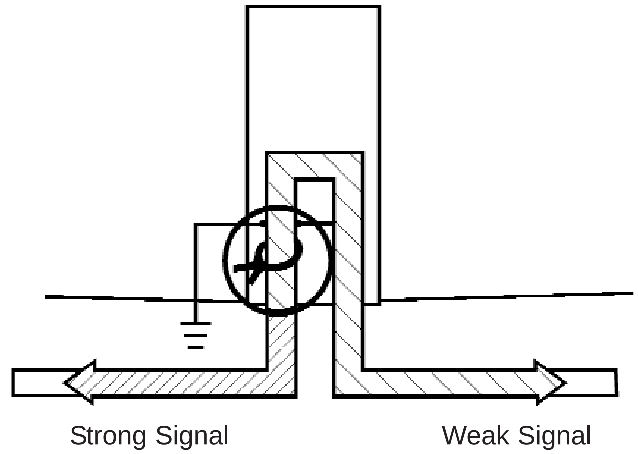
On short cables, such as service drops, do not use the Inductive clamp on an ungrounded end (C). It works better on the grounded end (D). If possible, ground the far-end (C). Use the ground stake and wire. If not, be sure to use the highest frequency possible.



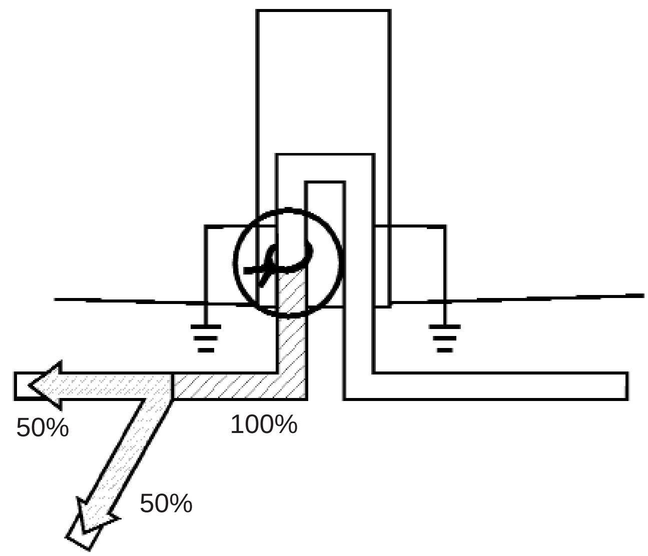
Normally, do not use the clamp on a cable that has the shield ungrounded at both ends. If the cable is long, remove the bonding and signal goes both ways as shown. You must use the highest frequency to increase the signal leakage since there are no grounds



Several cables grounded at a common point present no problem for the Inductive Clamp method. Even though signal is coupled into each cable, the cable with the Clamp is clearly identifiable because it has the strongest signal.



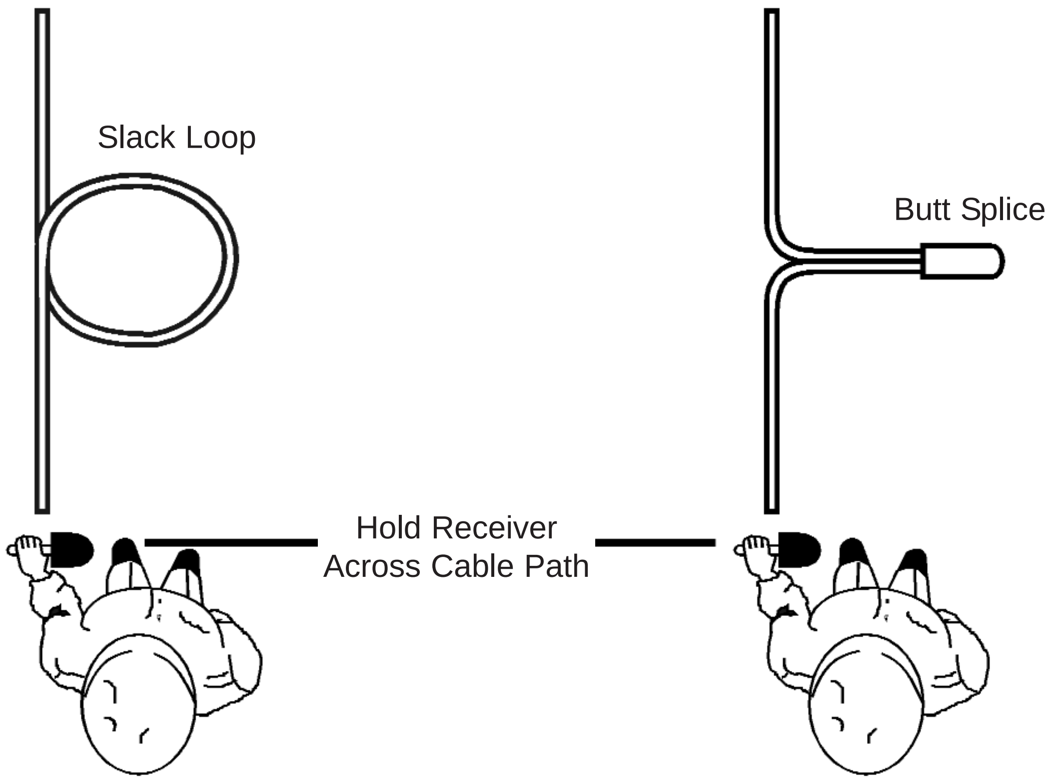
Clamping to a cable with drop lines or laterals puts full signal on the cable until the junction point. The signal may split evenly at the lateral as shown. When tracing, the signal level indication drops when the Receiver passes the junction. This is an easy way to find laterals.



Locating Slack Loops and Butt Splice

During normal tracing procedures, an unexplained loss of signal over a short distance may indicate a buried slack loop or butt splice. Suspect laterals if the signal strength reduces significantly after passing such a spot.

To identify the presence of these features along a cable path, first locate and mark the cable path near the abnormality. Find the strongest response over the marked cable path and check the gain. Retrace the cable path with the Receiver held so the handle is perpendicular to (across) the cable path, as shown. The Receiver will have weak or non-existent response until it passes over a slack loop or butt splice, then the numeric signal strength indicator will increase and the speaker will respond. Mark each response with an “X”. Whenever you encounter such a condition, check to see if an unknown lateral exists.

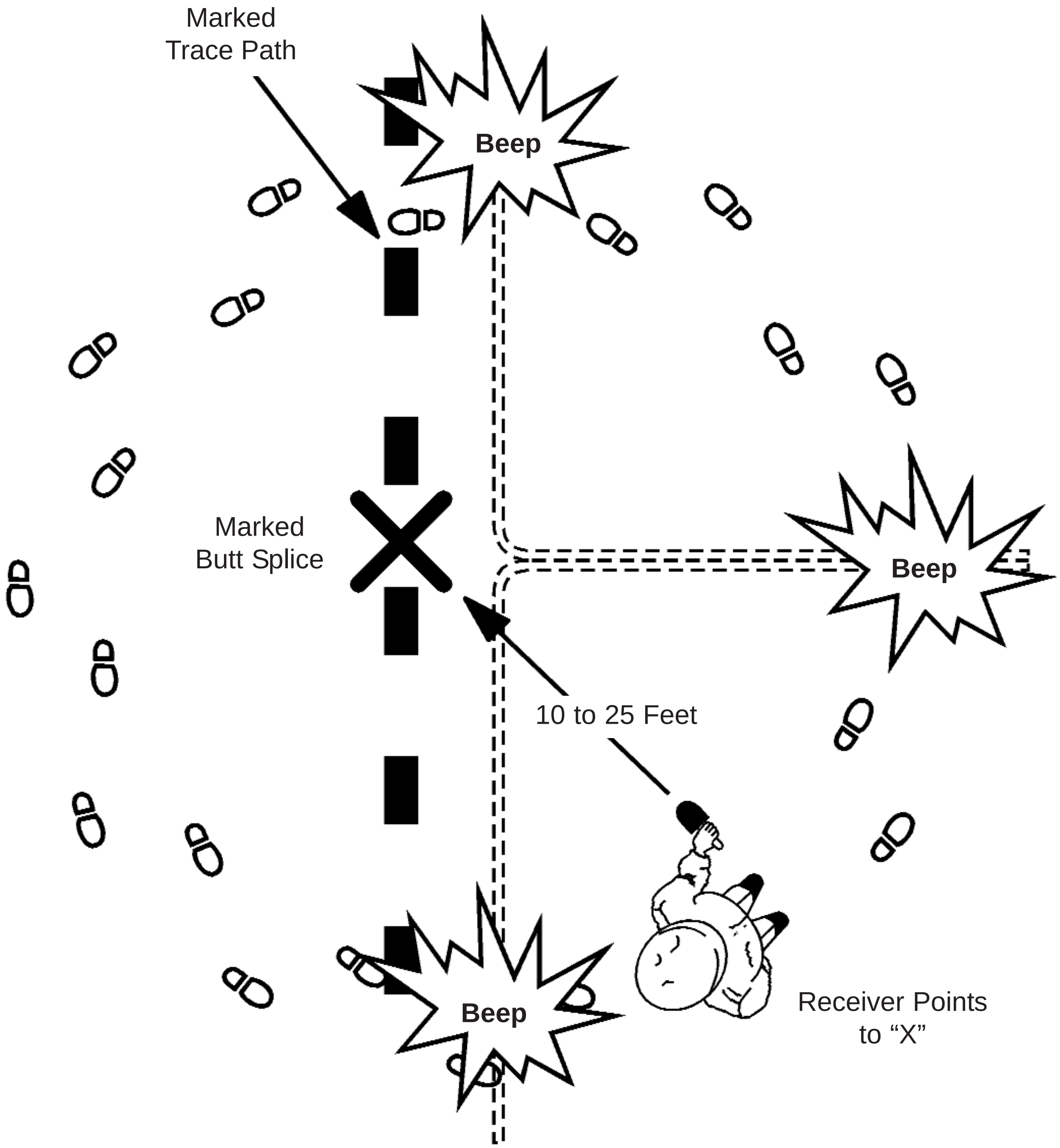


Locating Unknown Laterals

To check for unknown laterals that may radiate from a buried butt splice or closure, perform the procedure to locate butt splices or slack loops. Mark the spot of any detected abnormalities (see above).

Go to the marked trace path and pinpoint the path about 10 to 25 feet from the marked spot. Find a peak response and check the gain. Hold the Receiver so that the display end of the handle points directly to the mark. Walk in a circle around the mark with the Receiver handle pointing to the mark.

The Receiver remains relatively quiet until it crosses a lateral or the actual cable path. Since there could be several laterals radiating from the closure, mark each occurrence of signal around the circle. After you locate each lateral, trace and mark its path.



