GOLDAK Underground Detection Equipment

OPERATING MANUAL

MODEL TRIAD 2310 DIGITAL LOCATING SYSTEM

OPERATING MANUAL

Innovating Underground Locating Since 1933

GOLDAK PRODUCTS

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TRIAD™ MODEL 2310 DIGITAL LOCATING SYSTEM OPERATING MANUAL

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If you have any questions, please contact:

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1 INTRODUCTION

Since 1933, Goldak Inc. has manufactured top-of-the-line underground locating equipment. With the introduction of the Triad Model 2310 Digital Locator, Goldak has set a new standard in portable locators.

The Triad series of locators are designed with one key goal in mind: to simplify underground locating tasks for the user. The advanced signal detection system and state-of-the-art digital electronics work together to make these tasks straightforward, intuitive, and quickly managed. The battery-powered Model 2310 Receiver is lightweight and ergonomically balanced, and folds into a compact storage configuration. Activated and controlled by a single trigger, the 2310 Receiver aides the operator in locating underground lines (pipes, cables, etc.) or coil-type transmitters (a.k.a. "sondes") with easy-to-understand visual and audio cues.

Menus that are designed to be intuitive and self-teaching make the Model 2310 easy to operate regardless of one's level of experience, beginner to expert. With features such as automatic tuning and gain control, automatic depth reporting, multiple frequencies, constant numerical response, search direction indicators, and more, the user will recognize that the Model 2310 Digital Locator is truly one of a kind.

Triad Locating System

The entire locating system consists of the Model 2310 Receiver, the Model 23X Transmitter Case, and miscellaneous accessories. The standard accessories included with the basic system are a direct-connection cable (DCC), a ground rod, and operating instructions. Optional accessories are numerous, and can be purchased to perform specific kinds of jobs.

Before you get started…

It is important that the operator become familiar with this manual and with other basic safety recommendations (Appendix D) prior to using the Triad locating system. Also, the operator should make sure that batteries are installed in both the 2310 Receiver and the 23X Transmitter Case, and that the batteries are in good condition. To access the battery compartments for the 2310 Receiver and the 23X Transmitter, please follow the instructions in Appendix B, "Care and Maintenance", of this manual.

2 Equipment Features

MODEL 2310 DIGITAL LOCATING RECEIVER

The primary component of the Triad Locating System is the 2310 Receiver. It has been designed to be lightweight, ergonomic, and easy-to-use. Taking advantage of breakthrough technology, the 2310 Receiver provides real-time intuitive information to the user that makes locating jobs simple to understand. The only control is a single, gun-style trigger, which gives the user quick access to the Receiver's features. A crisp LCD display screen and robust speaker output provide the user with the intuitive information needed to make quick locates. Refer to the graphic below and the opposing page to understand more about the physical features of the 2310 Receiver.

DESCRIPTION OF FEATURES: MODEL 2310 RECEIVER

① ***Display***. A sharp, high-contrast LCD screen that provides visual feedback to the user during set up and locating operations.

② ***Pistol Grip and Trigger***. The pistol grip is molded for comfort and positioned for ergonomic balance while operating the 2310 Receiver. The trigger is positioned comfortably for gun-style operation. The trigger is the only control feature on the entire instrument. Please read Operating Details for more information about using the trigger.

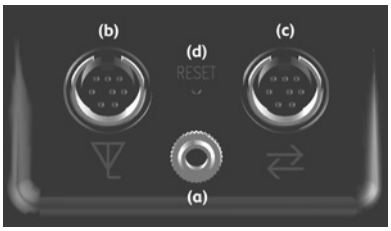
③ ***Speaker***. The speaker provides strong audio feedback to the user during operation. The volume of the speaker output is user-controlled.

④ ***Folding Antenna Arm***. While being operated, the receiver is configured in a slender, balanced package that is easy to wield. This is the "unfolded" position. To store the receiver, it must first be collapsed (folded). To do this, the antenna arm swings around the swivel point 180° to the folded position.

⑤ ***"Pointer" Antenna***. Mounted on the end of the folding arm is the "pointer" antenna, so called because it effectively points directly at the object being located.

⑥ ***Battery Compartment***. Found on the underside of the receiver, this easy-access spring-loaded compartment houses the power supply for the 2310 Receiver. The receiver requires eight (8) "AA" size alkaline batteries to operate (carbon batteries NOT recommended).

⑦ ***Connection Panel***. Also found on the underside of the receiver, this panel area provides plug-in access for various accessories.



(a) Headset Jack. Found in the middle of the panel, this jack allows for an 8-ohm headset with a 3.5-mm plug to be connected. When the headset is plugged in, the built-in speaker no longer emits a sound.

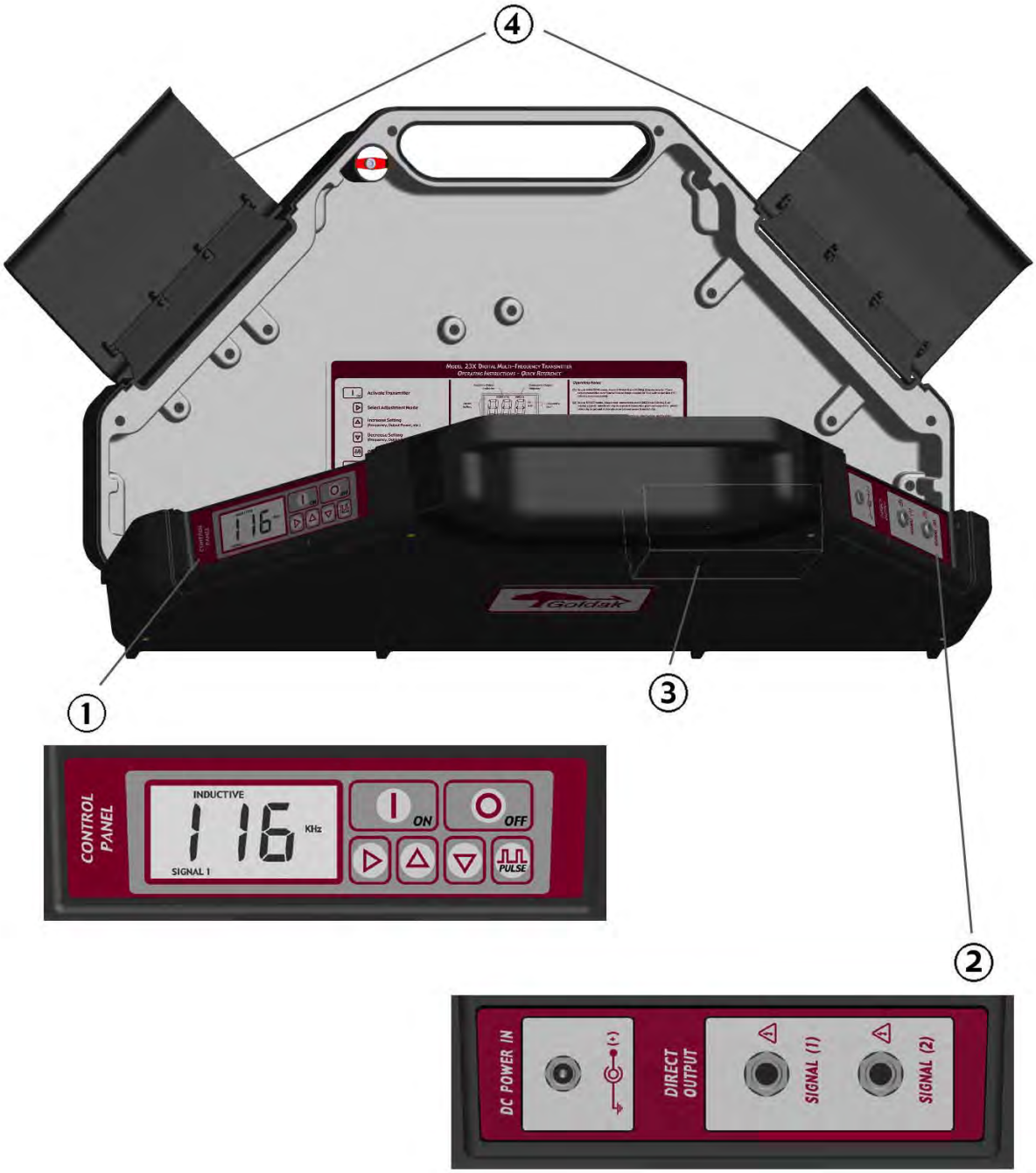
(b) Auxiliary Antenna Port. With the appropriate adapter, this port allows the user to connect up to two external antennas into the 2310 Receiver. Some examples of such antennas are a cable clamp (for identifying a specific cable among a grouping of cables) and an enhanced-sensitivity detection antenna.