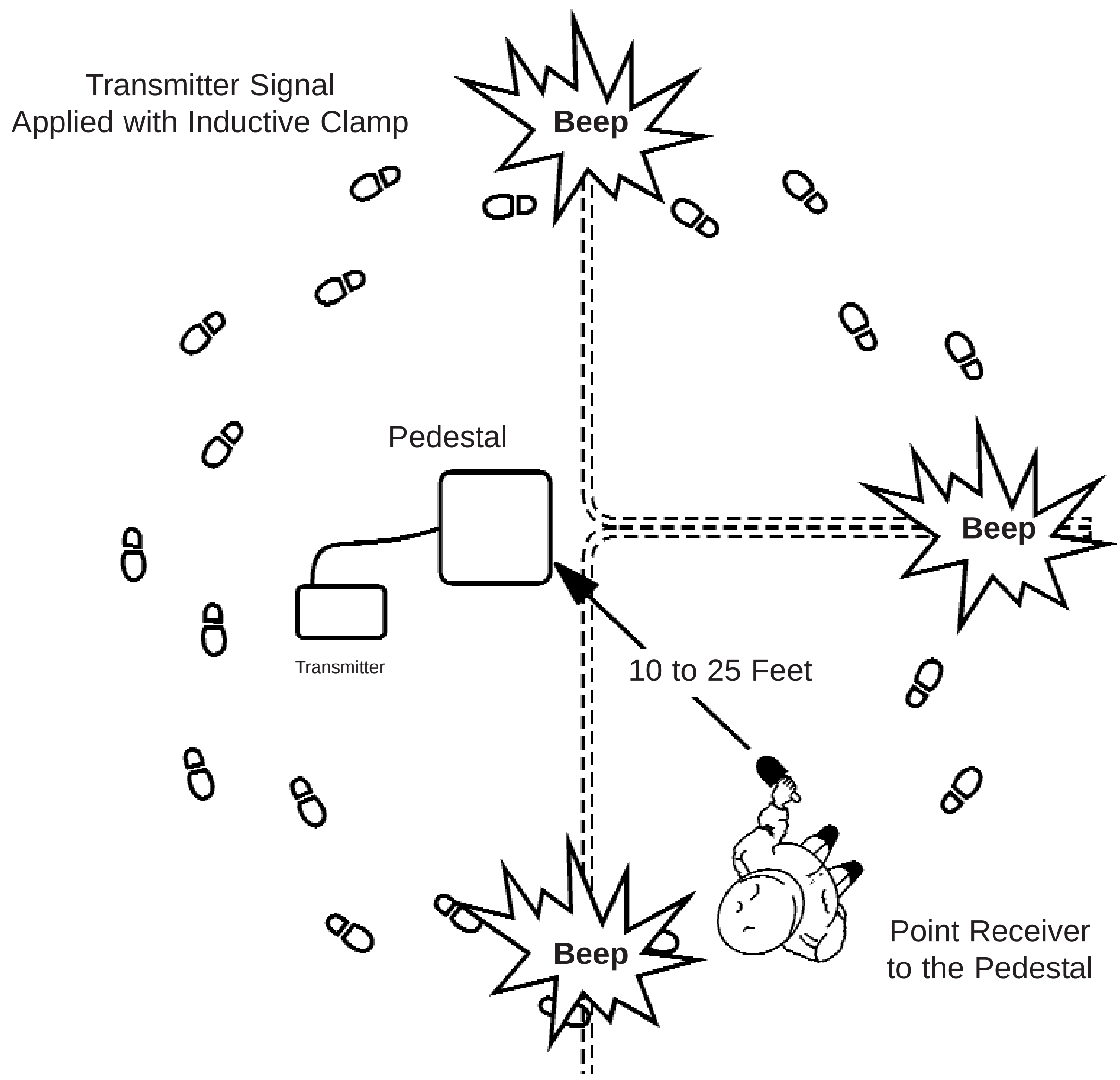
Locating Cables from Pedestals

To locate a single cable path from a pedestal, follow these steps:

At the pedestal, apply tracing signal on the target cable using the Inductive Clamp method. If the header in the pedestal is not grounded, use the ground stake and some wire to ground it.

Walk 10 to 25 feet away from the pedestal. Hold the Receiver so that the display end of the handle points directly to the pedestal. Start walking in a circle around the pedestal with the Receiver always pointing toward the pedestal.

The Receiver remains relatively quiet until it crosses a cable. Stop when there is a response. Find the point of strongest signal and adjust the gain. Check the numeric display for signal strength. Remember the number and continue walking the circle. As you walk away from the cable, the signal drops. When you encounter another response, find the point of strongest signal and note the signal strength number. After completing the circle, the cable with the greatest signal strength is the target cable.



Locating Service Drops

When locating the path of a service drop from a house or other building, it is more convenient to apply signal at the house or building. Connect the Transmitter using the Conductive method. Use the standard tracing techniques described earlier.

Locating an Open End

To locate an un-terminated or open end of a cable or drop, follow these steps.

If the cable is bonded to ground at the access point, connect the Transmitter using the Inductive Clamp method. Otherwise, if the cable is not bonded to ground at the access point, connect the Transmitter using the Conductive method. With either method, choose the highest frequency available.

Trace the cable path. The receiver's response decreases suddenly at the site of the clear or severed end.

Fiber Optic Locating

Can the Fiber Be Traced?

Fiber optic cables consist of fragile optical fibers encased in a strengthened outer member. The internal sheath of the cable may or may not be metallic. If it is not metallic, the manufacturer may include a metallic strength member (wire) within the sheath. Some fiber optic cables have no internal metal structure, in which case the contractor installing the cable may pull an insulated wire through the underground duct with the fiber optic cable. If a metallic conductor is not in or next to the fiber optic cable, you cannot trace the cable path. You must then rely on site plans for physical location.

You normally find underground fiber optic cable installed in a duct, or a tube within the duct. The installation is normally made from a central office to a remote terminal office or distribution point. There may be several splice points in hand holes or manholes along the route. Installation practices generally require that the fiber optic cable metallic sheath or strength member be grounded at the terminating ends. Bonding practices at the splice points vary by company. Therefore, the metallic strength member may or may not be grounded or may be grounded through a remotely actuated relay or a voltage transient suppression device.

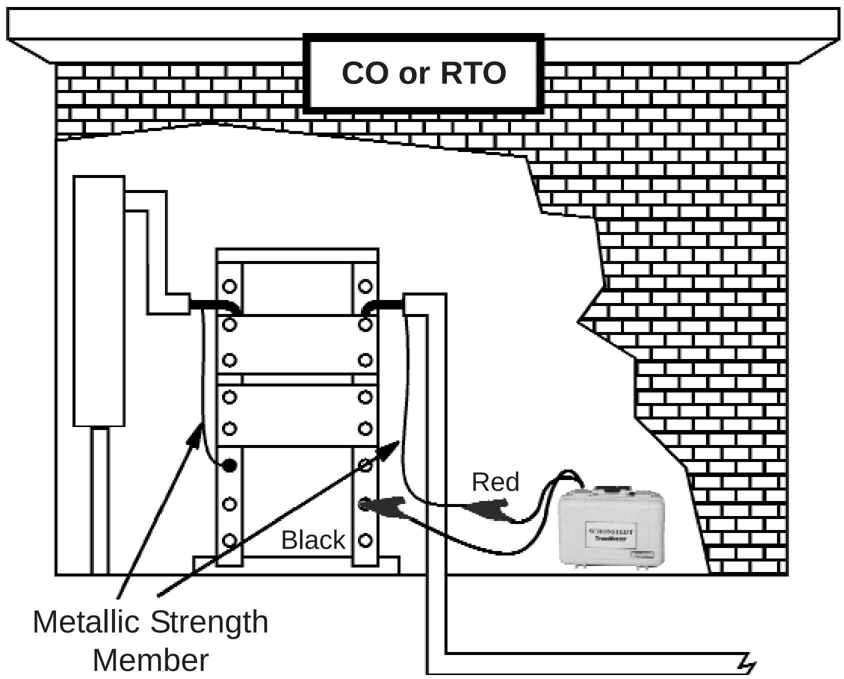
Some installations include a permanently installed rack-mounted transmitter that can selectively place a tracing signal on one of several fiber optic cables. If this transmitter produces a 575 Hz or 512 Hz signal, you can trace the fiber optic cable using your Receiver, if it is equipped with the 512 Hz sonde mode

Applying the Trace Signal

If the office installation includes a rack-mounted transmitter, check to see if your Receiver has the same frequency and modulation as your receiver. To use the transmitter, attach it to the sheath or strength member of the fiber optic cable to be traced and turn it on. If the transmitter frequency does not match the Receiver, or a rack-mounted transmitter is not available, attach your Transmitter at the CO or Remote Terminal Office, or at an intermediate splice point.

Attaching at CO or Remote Terminal Office

To attach the Transmitter at the Central Office or Remote Terminal Office, bring it to the location in the office where the fiber optic cable strength member is grounded. Typically, this is near the rack-mounted digital conversion equipment. Locate and disconnect the metal strength member from the frame or rack ground point. This is where the Transmitter attaches.



Connect the Conductive connectors to the metal strength member and to the frame or rack ground point.

Insert the Conductive cable plug into the Transmitter jack. Turn the Transmitter on and choose the lowest frequency (575 Hz) to get the greatest signal distance down the cable.

Observe the OUTPUT POWER LED on the Transmitter for a rough indication of the quality of the connection:

If the LED is GREEN, the circuit is very good, which typically means the impedance is below 2 k ohms. The circuit could be too good. There may be another ground point on the strength member within the CO. If you find there is no signal outside the CO, suspect another ground.

If the LED is alternating between GREEN & RED, the circuit is of medium quality, which typically means the impedance is between 2K and 4K ohms. This may be an indication of an open between this connection point and the ground at the terminating end or intermediate splice points. A diminished signal will be placed on the fiber optic cable outside the building.

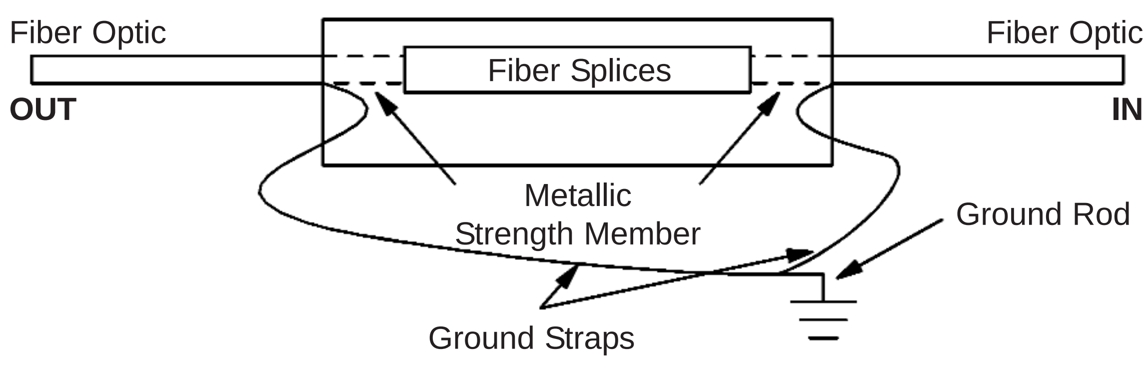
If the LED is RED, the circuit is poor, which typically means the impedance is higher than 4 k ohms. This is an indication of an open circuit or no far-end ground. Or maybe the wrong circuit completely. Very little signal will be placed on the fiber optic cable outside the building.

If the indicator is RED or alternating GREEN & RED, you should try to improve the connection (check the cables, the clips, the frame ground, the far-end ground(s), clean rust or dirt, etc.). However, you may not be able to improve the connection. This does not mean that you won't be able to locate. It just means that there is a smaller amount of current circulating in the circuit and you may have to increase your receiver gain, or not be able to trace the signal as far as you would with a higher current.

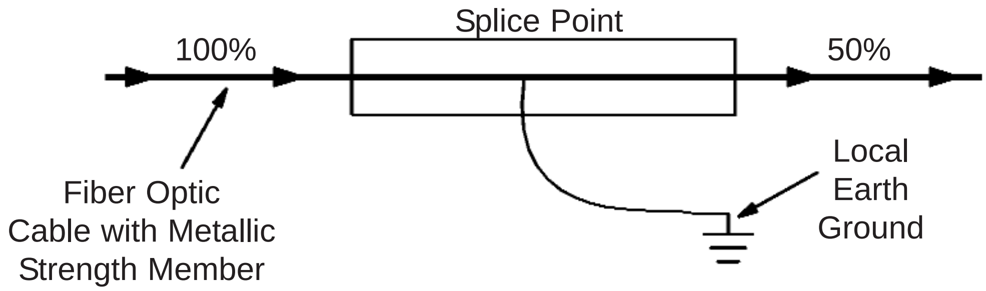
Attaching at the Splice Point

To attach the Transmitter at a field splice point, see if the splice case has one or two metal straps connected to ground. If so, you can attach the Transmitter at this location.

If the splice case has two straps, one of them most likely attaches to the metallic sheath or strength member on the incoming side and the other strap attaches to the outgoing side. This lets you connect the Transmitter to the incoming or outgoing side. The two straps may also be connected inside the splice case.



Maximum tracing signal is obtained by disconnecting the bonding strap(s) from the ground point before attaching the Transmitter, but local practice may not allow this. In this case, the signal splits between the incoming cable, outgoing cable, and the ground point, thus reducing the tracing range.



Tracing Fiber Optic Cable

When tracing from a CO or Remote Terminal office, move to the cable's expected exit point outside the building. Search the area until a signal is received.

When tracing at a manhole or hand hole, hold the Receiver so that the display end of the handle points directly towards the hole. Walk in a circle around the hole until a signal is detected. Find a peak, check the gain, and trace the path of the cable.

When tracing a cable over a long distance, the signal strength decreases. This can be caused by the signal "bleeding" off into the earth due to capacitance or by additional grounds at splice points along the fiber optic cable. The "bleeding" effect causes a gradual reduction in signal strength as the Receiver moves along the cable. The splice point ground causes an abrupt or distinct drop in signal because the signal is split between the outgoing fiber optic cable and the local ground. These intermediate ground points can severely limit the tracing distance. This abrupt drop in signal is a good indication of the presence of an earth ground at a splice point.

Chapter

3

Power Cable Locating Techniques

Applying Signal to Power Cables

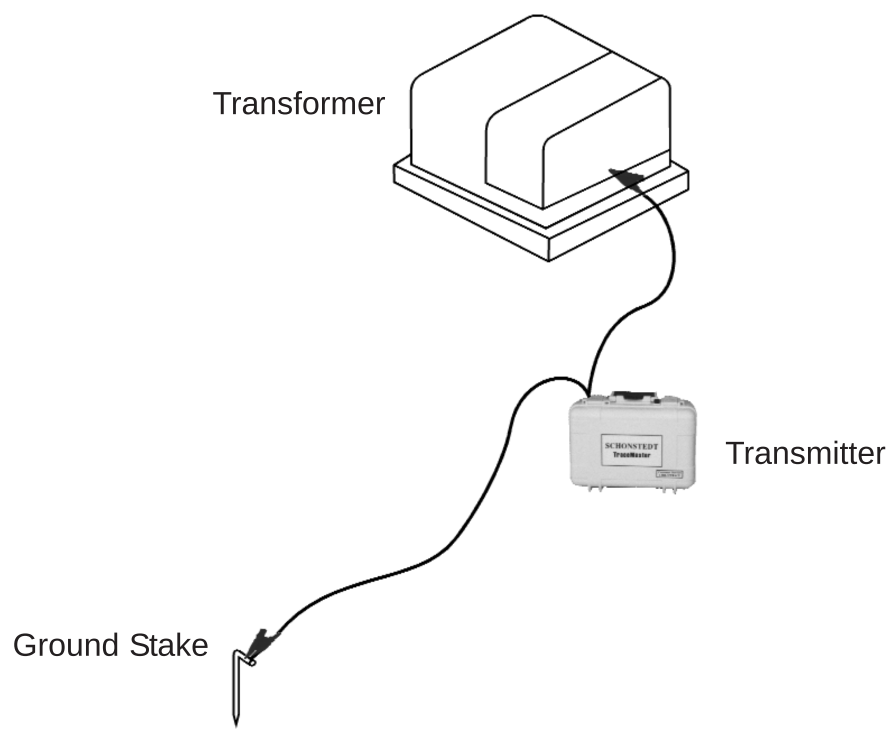
(Passive 60 Hz Locating is explained in the Cable & Pipe Locating Basics - Chapter 1)

Applying signal to Power Cables: Conductive Method

There are several possibilities for directly connecting the Transmitter to apply signal, including applying signal to the transformer, meter, and cable to be located.

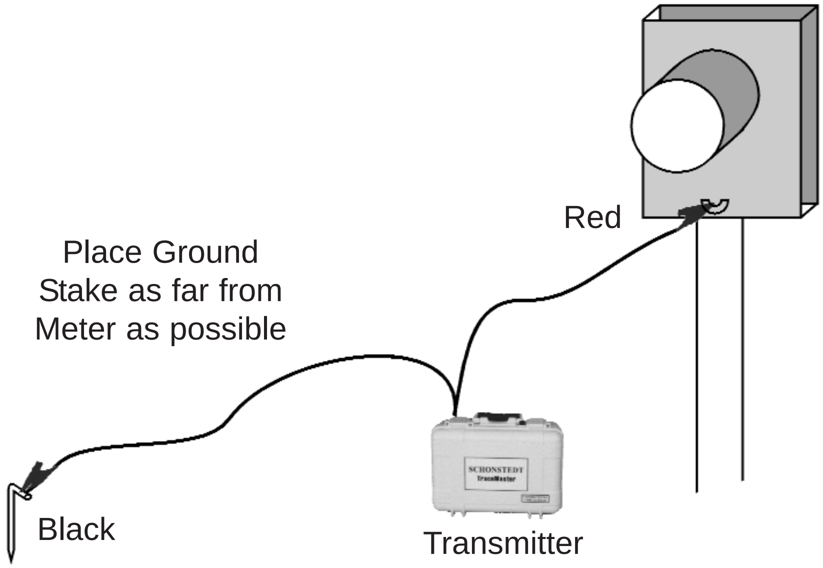
Applying Signal to the Transformer

The transmitter signal can be applied to all neutrals (both primary and secondary) that are grounded at the transformer by simply connecting the Transmitter to the transformer cabinet. There is no need to open the transformer or to de-energize any of the cables. However, all the neutrals will be carrying signal and it may be difficult to identify a single cable.



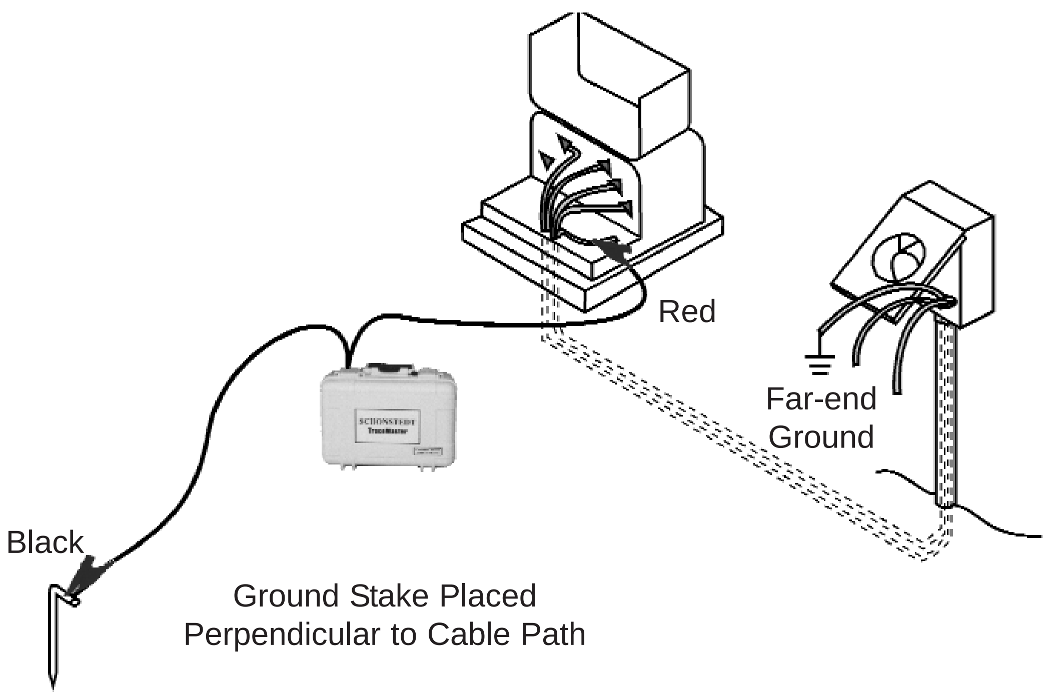
Applying Signal at the Meter

Since the secondary neutral connects to ground at the meter as well as the transformer, you can locate energized secondary cables by connecting the Transmitter directly to the meter box. The meter box is the preferred point to apply signal because the transformer usually has better grounding to earth than the meter. The locating signal will be weaker if applied at the transformer. You must place the Transmitter ground stake as far away from the meter ground as possible. If necessary, extend the ground lead with insulated wire. This technique is fast since you do not have to open the transformer, or break the meter seal. Select the lowest frequency (575 Hz); it does not couple to other grounded cables as easily as a higher one, but will place equal signals on telephone and CATV cables if common bonding is used.



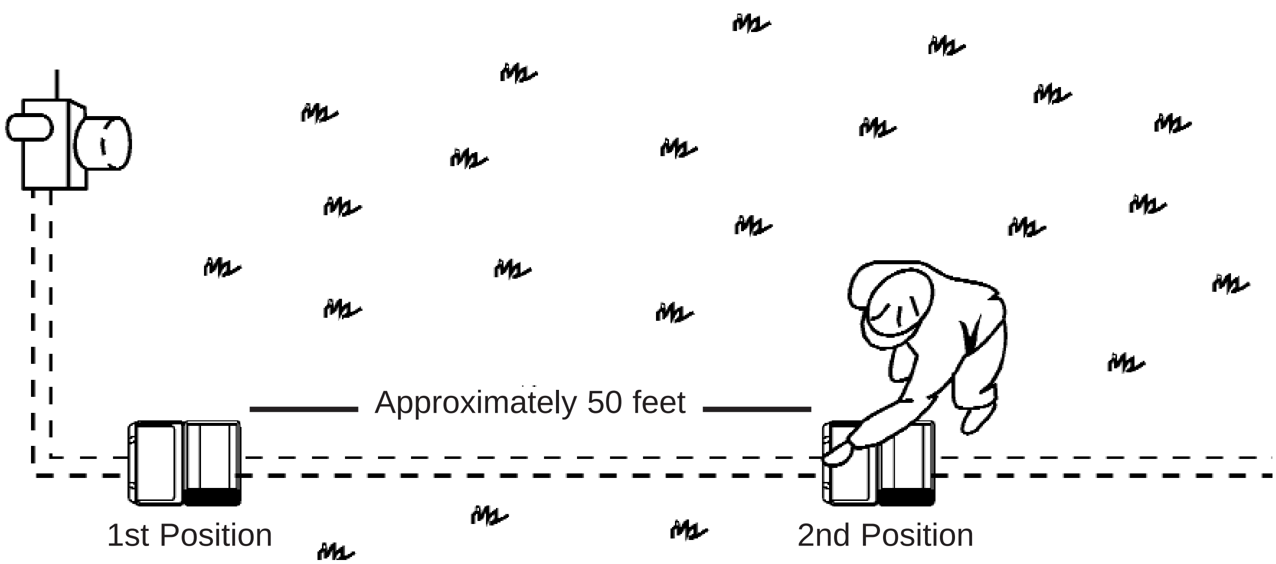
Applying Signal to a De-Energized Secondary

On de-energized cables with the far-end grounded, connect the Transmitter directly to the center conductor of the cable to isolate signal to that one cable. Use the Conductive method as shown to apply signal.



Applying Signal to Power Cables: Inductive Method

Both primary and secondary cables can be located with this method. Place the Transmitter on the ground over the cable to be located. The Transmitter arrow should be in line with the cable path, as shown below. Turn the Transmitter on and select the 82 kHz frequency. To be certain that the Transmitter is directly over the cable, use the Receiver to find a good clean peak about 50 feet down the cable. Move the transmitter to this spot. Confirm that this is the target line by backtracking with the receiver to the first site of the transmitter. If the Receiver has trouble picking up the cable path, switch to the higher frequency.



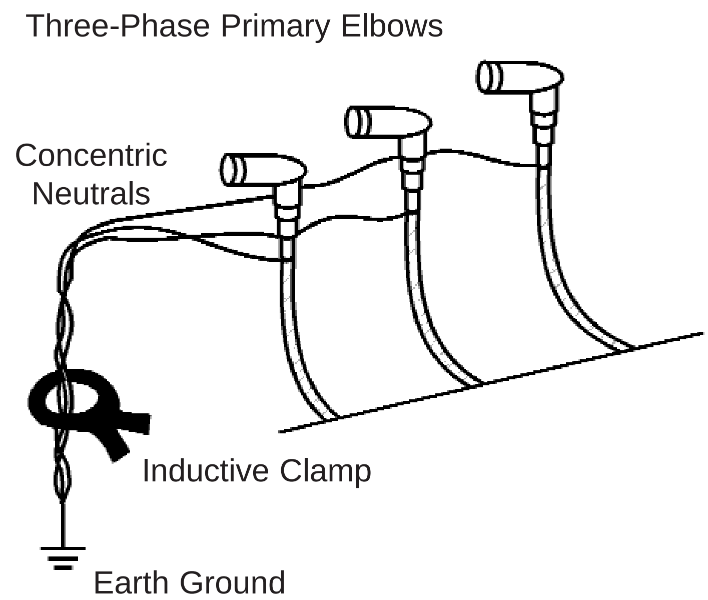
Applying Signal to Power Cables: Inductive Clamp Method

Applying Signal to Primary Cables

Use the Inductive Clamp method to put tracing signal only on the neutral of primary energized cables - never on the primary cable itself. The neutral and its grounds form a circuit path for the signal to follow. When you apply signal with the Inductive Clamp to the neutral anywhere between grounds, signal will be on the section between the grounds.