(c) Communications Port. This port allows the receiver to communicate with external devices via standard RS-232 protocol.

(d) Reset. This is a small pinpoint hole in the panel that allows the user to reset the 2310's internal computer, using for instance the open end of a paper clip.

MODEL 23X DIGITAL TRANSMITTER CASE

Built into the carrying case for the Model 2310 Receiver is a powerful and versatile line-energizing transmitter, the Model 23X. It has the capability to energize lines both by direct hook-up and by an inductive field. It provides flexible power level and multiple frequency options (standard and custom), including three for inductive energizing. Also, the 23X control panel provides a PULSE option, for identifying the transmitting signal in difficult tracing situations*. A detailed description of the transmitter case features follows.



** PULSE is included for compatibility with receivers other than the 2310. It should NOT be used with the Model 2310 Receiver.*

DESCRIPTION OF FEATURES: MODEL 23X TRANSMITTER

① ***Control Panel***. This panel, located under the left latch cover of the case, contains all of the buttons used to activate and control the transmitter. Also located on this panel is the LCD display, which reports the mode, the frequency, the output level, and other information.

ON Button. Press this to activate the transmitter.

OFF Button. Press this to deactivate the transmitter.

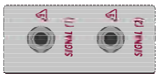
Select Button. This button advances the adjustment mode.

Up Button. This button advances to the next highest setting (e.g., frequency or power level)

Down Button. This button selects the next lowest setting.

PULSE Button. Press this button to cause the signal to pulse (see note on previous page). Hold the button for 2 seconds to display the status of the internal battery.

② ***Output Panel***. Located under the right latch cover, this panel contains three jacks that are used for signal output and power input.



Direct Output Jacks. These are labeled "SIGNAL[1]" and "SIGNAL[2]". The jacks are for standard 1/4" mono phone plugs (typically on a Direct Connection Cable). The SIGNAL[1] jack, when used by itself, outputs twice the standard signal level of the SIGNAL[2] jack. When used in conjunction with the SIGNAL[2] jack, the SIGNAL[1] jack outputs a standard signal level.

Auxiliary DC Power Input. This jack takes a standard 2.5mm DC power input plug, which is typically used on AC/DC wall transformer power supplies. The rated voltage of the external supply should be no higher than 25V and no lower than 7.5V

③ ***Internal Battery***. The battery compartment is inside the case, on the half where the 2310 Receiver is stored. The compartment takes a 12-Volt Alkaline C-Cell removable module. To access the battery, unscrew the two thumbscrews that hold the battery cover in place.

④ ***Latch Covers***. These secure the instrument in the closed position while protecting the Control and Output panels.

Super-Inductive Capability. A special patented antenna system is built into the transmitter case. With this special antenna, the 23X transmitter is the most powerful inductive line energizer available.

3 ACCESSORIES

STANDARD ACCESSORIES

[1] ***Direct-Connection Cable (DCC)***. Use the DCC to inject a signal directly (via electrical contact) into the target line. Advantage: better than using inductive mode for assuring that target line is only thing energized. Also, eliminates air-coupled signals that come from the transmitter case itself. Disadvantage: part of line must be electrically exposed to use the DCC, which sometimes is impractical. Also, requires adequate ground return to cause strong signal on line.

[2] ***Ground Rod***. This simple accessory can be used to establish good grounding for direct connection to a line. Advantage: establishes better ground return when used than when not used. Disadvantage: must have penetrable terrain to use it.

OPTIONAL ACCESSORIES

[3] ***GC-2 Inductive Clamp***. This is the non-contact version of the DCC. Use the Inductive Clamp to energize the target line by plugging into a Model 23X direct output jack and clamping around a portion of the line. Advantages: no electrical contact point needed; very effective at energizing the target line only, even in congested areas. Disadvantages: part of line must be mechanically exposed enough to get clamp around it; limited target line diameter (up to about 5.5″ OD).

[4] ***Transmitting Sondes***. These are small, capsule-type transmitters that may be located only in the immediate area surrounding the transmitter. They are usually inserted inside non-metallic lines in order to pinpoint a location in the line, but can be used for a variety of applications. Typically, transmitting sondes are battery-operated and water-tight.

(a) The *Model 3310 "Flusher"* is a watertight capsule transmitter designed specifically to be flushed down a toilet or a sewer cleanout. They are most often used for locating septic tanks.

(b) The *Model 3350 "Bullet"* is also watertight, and is small and streamlined to fit into non-metallic conduits down to 3/4" in diameter. Normally, the "Bullet" is attached to a fish-tape and fed down empty conduit lines. However, it can be used in a number of applications.

(c) The *Model 3330 "Tape-On"* is a watertight, roughly cylindrical transmitter designed to attach "piggyback" on a sewer rod, sewer snake, hydro-cleaner, or camera reel.

(d) The *Model 3340 "Navigator"* is the largest and most powerful of the insertable transmitters and is typically used in city main sewer lines.

(e) The *Model SR-116K* is a small but powerful transmitter that is designed to provide greater flexibility in locating jobs while maintaining good locating range. Designed for in-line attachment (sewer snakes, push rods, etc.), the SR-116K is streamlined to go where many other transmitting sondes cannot.

[5] ***Headset***. The 2310 Receiver includes a 3.5-mm jack to accommodate this accessory, an 8-Ω, walkman-style headset. Other headsets with compatiple plugs and ohmages may also be used.

[6] ***External AC Power Supply***. This two-prong AC wall socket adapter that supplies unlimited power to the 23X Transmitter. This is especially useful when the 23X drives heavy loads at audio frequencies for long duration. [Specs: Input = 120 VAC, 60 Hz, 22 W; Output = 15 VDC @ 1 Amp; Plug dimension = ø2.5 x 5.5 mm]

[7] ***Car Battery Adapter***. An external power supply cable that plugs into a standard automobile cigarette lighter socket. Fully extended, it is 12 feet in length, and comes with the 2.5-mm plug required by the 23X DC input panel. Like the AC power supply above, it is recommended to be used in low-frequency, high-output applications.

[8] *Accessory Bag*. A canvas pouch that mounts neatly on the outside face of the transmitting case. This bag provides flexible and easily accessible storage for all of your instrument accessories.

[9] *Alternate Antenna Adapter*. This special adapter plugs into the antenna port on the underside of the 2310 Receiver. It converts the port input to two standard 1/4" jacks, that may be used for a variety of special applications.

4 Operating Details

MODEL 2310 RECEIVER

Trigger Usage

The first important step in learning how to use the 2310 Locating Receiver is to understand and master the simple functions of the gun-style trigger. Having learned the two basic trigger commands, the user will be well on the way to properly and efficiently using this locator.

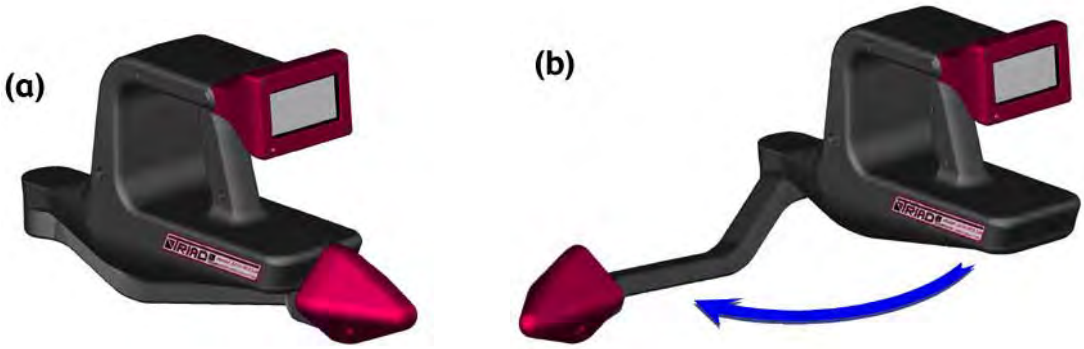
The trigger functions much like the button on a computer mouse. The two trigger commands are **CLICK** and **CLICK-HOLD**:

> To **CLICK**, pull and quickly release the trigger. In general, a CLICK will turn the Receiver on and off (when no menus are active); also, when a menu or control strip is active, a CLICK will always advance to the next choice on the menu or control strip
>
> To **CLICK-HOLD**, pull the trigger and hold it in until the desired action takes place (this takes a half-second or so). CLICK-HOLD *always* chooses the highlighted choice in the active menu/control strip.