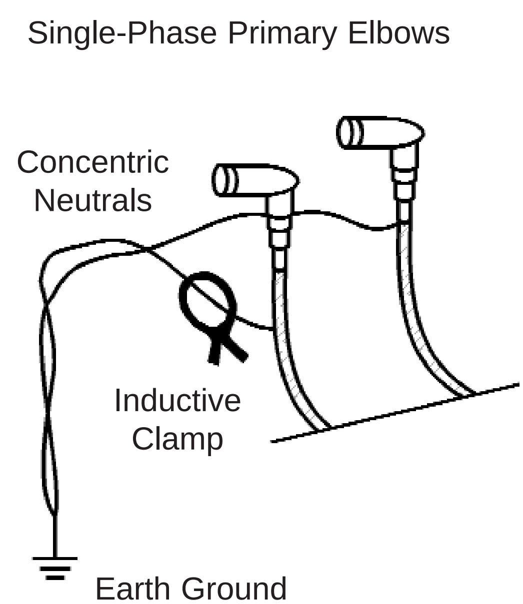
Always make sure the Inductive Clamp jaws are fully closed, and use a frequency of 82 kHz or higher.

Where you clamp the Inductive Clamp on the concentric neutral is very important. On three-phase primary cable, clamp the Inductive Clamp on all the concentric neutrals as close to the earth ground as possible. The signal is coupled onto each cable equally.



It is important ***not*** to place the clamp around one of the individual primary cables. Not only is this dangerous, but the cables are buried in the same trench, causing a canceling effect as signal goes one way on one cable and the opposite way on the other.

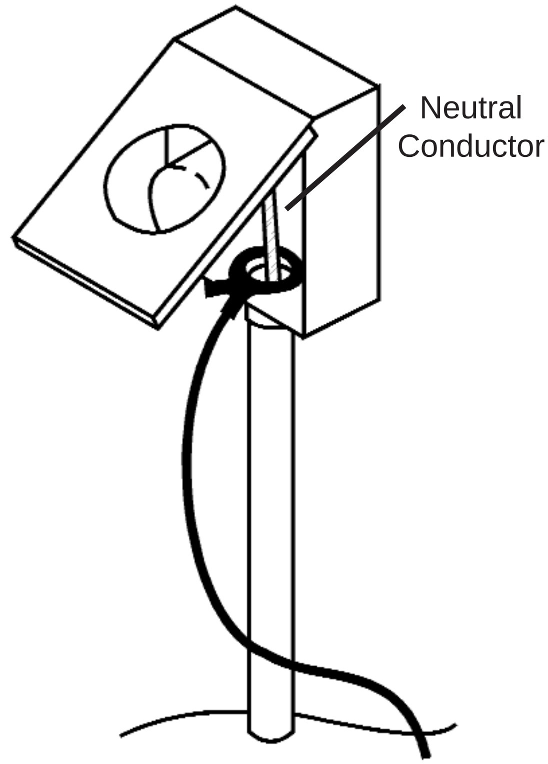
On single-phase primary cable used in a loop configuration, canceling is not a problem. You can apply signal with the Inductive Clamp to the individual concentric neutral of the cable to be located as shown.



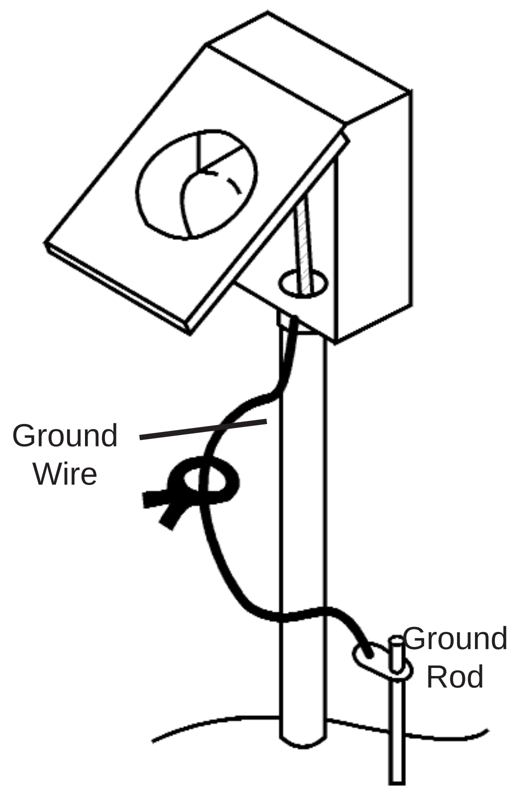
Applying Signal to Secondary Cables

To locate secondary cables, the easiest access to the neutral is at the meter box. There are several ways to put signal on the neutral. If the riser pipe is nonmetallic (usually PVC), clamp the Inductive Clamp around the pipe. The jaws of the clamp must fully close for signal transmission. This may be impossible if the riser is flush with the mounting structure or bigger than your clamp.

If this is the case and access is permitted, break the seal and open the meter box and clamp around the neutral in the box as shown.

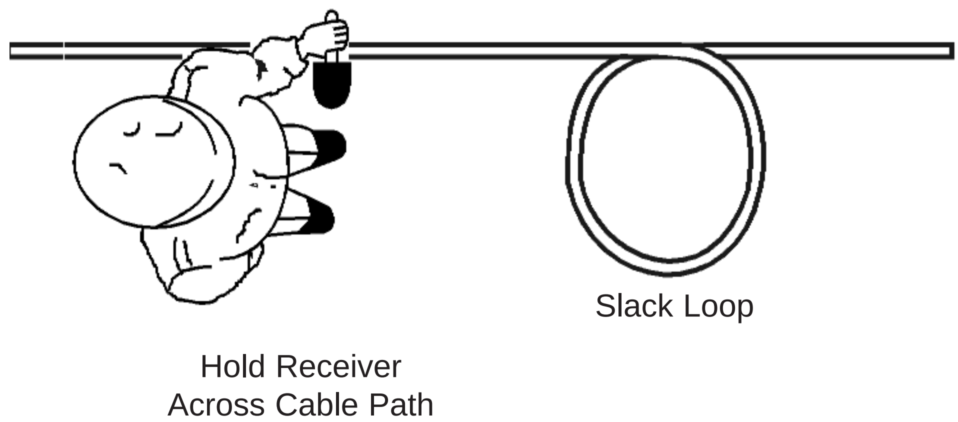


Some meters may have an external ground wire from the meter box to an earth ground. Clamp around the wire as shown. This puts signal on the neutral since the ground wire is connected to the neutral in the meter box. Make sure you place the Inductive Clamp above other utilities that may be grounded at the ground rod, or signal will be applied to them also.



Identifying Slack Loops

During normal tracing procedures, an unexplained loss of signal over a short distance may indicate a buried slack loop. To identify the presence of this feature, first locate and mark the cable path for a short distance on both sides of the abnormality. Find the strongest response over the marked cable path and check the gain. Retrace the marked cable path with the Receiver held so the handle is perpendicular to (across) the cable path, as shown. The Receiver will have weak or non-existent response until it passes over the slack loop, then the numeric signal strength indicator will increase and the speaker will respond.



Identifying A Cable Open End

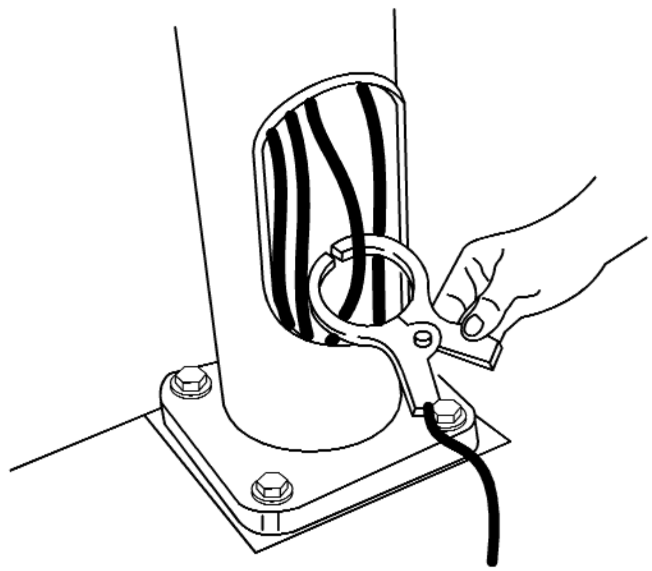
It is sometimes necessary to locate the open end of a buried power cable. The cable could have been severed or buried intentionally as in new construction. If the cable end is insulated from earth ground, use the following technique.

If the cable is grounded at the access point, connect the Transmitter using the Inductive Clamp method. Otherwise, if the cable is not grounded at the access point, connect the Transmitter using the Conductive method. With either method, choose the highest frequency available.

Trace the cable path. The receiver's response decreases suddenly at the site of the clear or severed end.

Locating Buried Streetlight Cables

Buried cables that bring power to streetlights are normally not energized in the daytime. Each streetlight has a light sensitive switch that will open during daylight hours. Trying to locate these cables using the passive power frequencies (either 50 or 60 Hz) will not work. Street light cables appear to be floating (no grounds) since the supply is a transformer and the light sensitive switch is open. This means there is no return path for a tracing signal to return to the transmitter. To put a tracing signal on the cable, use the Inductive Clamp and the highest frequency available. The easiest point to apply the signal is at the base of the light.



Before you dig, check all the nearby streetlights to keep from excavating a dangerous power cable.

Chapter

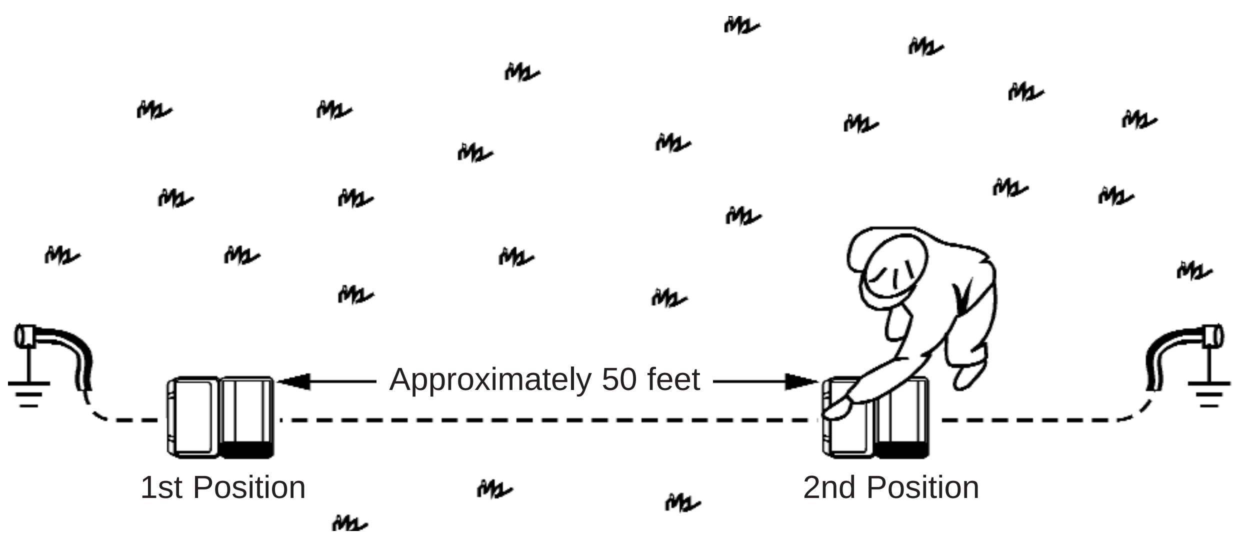
4

CATV Cable Locating Techniques

Applying Signal to CATV Cables

Applying Signal to CATV Cables: Inductive Method

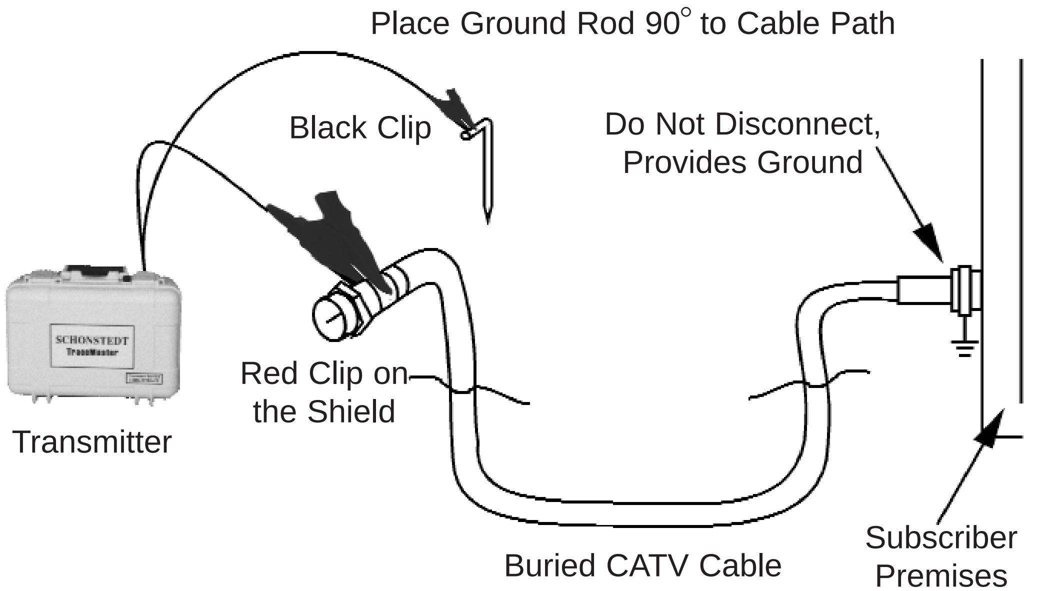
Place the Transmitter on the ground over the suspected cable path. Do not disconnect either end of the cable as this provides grounds. The Transmitter arrow should be in line with the cable path. Turn the Transmitter on and select the 82 kHz frequency. To be certain that the Transmitter is directly over the cable, trace the cable for about 50 feet. Find a spot that has a good clean peak. Move the transmitter to this spot (as shown below). Confirm that this is the target line by backtracking with the receiver to the first site of the transmitter.



If the Receiver has trouble picking up the cable path, switch to a higher frequency.

Applying Signal to CATV Cables: Conductive Method

The Conductive method requires access to the cable shield. Disconnect the cable where the Transmitter is to be connected. Do not disconnect at the far-end (subscriber's premises) since this supplies a far-end ground. Perform the following steps to use the Conductive method.



Connect the Conductive connectors to the cable shield and to the ground stake. Connect Red to the shield and black to the stake.

Place the ground stake as far away from the cable path as possible (90 degrees from the suspected cable path). Never ground to water pipes or other services in the area. The returning signal on these services may mislead the trace.

Insert the Conductive cable plug into the Transmitter jack. Turn the Transmitter on and choose the lowest frequency to get the greatest signal distance down the cable. The trace signal will be on the sheath between the Transmitter and the far end ground.

Observe the OUTPUT POWER LED for a rough indication of the circuit quality the transmitter is hooked to:

If the LED is GREEN, the circuit is very good, which typically means the impedance is below 2 k ohms.

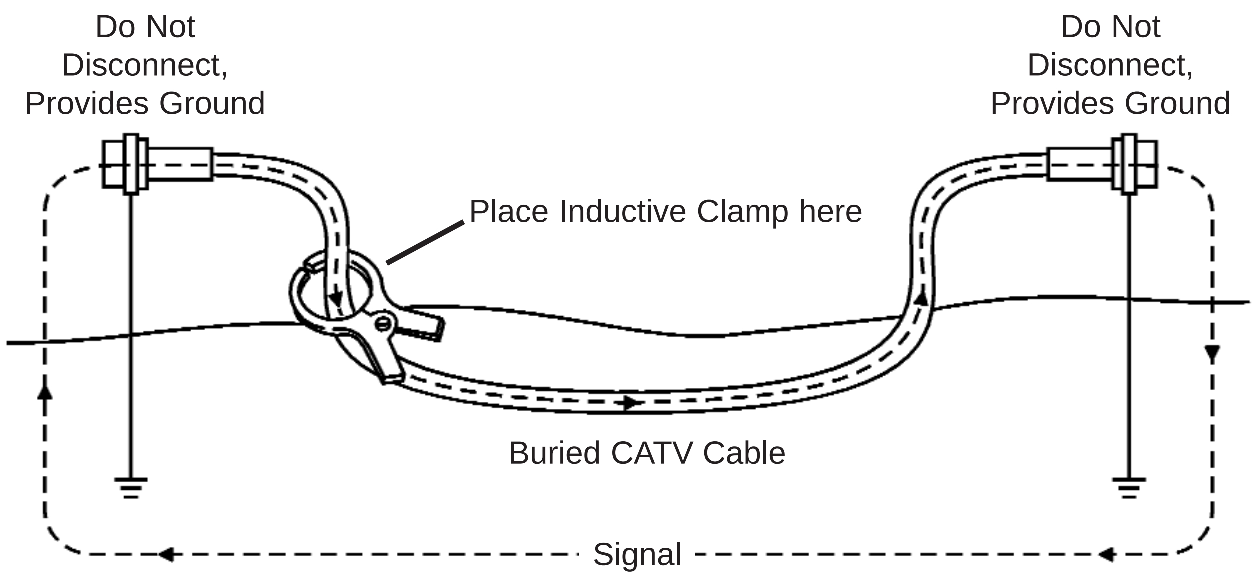
If the LED is alternating between GREEN & RED, the circuit is of medium quality, which typically means the impedance is between 2K and 4K ohms.

If the LED is RED, the circuit is poor, which typically means the impedance is higher than 4 k ohms.

If the indicator is RED or alternating GREEN & RED, you should try to improve the connection (check the far-end ground, the cables, the clips, the ground stake, wet the ground, clean rust, paint or dirt, etc.). However, you may not be able to improve the connection. This does not mean that you won't be able to locate. It just means that there is a smaller amount of current circulating in the circuit and you may have to increase your receiver gain, or not be able to trace the signal as far as you would with a higher current.

Applying Signal to CATV Cables: <u>Inductive Clamp Method</u>

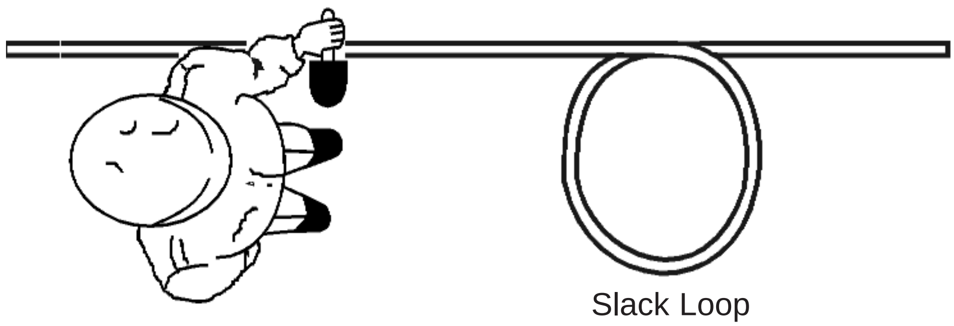
The Inductive Clamp is the easiest method to apply signal to a CATV cable. It is not necessary to disconnect the cable. Open the clamp jaws and place them around the desired cable. Make sure that the jaws close completely.



The Inductive Clamp couples the Transmitter signal onto the cable. The cable and its shield grounds form a complete circuit path for the signal to follow. When the Inductive Clamp is applied to the cable anywhere between earth grounds, signal is on the section between the grounds. Be aware that the shield may be grounded at the subscriber's premises and also at a bridging amplifier on an aerial feeder line several blocks away. Everything between these grounds will carry signal. A removable ground (use the ground stake and some insulated wire) placed at a surface access point limits signal to that part of the cable between the grounds and keeps signal from going where it is not needed. Remove the ground when the job is finished.

Locating Cable Slack Loops

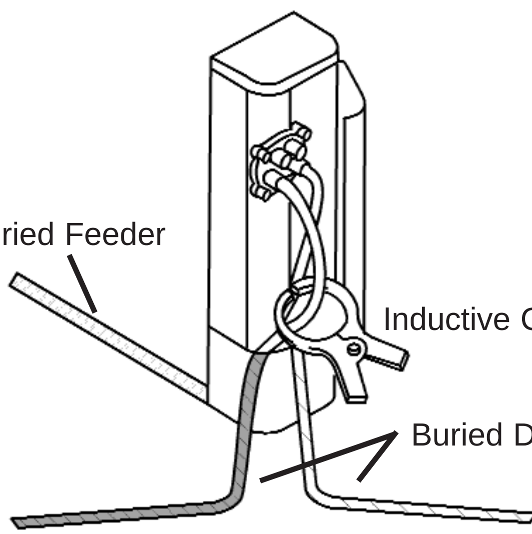
During normal tracing procedures, an unexplained loss of signal over a short distance may indicate a buried slack loop. To identify the presence of this feature, first locate and mark the cable path for a short distance on both sides of the abnormality. Find the strongest response over the marked cable path and check the gain. Retrace the marked cable path with the Receiver held so the handle is perpendicular to (across) the cable path, as shown. The Receiver will have weak or non-existent response until it passes over the slack loop, then the numeric signal strength indicator will increase and the speaker will respond.



Locating CATV Cables from Pedestals

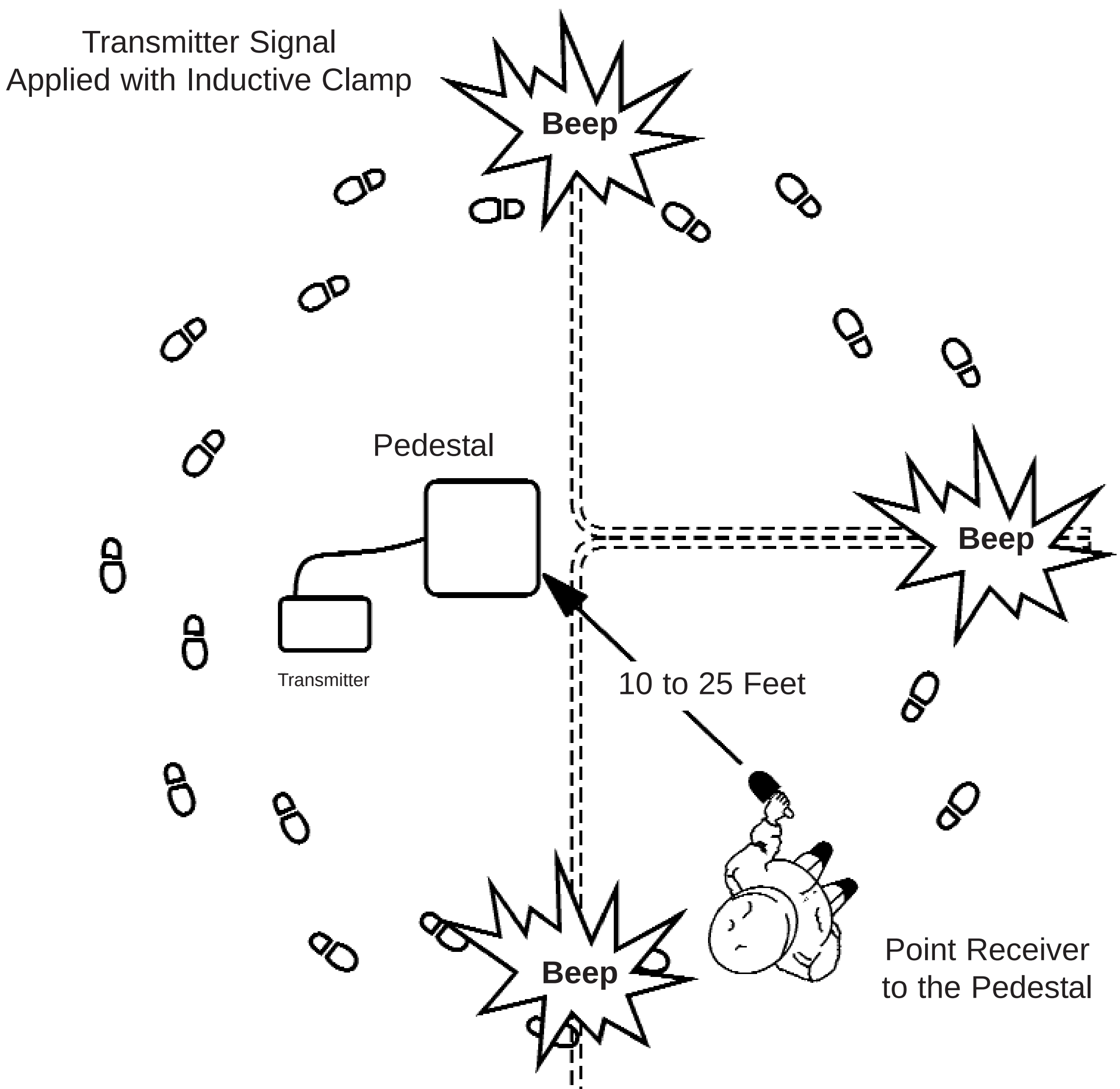
To locate a single CATV cable path from a pedestal, follow these steps:

At the pedestal, apply tracing signal on the target cable using the Inductive Clamp method. You can identify one of several CATV cables that fan out from a common point, as in a header pedestal. Even though signal is coupled onto each cable, the cable with the Inductive Clamp is clearly identifiable because it has the strongest signal. If the header in the pedestal is not grounded, use the ground stake and some wire to ground it. This helps shorten the ground return path and increases signal.