Mastering the trigger functions is not difficult, and knowing them is essential in using the receiver efficiently. For your convenience these instructions for trigger usage are summarized on the triangular serial number label on the underside of the 2310 Receiver.

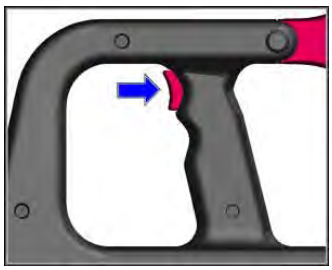
Preparing to Use the Receiver

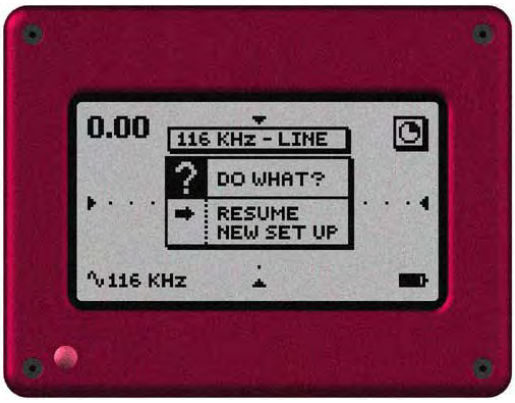
When removed from the case, the 2310 Receiver will be in its (a) compact storage configuration. To unfold it, (b) swing the lower antenna arm in a clockwise direction 180° about the swivel, until it is fully extended in its operating position.



Activation

To turn on the Receiver, simply CLICK the trigger. Upon startup, the receiver display will momentarily present the Goldak logo. The logo screen will scroll open, and the following control screen will be presented:





At the top of the screen you will see a memory strip indicating the most recent device set up (i.e., that was used on the previous locating job). At this time, you may either continue to locate with the stored settings (RESUME), or opt for new settings (NEW SET UP). Notice that a small timer icon appears in the upper right corner of the screen. When this graphic "times-out", any active menu will be removed from the screen, and the receiver will return to its original operating settings.

To RESUME: Verify that the ➡ icon is pointing at "RESUME" in the startup menu, then CLICK-HOLD. The receiver is now ready to locate. (NOTE: the ➡ icon will always point at "RESUME" at startup, making it very easy to continue with an ongoing job.)

NEW SET UP: To opt for new settings, CLICK to advance the ➡ icon to "NEW SET UP", then CLICK-HOLD. The display will then immediately present the "Set Frequency" screen shown below.

SETTING THE FREQUENCY

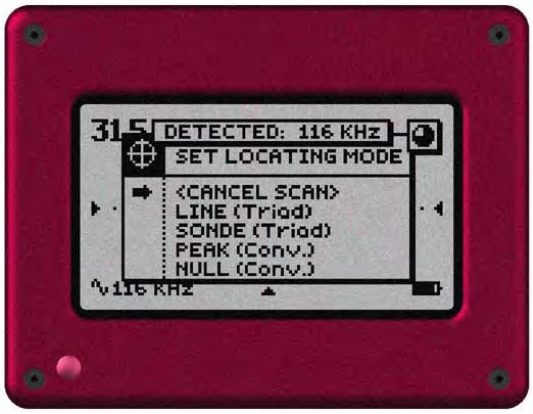
As the menu graphic to the right indicates, there are three different ways to set the receiver's locating frequency: by scanning for it, by selecting it from a catalog, or by selecting the "passive" mode.

Setting Frequency by Scanning

Using the "BY SCAN" Option will automatically tune the 2310 Receiver to the exact frequency of the transmitting source (i.e., Model 23X Transmitter, another active line energizer, a "sonde", or a camera head). To do this, hold the receiver with the pointer antenna aimed directly at the active transmitting source, and held about 3 to 5 feet away from it. CLICK the ➡ icon to point to "BY SCAN" and then CLICK-HOLD.

You will see the word "SCANNING" flashing on the screen while the receiver scans for the active transmitter. If SCAN fails to detect anything, you will here a low-pitched tone, and the 2310 will return to its previous operating mode.

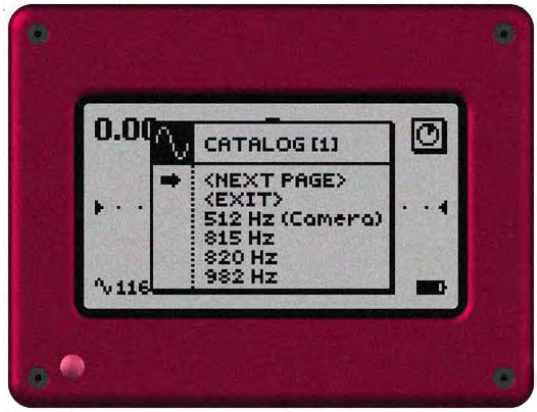
When scanning for a signal that has been set up by a DIRECT connection, if SCAN fails to work by holding the pointer around the supposed area of the energized line, then try draping the red lead from the DCC over the pointer antenna and re-attempting SCAN. This will guarantee that the tracing signal will be detected.



After a successful scan, the display will report as shown to the left. Having detected a signal from an active transmitter, the receiver will automatically present the "SET LOCATING MODE" menu. To continue, follow the instructions for setting the locating mode given on the following page of this manual. If you are unable to SCAN successfully, please refer to Appendix C, "Troubleshooting", for more help.

Setting Frequency from the Catalog

The "BY CATALOG" option allows the user to choose the desired receiver frequency manually from a list of pre-catalogued selections. To use this feature, CLICK the ➡ icon to "BY CATALOG" in the menu and then CLICK-HOLD. Doing so will call up the catalog menu shown below.



Visually scan the first page of the catalog. If your desired frequency is not found, CLICK-HOLD with the ➡ icon pointing at "<NEXT PAGE>" and continue to search (NOTE: frequencies are organized from lowest to highest as you advance from page to page). Once you have found the desired frequency, CLICK the ➡ icon to that frequency, and CLICK-HOLD to select it. Once the frequency is selected, the display will automatically advance to the "SET LOCATING MODE" menu. To learn more about this, look at the instructions for setting the locating mode on the following page of this manual.

Selecting Passive Mode (60-Hz Line Tracing)

To select passive mode, CLICK the ➡ icon to "Passive (60 Hz)" on the menu, and CLICK-HOLD. Once this mode is selected, the receiver will automatically enter the Triad LINE mode. If you wish to select a different locating mode, follow the instructions given in the next section, "Set Locating Mode".

SETTING THE LOCATING MODE

While performing the automatic set up routine, and after the frequency has been selected, the receiver will prompt the user to select the desired locating mode, as shown to the right.

Visually scan the "SET LOCATING MODE" menu, and CLICK the trigger to advance the ➡ icon to point to the desired selection. Then CLICK-HOLD the trigger to make the selection. NOTE: choices on this menu will vary depending upon the specific model type of the receiver ("SC", "UL", etc.). The various locating modes are listed and described here for reference.

LINE (Triad) Mode

Select this mode to graphically display a representation of the target line on the screen while it is being traced. This mode is fully automatic, requiring no user intervention after set up to perform its function. It displays line position and direction, and automatically calculates the depth and depth accuracy when the pointer antenna is positioned over the buried line.

SONDE (Triad) Mode

This mode aids the user in locating a sonde by displaying a graphic icon representation of its orientation and relative position. As the user approaches the sonde, the audio response will gradually increase in pitch, and the display will indicate which way to position the receiver so that it "points" at the sonde. As the receiver homes in on the sonde, the centering circle constricts about the sonde icon. At the same time, the approximate depth of the sonde will be displayed in the upper right corner of the LCD. When the circle fully constricts about the icon and the 2310 Receiver points directly at the sonde, the depth reading will stabilize on an actual value and the actual orientation of the sonde will be evident from the icon.

PEAK Mode

This is a conventional locating mode. "Conventional" means that this method of locating is common to many locating devices industry-wide, including many Goldak products. In PEAK mode, the user relies on the relative directional response around the target object to determine location. Thus, PEAK mode only provides a bar-type relative response graphic, which accompanies the ANR that is always on-screen in the upper left corner of the display. PEAK mode responds only to signal that is detected in the horizontal, side-to-side direction.