After applying the transmitter signal, walk 10 to 25 feet away from the pedestal. Hold the Receiver so that the display end of the handle points directly to the pedestal. Start walking in a circle around the pedestal with the Receiver always pointing toward the pedestal.

The Receiver remains relatively quiet until it crosses a cable. Stop when there is a response. Find the point of strongest signal and adjust the gain. Check the numeric display for signal strength. Remember the number and continue walking the circle. As you walk away from the cable, the signal drops. When you encounter another response, find the point of strongest signal and note the signal strength number. After completing the circle, the cable with the greatest signal strength is the target cable.



Chapter

5

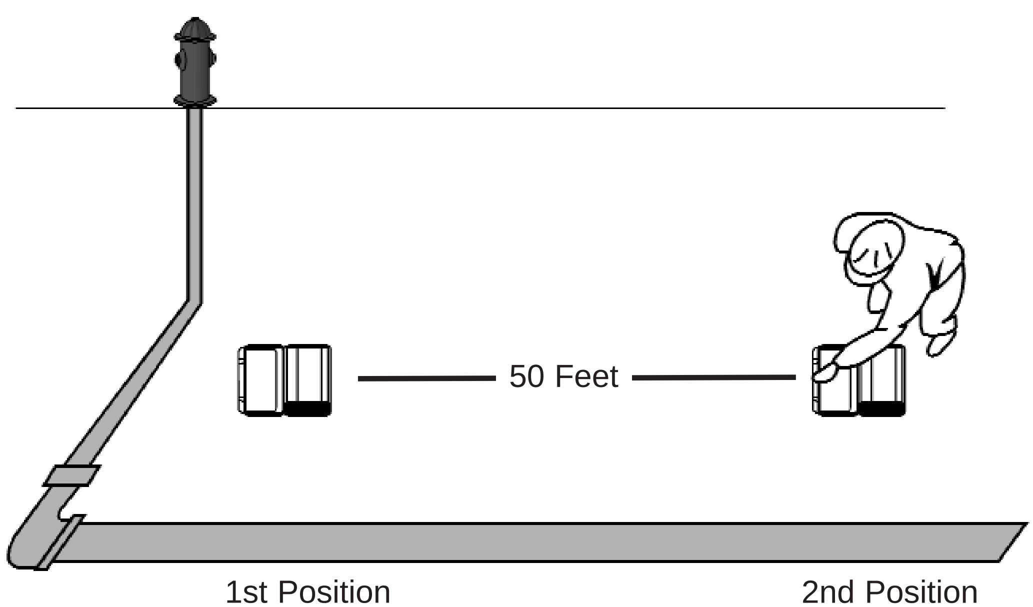
Pipe Locating Techniques

Applying Signal to Pipe

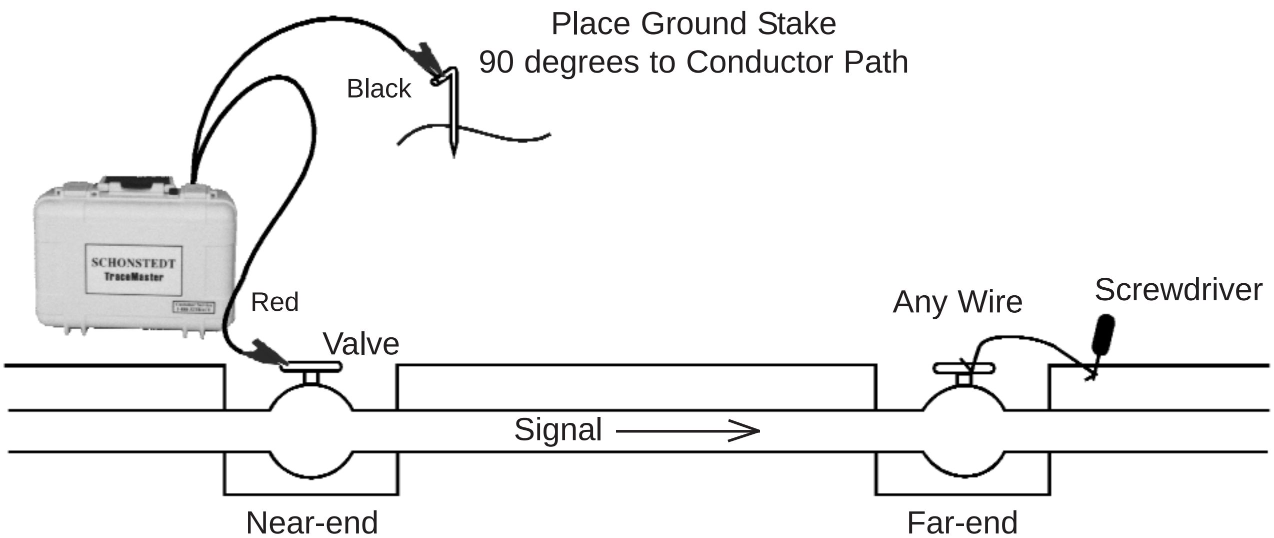
Applying Signal to Pipe: Inductive Method

Place the Transmitter on the ground over the suspected pipe path. The Transmitter arrow should be in line with the path. Turn the Transmitter on and select the 82 kHz frequency. To be certain that the Transmitter is directly over the pipe, trace the pipe for about 50 feet. Find a spot that has a good clean peak. Move the transmitter to this spot (as shown below). Confirm that this is the target pipe by backtracking with the receiver to the first site of the transmitter. If the Receiver has trouble picking up the pipe path, switch to a higher frequency.

This procedure of leapfrogging the transmitter is also a good method for extending the tracing range on pipe with insulated pipe joints or uncoated pipe that allows the signal to leak off rapidly.



Applying Signal to Pipe: Conductive Method



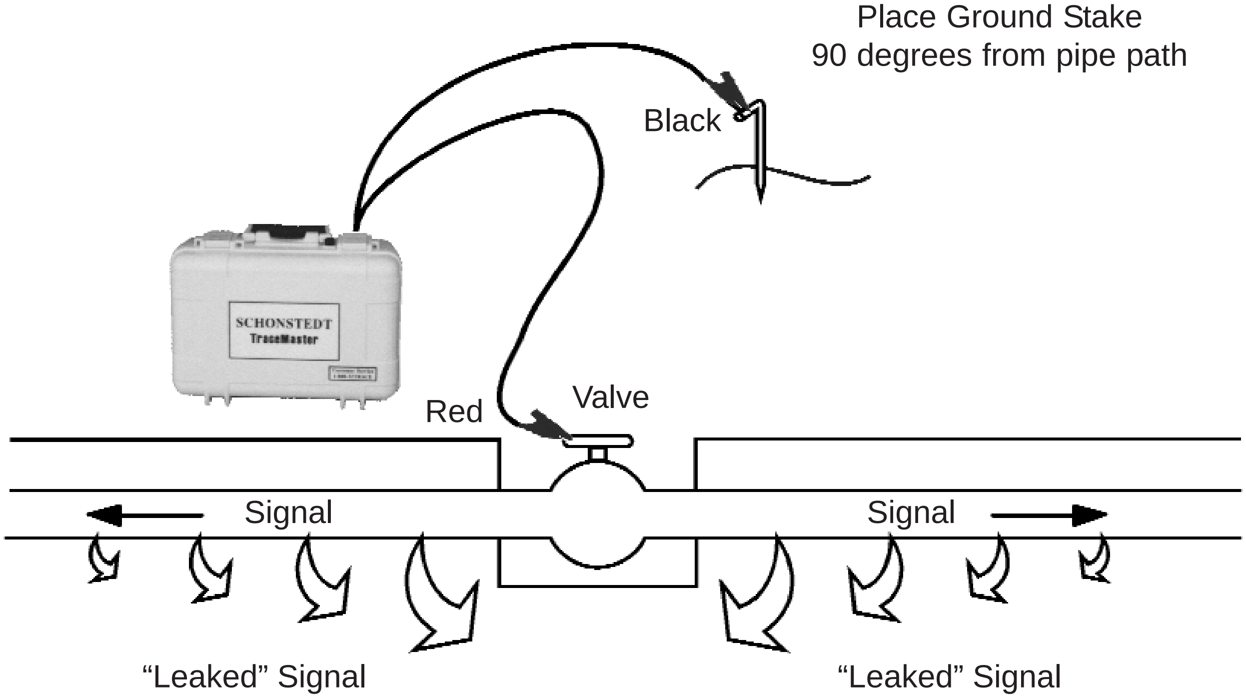
You can use the Conductive method to apply tracing signal to a coated metallic pipe at an access point such as a valve, meter, or the metal pipe itself. The red lead is connected to the pipe and signal current travels down the pipe. The return path to the Transmitter is through a far-end earth ground such as a screwdriver stuck in the ground or by system grounding at buildings. Ground stake placement completes the circuit back to the Transmitter via the black lead. Some pipe systems are sectionalized by using nonconducting gaskets at selected pipe joints. These insulated pipe joints will stop the signal current and limit the distance you can trace.

Connect the Conductive connectors to the pipe and to the ground stake. Connect Red to the pipe and black to the stake.

Place the ground stake as far away from the pipe path as possible (90 degrees from the suspected cable path.

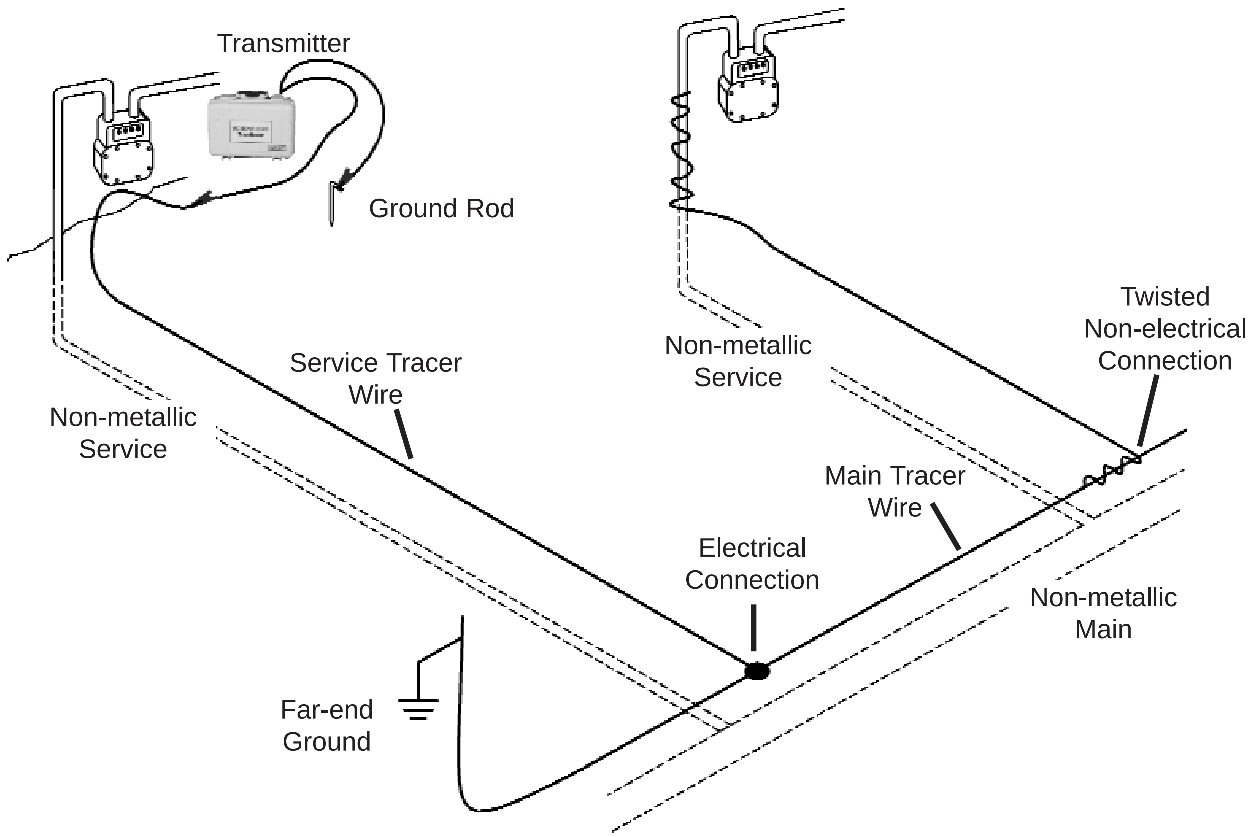
Insert the Conductive cable into the Transmitter jack. Turn the Transmitter on and choose the lowest frequency (575 Hz) to get the greatest distance.