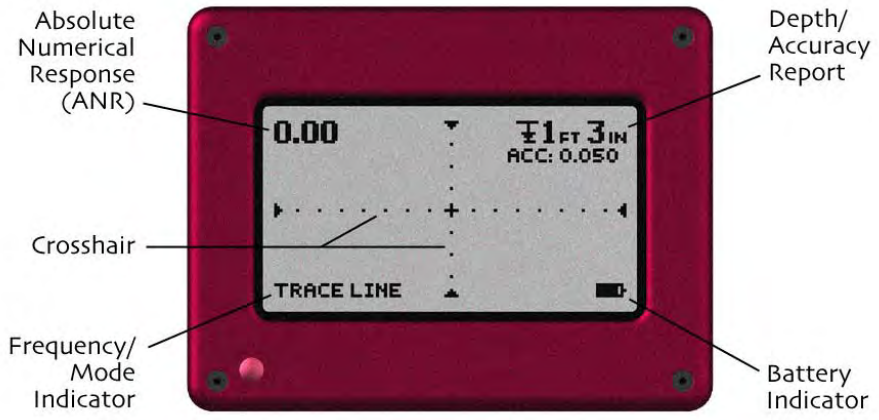
NULL Mode

Like PEAK mode, NULL mode is conventional. It presents that same bar-type graphic as PEAK mode. However, NULL mode responds only to signal that is detected in the vertical direction (see graphic in upper right corner of display). This means that the response vanishes when the signal field is perfectly horizontal.

WHILE LOCATING...

After the initial set up routine, the 2310 Receiver is completely automatic. To search, locate, and pinpoint, simply follow the visual and audio cues on the display and from the built-in speaker.

Features of Display During Operation. When either of the special "Triad" locating modes, **LINE** or **SONDE**, are being used, the LCD display presents the basic screen shown below.



A brief description of each display feature follows here:

Absolute Numerical Response (ANR). This number is always displayed in the upper left corner of the display, regardless of the mode being used. It indicates at all times the strength of the signal being detected at the desired frequency. Because it is absolute, it always reflects the actual signal strength. So, the ANR is always a good indicator of the working signal level. An ANR of "5.00" and above is considered a strong working signal; an ANR between "1.00" and "5.00" is fair; an ANR below "1.00" is weak, even though it may still be usable.

Depth Report. When the locating target becomes centered under the crosshair, the estimated depth will appear automatically and remain as long as the target remains centered.

Depth Accuracy Report. This is the receiver's estimate of how accurate it deems the calculated depth report. In general, the closer the depth accuracy number is to "0.000", the more accurate the receiver's programming deems the depth report to be. However, the user should be cautious when using this indicator, because it is a "fuzzy" estimate. Also, it is always recommended that depth estimates be verified by some other means, if possible. (One way of verifying depth is by triangulation. This and other techniques for ascertaining depth accurately are discussed in Appendix A of this manual.) In practice, it has been found that the depth accuracy report tends to be "worst case"; that is, the depth report will often be more accurate than the depth accuracy number seems to indicate.

Frequency/Mode Indicator. The current frequency and locating mode being used alternately flashes in the lower left corner at all times.

Crosshair. Just as might be expected for a targeting or locating device, the horizontal and vertical crosshairs aide the user in positioning the pointer antenna directly at the target in question.

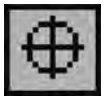
Battery Indicator. This icon in the lower right corner constantly reports the status of the 8 "AA" batteries powering the receiver. It should be seen as a "fuel guage". When the icon is "empty", the batteries should be replaced with fresh ones.

Control Strip Menu

The pop-up control strip menu (shown below) provides a quick and easy way for the user to make any desired adjustments to the receiver's settings at any time during a locating job.

To access the control strip while locating, simply CLICK-HOLD the trigger. CLICK to advance through the available choices. As each icon becomes highlighted, a help text above the strip indicates the function of the icon. Once the desired choice is highlighted, CLICK-HOLD to select that choice. The adjustments that can be made via the control strip follow here.

SET FREQUENCY. Selecting this will take you directly to the "SET FREQUENCY" menu described in the startup procedure on the previous pages.



LOCATING MODE. Selecting this will activate the "SET LOCATING MODE" menu previously described.

SET VOLUME. Adjust the speaker/headset audio volume via this choice.

SET CONTRAST. Adjust the LCD image contrast via this choice.

BACKLIGHT THRESHOLD. Use this function to set the light level at which the LCD backlight comes on.

HELP. Allows access to information about the 2310 locating receiver.

When setting the volume, the LCD contrast, or the backlight threshold, the following adjustment bar will be displayed:

As usual, CLICK to advance to the "←" (decrease), the "X" (exit), or the "→" (increase) icon. CLICK-HOLD to make the adjustment. As you continue to hold the trigger, the adjustment bar will continue to increase or decrease.

Automatic Gain Control. There is no manual gain control on the Model 2310 Receiver. The instrument automatically self-adjusts as required during any locating task, providing maximum sensitivity while searching and the appropriate sensitivity while pinpointing. [NOTE: it is important to understand that audio volume and gain (sensitivity) are completely unrelated. Increasing the speaker volume has no effect on the receiver's ability to detect and locate a signal source.]

Shut Down. The receiver may be turned off at any time by CLICK-ing the trigger, provided no menu is being displayed on the screen. Also, the 2310 will automatically turn itself off after 10 minutes with no significant activity.

Reminder: During normal locating operation, the trigger has two functions.
CLICK will turn off the receiver.
CLICK-HOLD will call up the control strip menu.

MODEL 23X DIGITAL TRANSMITTER CASE

Activating the Transmitter

Before turning on the transmitter, the user should make sure that it is set up for the locating job he intends to perform. For example, if the user intends to energize a line by direct connection, he should plug the DCC into the SIGNAL[1] or SIGNAL[2] jack, and connect the red clip to the hook-up point and the black clip to ground.

When either SIGNAL jack is being used, the word "DIRECT" will be indicated at the top of the display screen. When neither jack is being used, the word "INDUCTIVE" will appear at the top of the display. If the user wishes to use the INDUCTIVE feature to energize a line, he should make sure both SIGNAL jacks are empty.

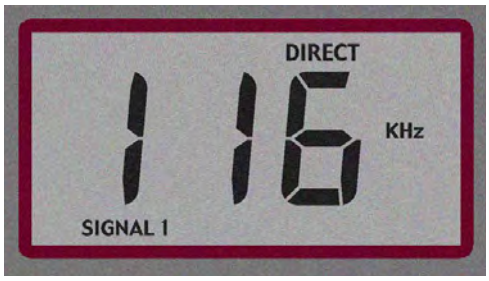
Once the transmitter is set up, activate it by pressing and holding the button until the display flashes the word "On". Then release the button. After "On" flashes, the current firmware version is displayed (e.g., "1.0.1"). Then, the transmitter will completely activate, displaying the active operating frequency.

Selecting a Locating Frequency

To select an operating frequency, the transmitter must be in frequency adjustment mode. This mode is selected if either "Hz" or "KHz" is displayed on the right half of the display screen.

If frequency mode is not selected, use the Select button to advance to this mode.

Use the or button to select a higher or lower frequency, respectively. To the right is a typical screen one would see while adjusting the frequency.



Setting Output Level

To set the output power level, the transmitter must be in power level adjustment mode. This mode is selected if the "%OUTPUT" label is displayed in the lower right corner of the screen. If this mode is not selected, use the Select button to advance to it. Then use the Up or Down button to select a higher or lower output level. The available output levels are: 10%, 25%, 50%, and 100%. To the left is a typical screen one would see while adjusting the output level.

Using the PULSE button 

This button will cause the output signal to pulse, but will function this way only if the transmitter is in frequency adjustment mode. Also, the PULSE button applies only to whichever SIGNAL jack is currently selected on the screen. If the 23X is in INDUCTIVE mode, the PULSE setting applies to this mode only. If PULSE is already active, then pressing the PULSE button again will deactivate it. That is, the PULSE button toggles the status of the pulsing function. [NOTE: Using the PULSE feature with the Model 2310 Receiver is NOT recommended. It has been included for the sake of compatibility with older receivers.]

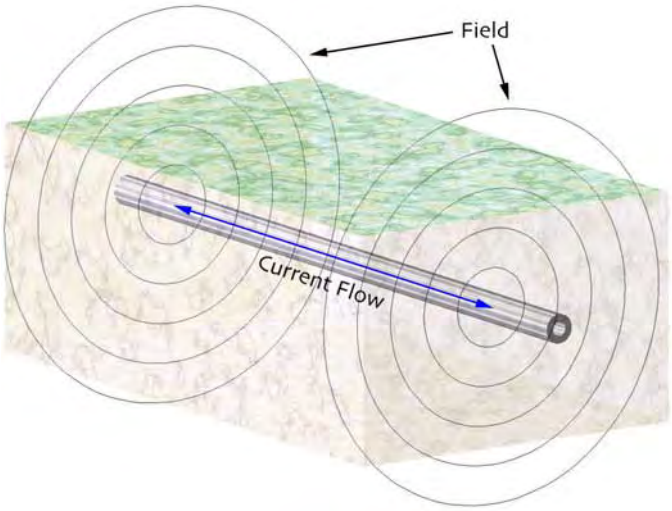
Checking the Status of the Internal Battery

Usually, the 23X transmitter will be powered from the internal 12-Volt C-Cell module. Because a battery has a limited lifetime, the user may want to check its status during operation. To do this, hold down the PULSE button for 2 seconds, and keep holding it. The display will alternate flashing "bAt" and a number from 0 to 100 that represents the life of the battery. The higher the number, the greater the amount of energy left in the battery at the current setting. As the number approaches zero [0], the user should consider replacing the batteries with fresh ones.

Even if the user does not check the battery status, the LCD will flash "bAt" automatically when it is time to replace the batteries.

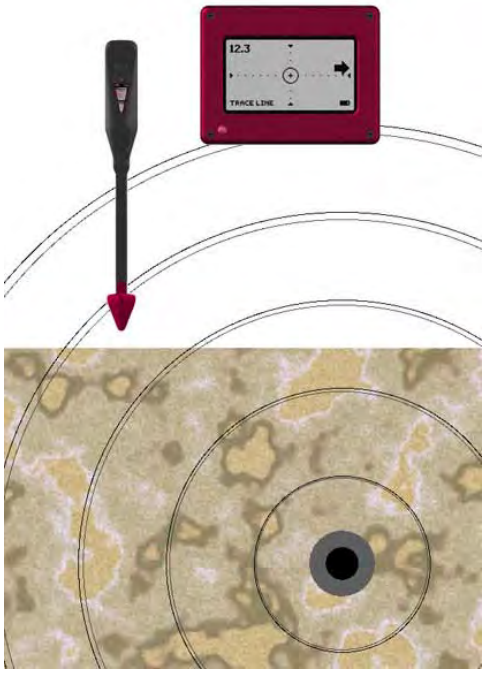
5 LINE TRACING

General Overview of Line Locating Basics



More often than not, underground pipelines and cables are located and traced by sensing invisible "fields" around the line. Such fields are typically created by an active transmitting device, which connects to an access point on the target line and causes electrical current to flow in the line. Wherever a current flows in a line, an associated field is present as well.

The Triad 2310 Receiver, like traditional locating receivers that have been used for decades, responds to the magnetic field associated with an electric current that is travelling along the path of the line. The shape of this field is cylindrical, with the center of the cylinder being the current-carrying line itself. The receiver determines the location of the actual line based on measurements made by the detection antennas.



In the case of a pipeline or cable (or other conductive line), the receiver reports in an intuitive way the location of the line relative to the "pointer" head. When the receiver is held such that the virtual line on the screen is centered under the crosshair, the line will be located directly under the pointer head.

How to Trace A Line With the 2310 Receiver

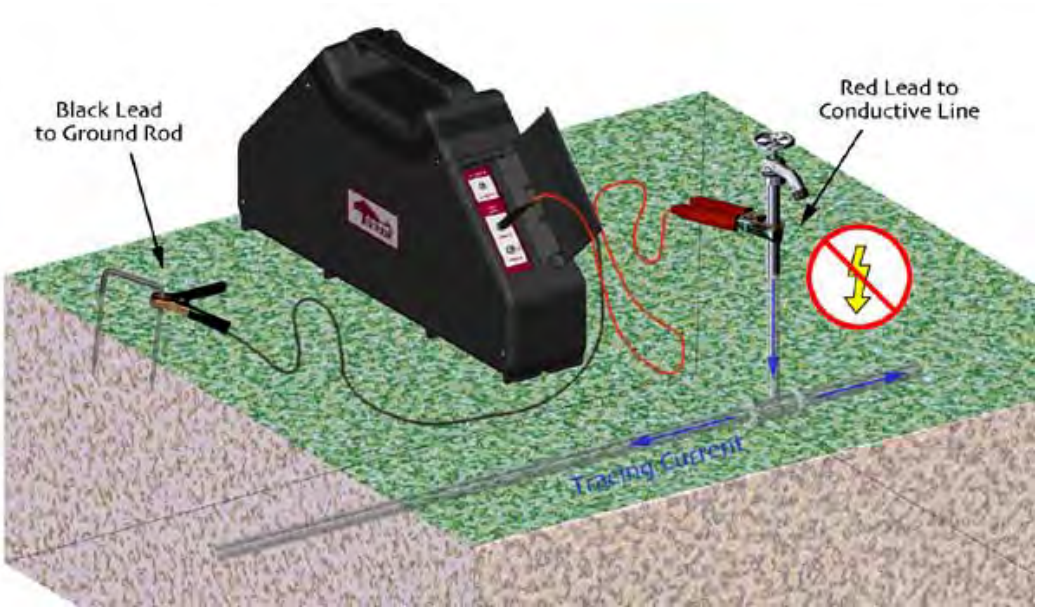
Typically, there are three steps involved in line tracing: **[1]** Energize the line, **[2]** Search/Trace the line, and **[3]** Pinpoint the line.

[1] *Energize the line*.

Before a line can be traced, it must carry a current at the frequency of interest. A line that carries a tracing current is referred to as being "energized". Following here are a few typical methods of introducing a current into a line.

Using DIRECT (Conductive) Energizing. The most common method to energize a line is via DIRECT connection, in which the user injects the signal from the active transmitter output into the line using a connection cable. To energize a line by DIRECT hook-up, the user should first make sure that there is an accessible, electrically exposed part of the line to which to connect. This could be a metallic water riser or the bare end of a tracer wire, for instance.

Also, the user should make sure that the line does not present a high voltage relative to ground at the exposed point, or any other condition that might be hazardous to the equipment or to oneself.



Follow these steps to energize the line via DIRECT connection:

(a) Before turning on the transmitter, insert the plug of a DCC into a SIGNAL jack (SIGNAL[1] jack preferred). Set the case near the exposed part of the target line, as shown above.

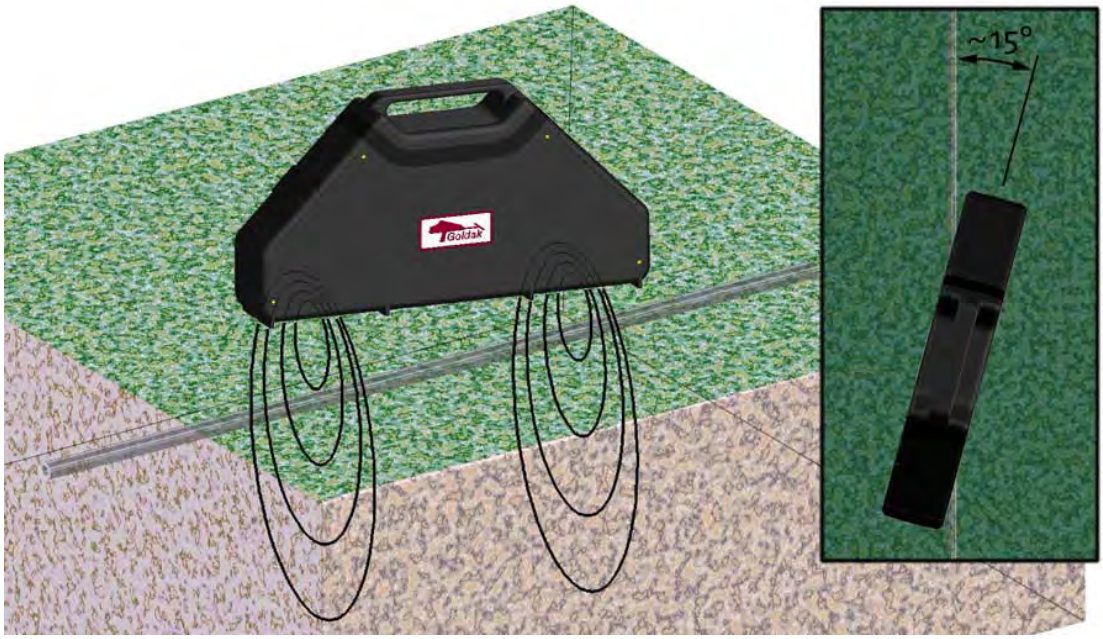
(b) Attach the red clip lead to the exposed part of the target line (see above).