If no far-end access is available to apply a far-end ground, you can still use the Conductive method. The red lead connected to the pipe sends signal current in both directions from the application point. The signal continuously 'leaks off' the pipe and returns to the Transmitter ground stake connected to the black lead. The rate at which the current leaks away from the pipe determines how far down the pipe the signal can be detected. Two factors that control this distance are the pipe size (diameter) and the frequency of the Transmitter. A general rule of thumb to maximize the detection distance is 'big pipe - low frequency' or 'small pipe - high frequency.' Select the lowest frequency that provides adequate signal for the receiver.

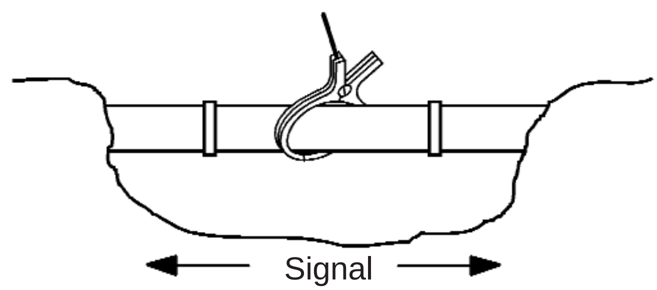


Conductive Method on Tracer Wires

To locate tracer wires buried with nonmetallic pipe, connect the Transmitter's red lead to the tracer wire at an access point. The black lead is connected to the ground rod. For best results, ground the tracer wire at the far-end. If you cannot access or locate the far-end, use a high Transmitter frequency. Otherwise, use a low Transmitter frequency. If you use a high frequency, be aware that in some installations a tracer wire for a service line may not be electrically connected to the tracer wire for the main line. The purpose is to reduce confusion by not allowing tracing signal applied to the main from appearing on the service line. The unconnected end of the service tracer wire may have been placed in the trench and covered or it may have been twisted around the tracer wire for the main. If the twist method was used and the Transmitter frequency is high, signal may appear on both the main and service tracer wires. High frequency signal couples from one tracer wire to the other through the twist, even though there is no metallic connection.

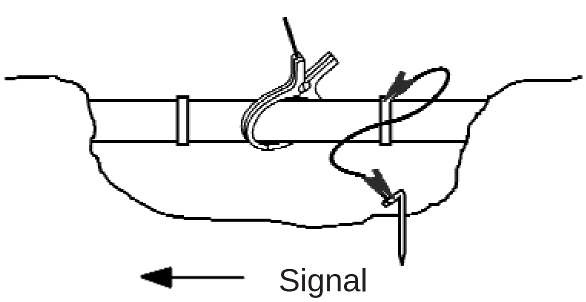


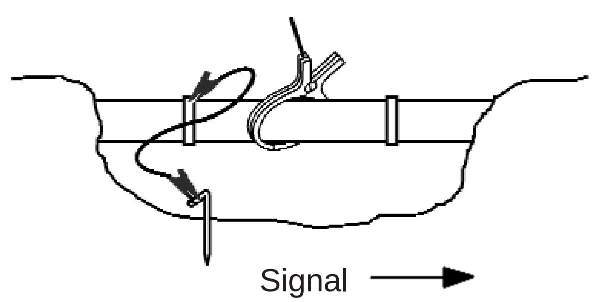
Apply Signal to Pipe: <u>Inductive Clamp Method</u>



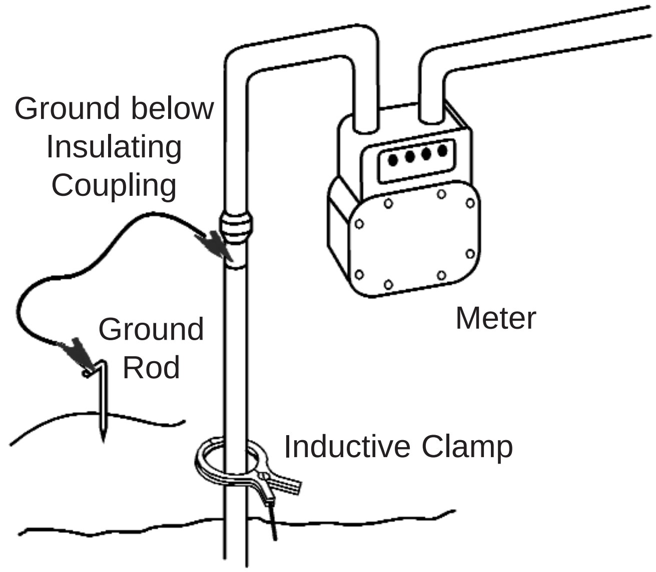
The Inductive Clamp method works well on buried metallic pipe. You can detect signal on either side.

You can control the direction of the signal on the pipe by using the ground stake and some wire to apply ground to that part of the pipe where signal is not needed, as shown. The external ground keeps the signal off the pipe on that side of the clamp. Since the signal is being sent to only one part of the pipe, the magnitude is greater.





When you use the Inductive Clamp to apply signal to a metallic service line at a gas meter, always ground the valve. This provides good return for signal. Otherwise, the insulating coupling above the valve isolates the returning signal from ground and may make locating the service line difficult.



Chapter

6

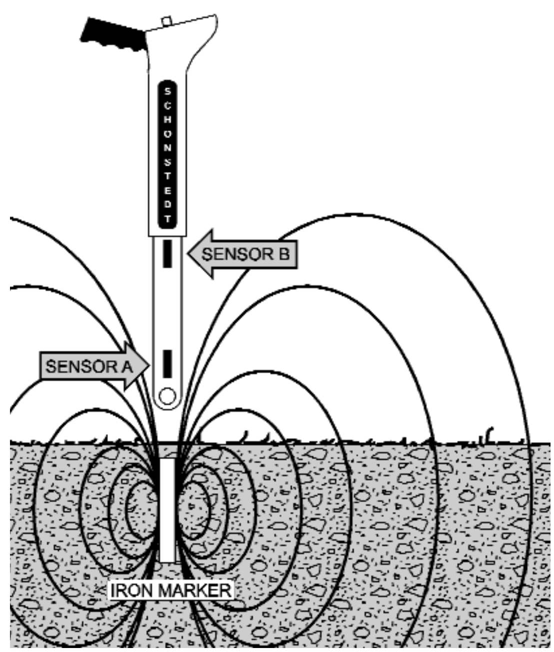
Magnetic Locating

Theory of Operation

A magnet is a body having the properties of producing a magnetic field external to itself. This magnetic field is always bipolar to the object. The object will exhibit a north pole from which the magnetic field emanates and a south pole where the field enters the object. To avoid confusion, that part of the field near the North Pole is said to be positive and that part near the South Pole is negative. The shape of the field will surround the object and the size of the field is determined by the strength of the magnet.

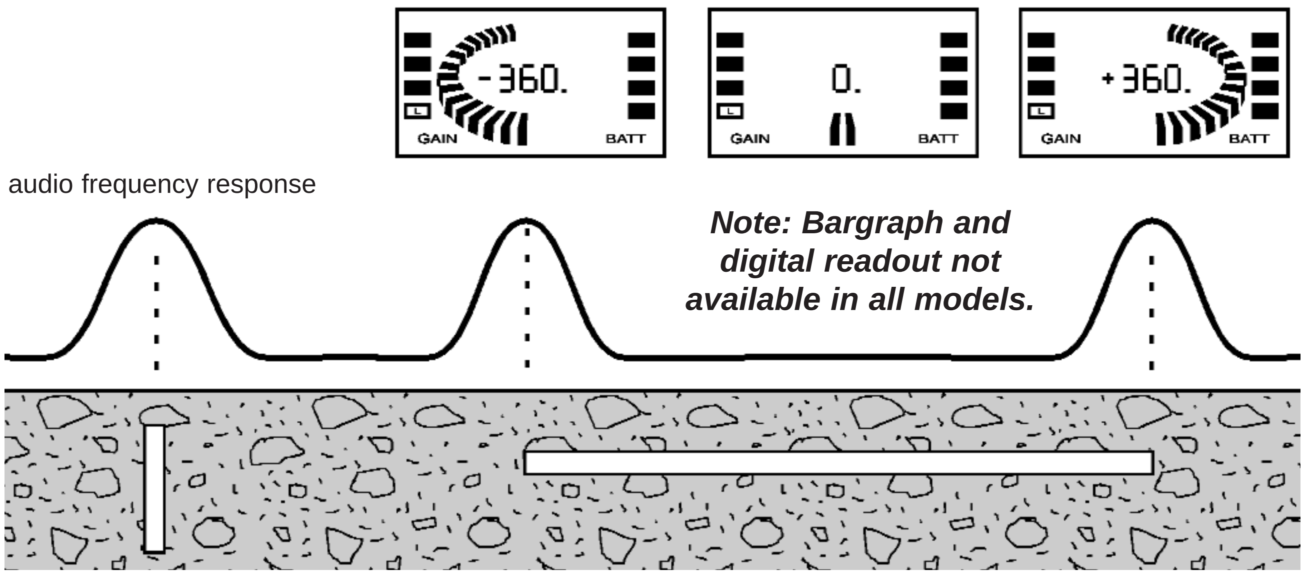
Ferrous (Iron) objects buried in the ground may have two types of magnetization that produce magnetic fields. One is the natural magnetization induced by the Earth's magnetic field. This induced magnetization is weak, and always positive in the Northern Magnetic Hemisphere. The other type of field is permanent magnetization that is artificially imparted to ferrous objects to produce a strong, long lasting field. Its orientation is determined when the object is magnetized.

Magnetic locators detect the magnetic field, either natural or artificial, about ferrous objects. The locator has two sensors separated vertically about 8 to 20 inches apart. The receiver will produce a response when the magnetic field strength at the two sensors is different. This response may be a frequency change in an audio signal emitted from a speaker or merely the presence of an audio response (no response when no field is detected). Some receivers also produce visual responses on bar graphs or strength indicators.



Searching

Set the Sensitivity control to a normal level. Because the upper sensor is near the locator's handle, wristwatches may produce unwanted changes in magnetic fields about the instrument and should be removed. Keep the locator away from your shoes since they might contain magnetic material. To obtain maximum area coverage, sweep the locator from side to side. When the locator comes within range of an iron object, the audio signal will peak, the bar graph will expand positive or negative, and the digital readout will peak as shown.



When the Receiver is positioned directly over a vertical pipe, the audio and digital indications will peak. The expanding bar graph and digital readout may be either a positive or negative. The audio response, bar graph, and digital indications peak over each end of a horizontal pipe. One end is positive the other is negative. This will help to distinguish between two vertical pipes or one horizontal pipe. Usually two vertical pipes buried in close proximity will produce similar polarities.

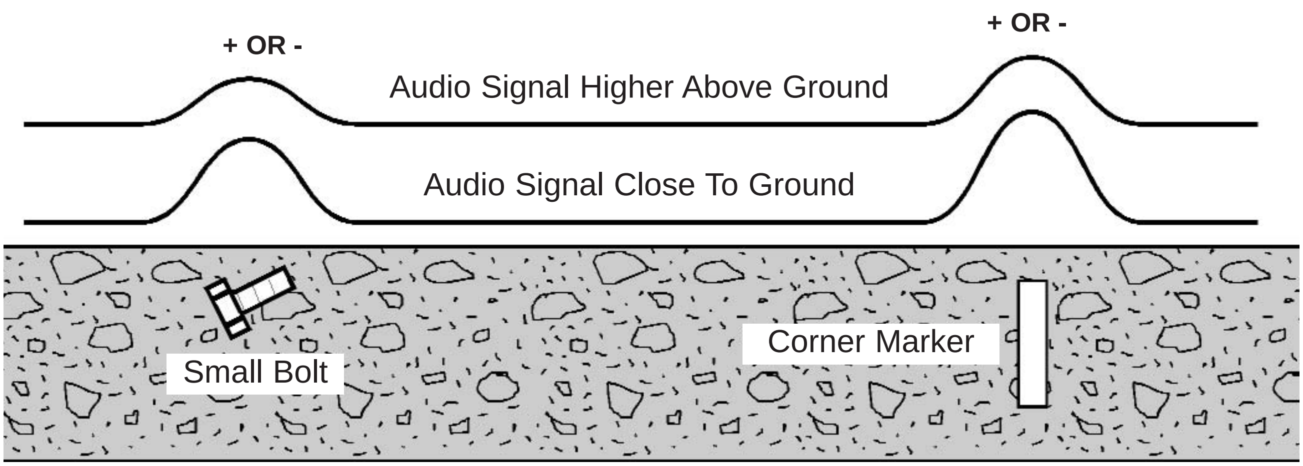
Pinpointing

After you have detected the presence of a target, hold the locator vertically and slowly move it back and forth in an "X" pattern while observing the digital readout. The value of the number will be highest when the locator is directly over a target, and over the ends of a horizontal target. The "X" pattern is ideal for pinpointing small objects.