(c) Connect the black lead to a metallic stake that has been securely plunged into the ground. The amount of current generated on the target line depends largely on the nature of this ground connection. For longer traces, place the ground stake as far away from the red clip as possible. If little signal is required for the tracing job, then the user can even leave the black lead unattached and laying on the ground some distance from the red lead. This is referred to as an "off-ground" condition.

(d) Activate the transmitter. Select the operating frequency and the output level as described previously in this manual.

(e) The line is now energized.

Using INDUCTIVE Energizing. Another common method to energize a line is by induction. When the signal jacks of the Model 23X are not being used, the transmitter case emits an INDUCTIVE field, which, when placed over the target line, will energize it. This method requires none of the underground line to be exposed. However, INDUCTIVE mode is best used on isolated lines and away from areas congested with many services and metallic objects.



(a) Make sure both SIGNAL jacks are empty, and activate the transmitter.

(b) Select the operating frequency and the output level as described previously in this manual.

(c) Close the latch covers on the case, and position the case over the underground line so that the hinge of the case is roughly in line with the target line. Also, it is recommended that the transmitter case be turned so that the hinge axis is offset about 15° from the supposed direction of the underground line.

(d) The line is now energized.

PASSIVE Energizing. Finally, the user should be aware that some lines are "always" energized. An example of this kind of line is a power line. Power lines that are actively in service constantly carry AC current. This current is typically at a frequency of 60 Hz, with harmonic components at multiples of 60 Hz (i.e., 120 Hz, 180 Hz, 240 Hz, etc.). In Europe, this

frequency is 50 Hz (plus 100 Hz, 150 Hz, etc.). Commonly, power services are grounded to other services, such as water. Because of this, any line that is so grounded also carries power line currents. A line that has been energized like this is often referred to as being "passively" energized.

There are other methods of energizing a line that serve well in special locating situations. Please refer to Appendix A, "Advanced Locating Techniques", for more.

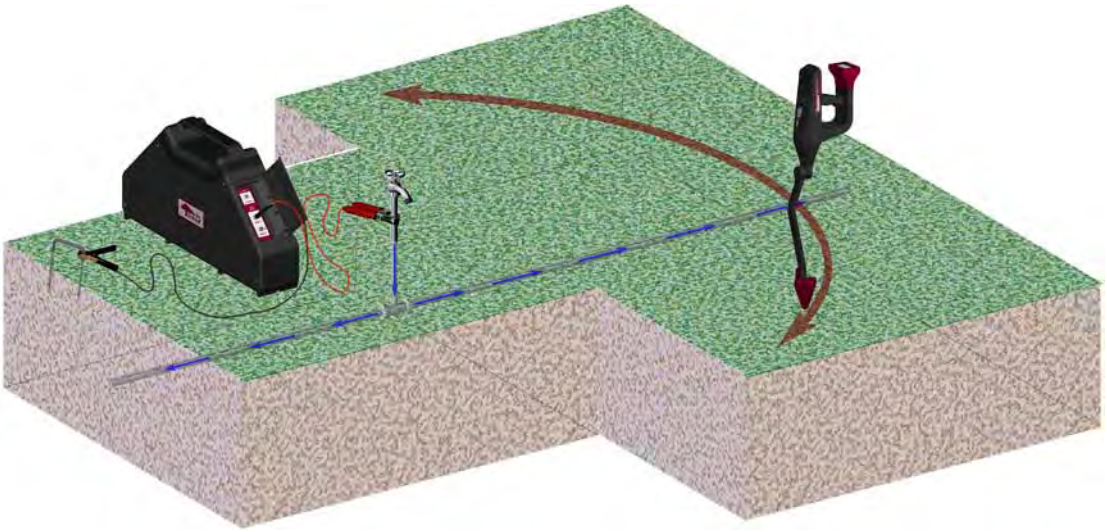
[2] *Search/Trace the Line*

Once the target line has been energized, do the following:

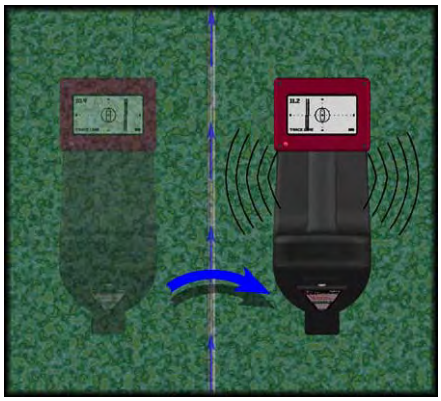
(a) Activate the 2310 Receiver and select the frequency, either "BY SCAN" or "BY CATALOG" as described previously in this manual.

(b) In "SET LOCATING MODE", select "LINE (Triad)". (PEAK mode may also be used, but the following instructions will not apply.)

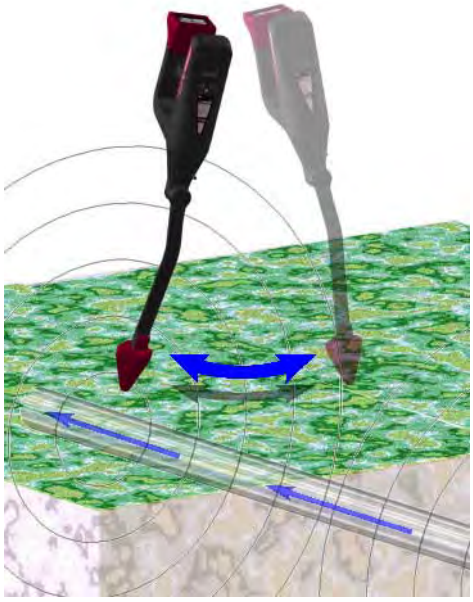
(c) With the receiver held approximately vertical, walk away from the hook-up point of the transmitter (perhaps 10 feet or so). Walk a



circle around the hook-up point. When the pointer head crosses over the line, the receiver will make a distinct alert sound (crossover sound). This, with graphic feedback on the LCD display, indicates the direction that the line is travelling away from the hook-up point. You will notice that a "line" is graphically presented on the display, and that the direction of the line on the screen corresponds with the direction of the actual underground line. Also, the position of the line on the screen indicates the position of the underground line relative to the pointer head.



(d) Continue to walk away from the hook-up point, keeping the "line" on the screen under the center crosshair. If you wish, you may "wag" the pointer head side-to-side; this will cause the crossover alert to sound off as you walk along the line, and helps you to trace without watching the screen.



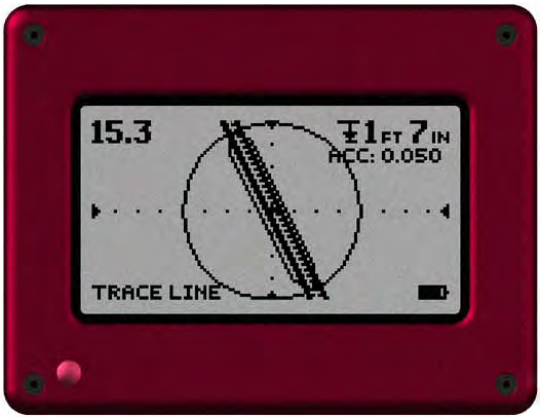
[3] *Pinpoint the Line Location*

The user will notice during tracing that the on-screen line can be centered at any time, and that a depth typically is displayed within a second or so. So, to pinpoint the underground line:

(a) Hold the receiver vertically, and center the on-screen line under the crosshair, between the centering lines.

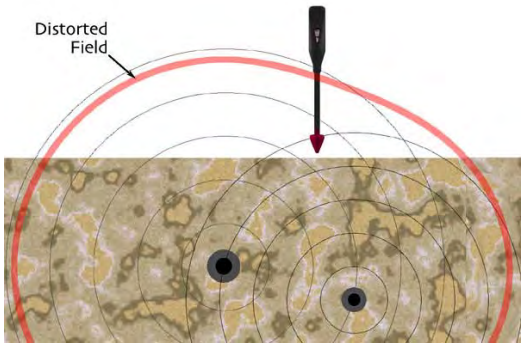
(b) Within a second, the depth of the line will be reported in the upper right corner of the screen. Below the depth the receiver indicates what it interprets to be the accuracy of the depth report. An accuracy report close to "0.000" implies more confidence in the depth estimate than otherwise.

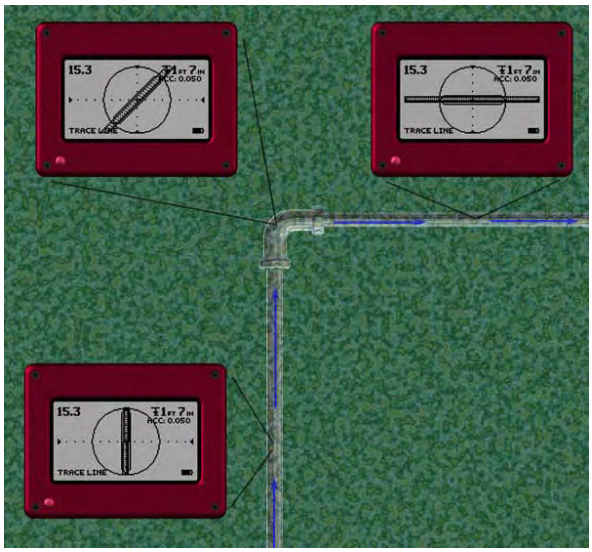
(c) When reporting the depth, the receiver requires a few moments to arrive at its most accurate result. Hold the receiver steady over the underground line until the depth report has stabilized.



Potential Causes of Error During Line Tracing

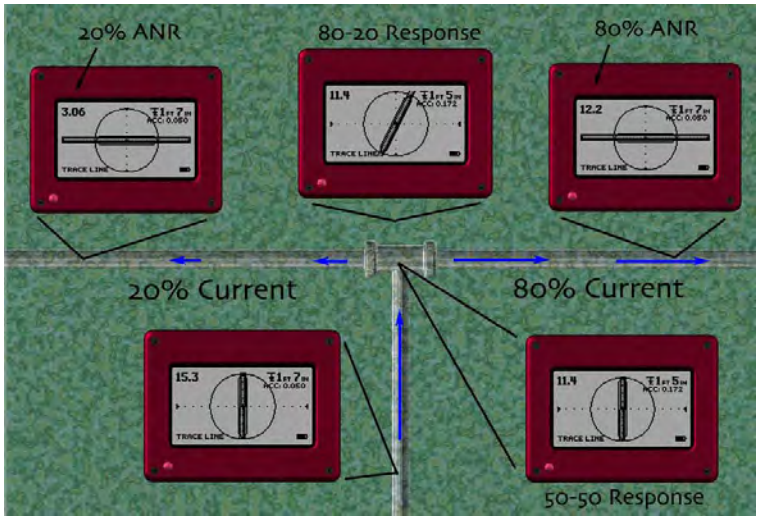
It is important for the user to understand potential causes of error when locating a line. The most common reason for error is that of "competing fields"; that is, fields generated by currents from sources other than the target line. These competing fields distort the assumed cylindrical shape, so that measurements made by the receiver may not necessarily correspond exactly to the desired target line. This can cause errors in not only the apparent location of the line, but also its calculated depth. Fortunately, the 2310 Receiver reports an accuracy estimate with the depth report. If the reported accuracy is poor, then the depth readout is probably unreliable, and the reported location may be questionable as well.





When tracing around junctions (turns and T's) in Triad LINE mode, the user must understand that the 2310 Receiver displays a *representation* of the line being traced. The 2310 Receiver is NOT an X-ray machine, which might depict the actual image of the line. Instead, it shows an intuitive representation of the line based on field measurements. Because of this, the "line" displayed will reflect the overall composite of fields present. At a 90° turn, for instance, the display will show the turn as a line at a 45° angle relative to the supposed line direction(s).

At a "T", the behavior of the displayed line will depend on the relative amounts of current that flow in the legs of the "T".

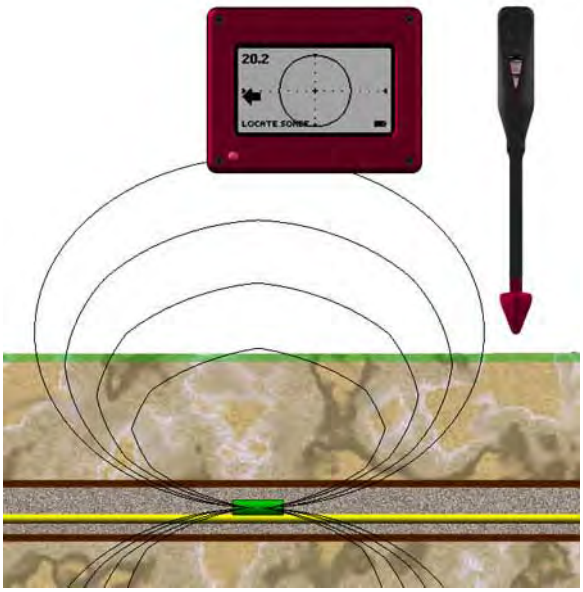


6 SONDE LOCATING

General Overview of Sonde Locating Basics

Many times, a user will want to locate and trace a line that is not capable of carrying electric current. This kind of line is referred to as "non-conductive". In the case of non-conductive lines, the user may insert a small, often self-contained, transmitter that creates a locating field only around its own position. Such a transmitter is often referred to as a "sonde" (English: "sender").

These coil-type transmitters emanate a magnetic field that has a well-defined shape or pattern. They are typically cylindrical in shape and battery-operated. Most often, they are inserted inside a non-metallic line or conduit, in order to find specific locations of points within the line. A common application of this technique is to find the location of a diagnostic camera head, used in the plumbing and rooter industry. Among the items of information that can be learned from locating the sonde are the depth and the direction of travel of the conduit or line.



The Triad 2310 Receiver employs a unique technology to determine the location of the sonde. This technology allows the user to know immediately the location, depth, and orientation of the sonde. The technology is unlike traditional "peak and null" methods for sonde locating in that it does not rely on the use of a directional antenna to find tell-tale points around the sonde. Therefore, the technique is not limited by unusual or unanticipated orientations of the sonde.

Nonetheless, it is important for the user to understand some simple guidelines. First, the ANR generally corresponds to the nearness of the "pointer" antenna to the sonde. Second, there is a case where the user must exercise care when locating a sonde. When the sonde appears as a flat rectangle on the screen, it is possible that the pointer antenna is not pointing directly at the sonde. The remedy to this is found in step (d) of section [4], "Locate the Sonde", a little later in this manual.

How to Use and Locate A Sonde with the 2310 Receiver

Sondes vary in size and shape, as well as in usage. As mentioned above, many sondes are stand-alone, battery-operated devices, and may be of various frequencies. Some sondes are powered through a wire that runs down a snake or a pushrod. Still others are integrated into more elaborate devices, like diagnostic pipeline cameras.

Regardless of the type of sonde used, there are four basic steps when using the 2310 Receiver with a sonde: **[1]** Activate the sonde, **[2]** Tune the receiver to the sonde, **[3]** Feed the sonde into the pipe or conduit to be located, and **[4]** Locate the sonde.

[1] *Activate the sonde*

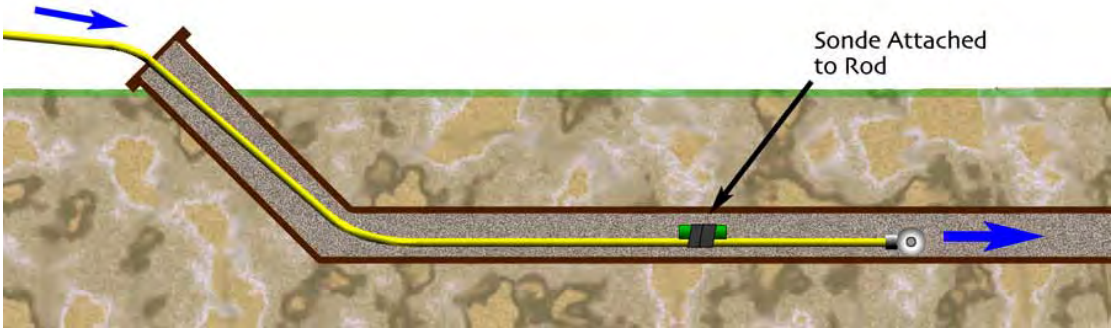
Typically, to activate the sonde requires simply to install the battery into the sonde. If the sonde device is built into a sewer camera head or attached to the end of a pushrod, please consult the instructions given by the manufacturer of the sonde to learn how to activate it.