Adjusting the Sensitivity

The Receiver sensitivity can be reduced by either raising the locator several inches above the ground or by using the gain control. Reducing the sensitivity is useful in discriminating small shallow objects from larger more deeply buried ones.

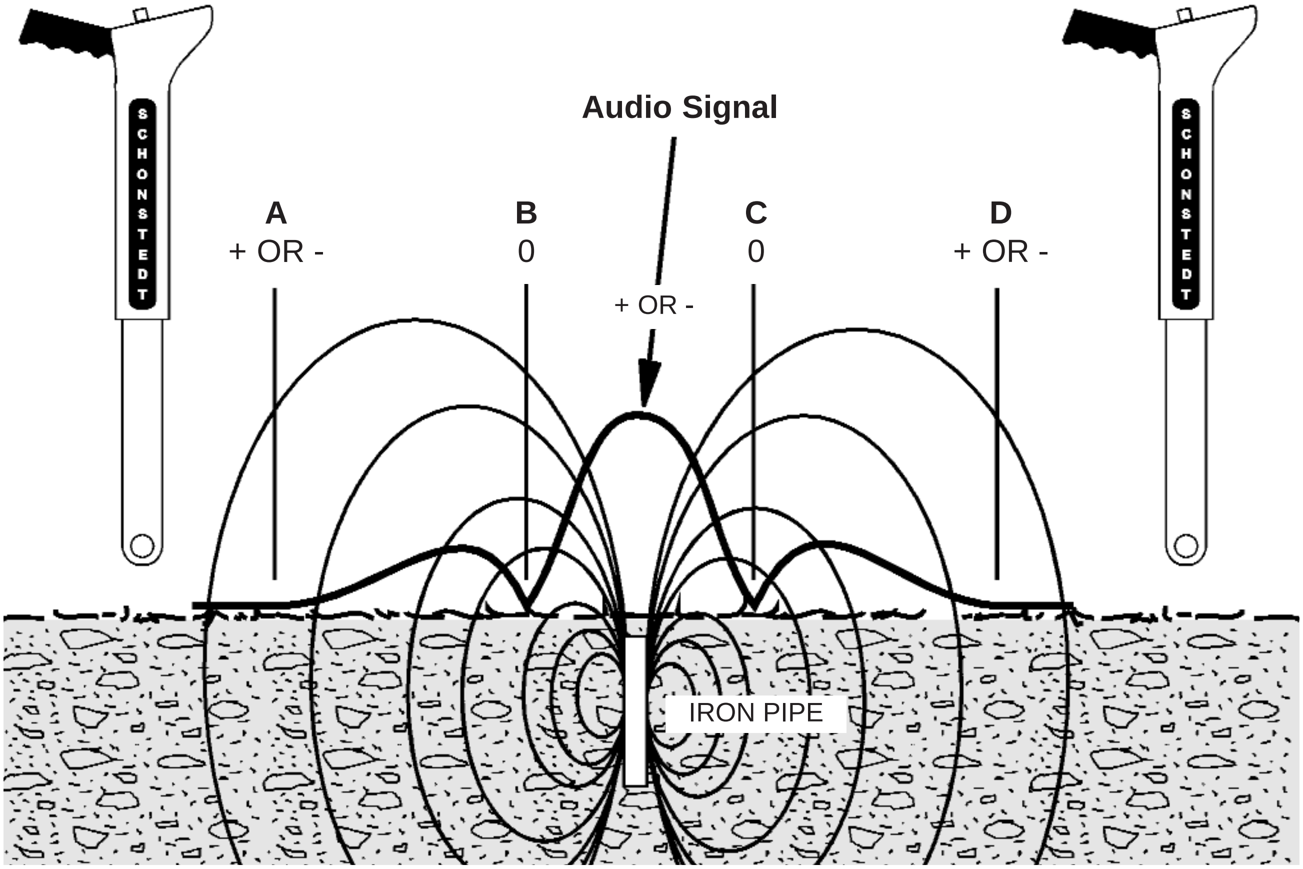
Any signal that disappears when the locator is held higher is probably coming from a shallow target. The signal from a rusty bolt or other small item decreases much faster with distance than the signal from a larger corner marker such as a 18-inch length of 3/4 rebar which can be located at depths up to 7 feet.



Strongly Magnetized Markers

A strongly magnetized marker at or near the surface provides a weaker indication on both sides of the marker that could be mistaken for the marker. The heavy line in the figure below represents the increase and decrease in the audio and digital indications as you move the locator over a marker. Between points **A** and **B** the signals increase slightly and then decrease. Just beyond B the signals increase rapidly, peaks directly over the marker and then decreases at point **C**. From **C** to **D** the signals increase and decrease again. So if you do not move the locator completely across the marker you might assume that the weaker indication on either side of the marker is its location.

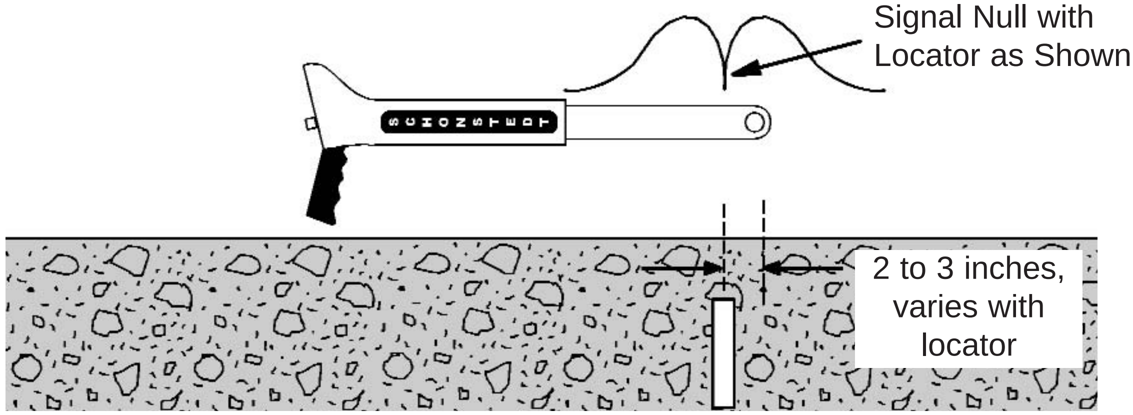
The two weaker indications occur because the locator is extremely sensitive to the magnetic field components parallel to its long axis. At point **B** and **C** the field is perpendicular to the locator so no peak audio of digital indications are produced at these points.



Searching Areas Along a Chain Link Fence

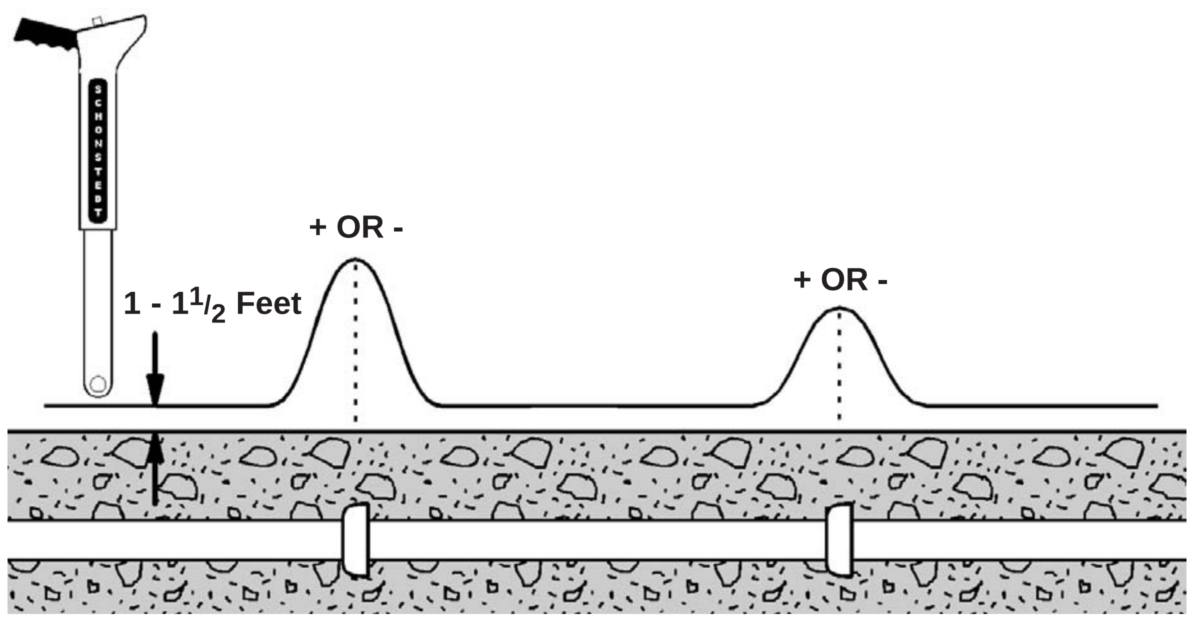
Searching in the vicinity of a chain link fence requires a reduced Gain setting and also control over the orientation of the locator. Position the locator horizontally with its long axis perpendicular to the fence. This ensures that the upper sensor is kept away from the fence. Perform the search by slowly moving the locator forward along the fence while also moving it to the right and to the left. This technique allows you to search an area several feet wide as you move forward.

Listen for an abrupt drop in the signal (as shown by the small null in the illustration below) that will occur when the lower sensor, located a few inches from the end of the locator, is directly over the target. Any variation from this position will produce an abrupt rise in the frequency of the signal.



Locating Metallic Pipe

Magnetic fields extend from the ends of long ferrous metal objects. This is true for metallic pipe even if the pipe joints are welded together. Therefore, a run of pipe (a pipeline) will have a maximum magnetic signal that is at every joint.



To magnetically trace a pipeline, set the gain control for maximum. Hold the locator vertically approximately 1 to 1-1/2 feet above the surface. Walk along without turning or tilting the locator. Don't worry about pinpointing or being accurate. Temporarily mark the locations where the maximum signal levels occur. Return to an area of maximum signal strength and hold the locator several inches above the surface. The gain will probably have to be reduced during this second pass. Pinpoint and mark the places of maximum signal. Looking then at your markers, you will see the run of the pipeline. Four-inch pipes can be located at depths up to 8 feet.

Locating Objects In Areas of Clutter

It is possible to pick up the magnetic field from a larger-mass target in the vicinity of smaller ferrous metals, by reducing the sensitivity so that the smaller targets are missed, and only the larger are detected. Also, physically raising or moving the locator away from the target reduces the sensitivity faster because the percentage of change in distance is greater than the sensitivity settings on the locator. For example, a very large steel drum may be found under concrete rebar by raising the locator until the rebar disappears then searching for the drum whose signals will be much stronger than the rebar that you have tuned out.

Remember that magnetic fields flow out of and into ferrous objects at the ends, therefore, steel rebar has its strongest signal at the end of every piece. Also, if the installer used steel wire to tie the bars together in a grid pattern, even the steel ties may be detected causing confusion as to where the exact end of a bar is located.

Things to Remember about Magnetic Locating

Used to find ferrous targets such as manhole covers, valve boxes, iron & steel pipes, marker magnets on plastic PVC pipe, surveyor's corner markers and PK nails, unexploded ordnance, and discarded weapons.

Use to find the joints in iron & steel pipe - even if they are welded together.

Use to find septic tanks (the handles), buried waste drums and canisters.

Can detect energized (current flowing) 50/60 cycle power lines with a distinctive "warbling" sound.

Can be used to find targets under snow or water. You must keep the electronic unit out of the water.

Properly performed, magnetic locating can be so accurate as to detect a "PK" 1-1/2" nail used in survey marking up to 18" under asphalt, and pinpoint the spot so that you could hit the nail with a ½" drill.

Magnetic locators do not respond to non-ferrous materials such as gold, silver, copper, brass, aluminum, or plastic.