[2] *Tune the receiver to the sonde*

Set the receiver frequency to that of the sonde by using either "BY SCAN" or "BY CATALOG" in the "SET FREQUENCY" menu. Of course, using the scanning feature is recommended, as it is the most convenient, and will enable the user to use the sonde even if its frequency is unknown. Once the receiver frequency is set, be sure to select "SONDE (Triad)" from the "SET LOCATING MODE" menu. If you prefer, you may also select "PEAK" or "NULL" to perform traditional locating tasks (see Appendix A, "Advanced Locating Techniques").

[3] *Feed the sonde into the pipe/conduit*

Sondes are commonly used for sewer pipe location work. In this case, feed the sonde on a snake or pushrod through a clean-out, sewer vent, or other access point. In the case of some other kind of conduit, one might use a fish tape or a pushrod to feed the sonde into the pipe.



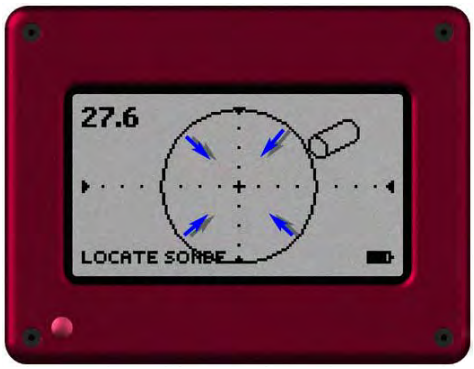
[4] *Locate the sonde*

Once the sonde has been inserted into the pipe, use the 2310 Receiver to determine the location of the sonde, as follows:

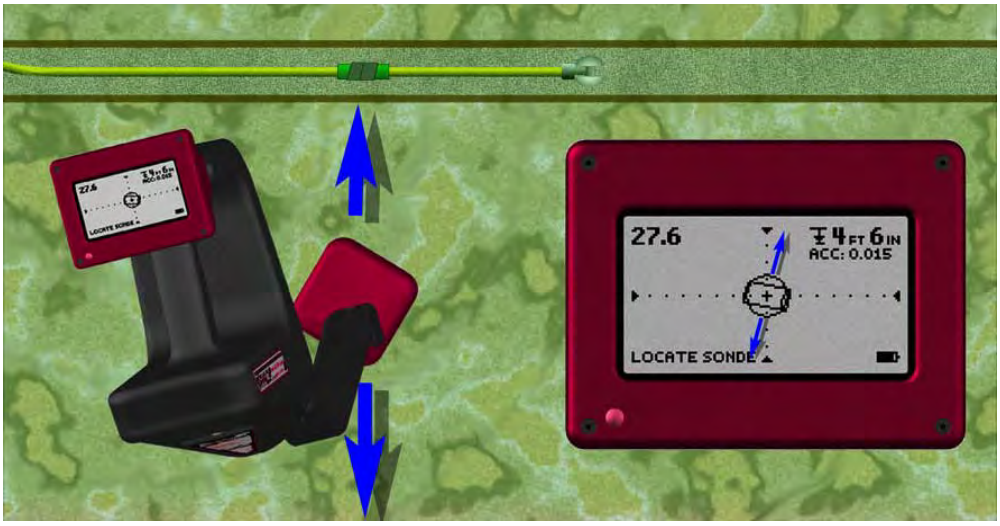
(a) If possible, track where the sonde is going from above ground every 10 to 20 feet that it is fed out. Continue to feed until the sonde reaches the point of interest.

(b) Use the ANR in the upper left corner of the display, and the audio tone, to guide you to the general area around the location of the underground sonde. Typically, the larger the ANR, the closer the pointer antenna is to the location of the sonde.

(a) To pinpoint the location of the sonde, center the cylinder icon that represents the sonde under the crosshair on the screen. The user will notice that as the cylinder is centered, the centering circle will constrict. The tighter this centering circle, the more positive the location of the sonde (see next step). The user will also notice that the receiver will report the depth and depth accuracy in the upper right corner of the screen.



(d) There is one condition that the user should be aware of when centering the sonde in the constricting circle. If the icon is a flat



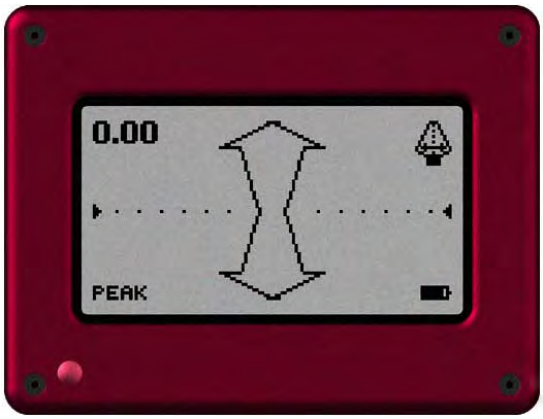
rectangle (or nearly so), the user should swing the pointer along the line that cuts through the middle of the icon. Move the pointer along this line, searching for the maximum ANR and/or the minimum depth report. When the receiver is so positioned, it will be pointing directly at the sonde.

(e) When reading the depth, hold the receiver steady. After a few moments, the depth report will stabilize to the most accurate reading.

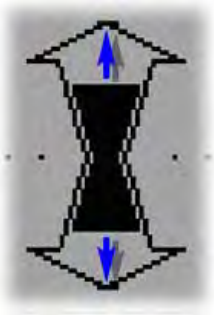
For more information about other methods that can be used when attempting to locate a sonde, please consult Appendix A, "Advanced Locating Techniques".

7 Using Peak & Null Modes

When the "SET LOCATING MODE" menu is displayed, the user is presented with the **PEAK** and **NULL** options. PEAK and NULL are utility modes that can be used on any type of job. Their purpose is to allow the user to monitor only the signal response in the horizontal or vertical direction, relative to the pointer antenna. Being able to isolate directional responses can be very useful in both line tracing and sonde locating jobs.



To activate PEAK mode, select it in the "SET LOCATING MODE" menu. The receiver will present the screen shown to the right on the LCD display. While using PEAK mode to locate and pinpoint a target, one should monitor both the ANR in the upper left corner and the double-arrow graphic drawn in the center of the screen. As the receiver detects an increasing signal level, the double-arrow graphic will darken from the middle outward. Also, the ANR will increase, indicating that the pointer antenna is approaching the target. When both the ANR and double-arrow graphic reflect a highest (peak) relative reading, then the target (line or sonde) is typically directly beneath the pointer antenna. (NOTE: for the double-arrow graphic, the maximum response is relative. That is, the graphic need not be blacked out completely when reflecting a peak in signal response; the response simply needs to be the highest of immediately nearby readings.)



Just as with PEAK mode, NULL mode may be selected from the "SET LOCATING MODE" menu. The screen graphic for NULL mode is effectively the same as it is for PEAK mode. The only difference is what field direction is being monitored (see upper right corner of display). The response of the receiver will increase when it detects increasing signal in the vertical direction, and it will "null" to zero when a vertical field is not present. This feature can be useful in a variety of locating tasks.

To understand more fully the application of PEAK and NULL modes in various locating situations, please see Appendix A, "Advanced Locating Techniques".

Uses and Advantages of Using PEAK/NULL Modes

Line Tracing: Although the Triad LINE Mode allows the 2310 Receiver to reveal much useful and intuitive information during line tracing, certain situations will arise that prove difficult for the receiver's programming to interpret. An example of such a situation is when multiple lines, all energized at the same frequency, converge together (e.g., a soft-copper manifold or an electrical panel manifold). In this situation, as the user approaches the

congested area, he will find that switching the mode to PEAK will enhance his ability to isolate individual lines more succinctly and with less confusion (Appendix A).

Also, the PEAK mode tends to be more sensitive, requiring less available signal to perform its function. Therefore, the user will often be able to increase overall tracing distance in PEAK mode as compared to Triad Line mode. Thus, switching to PEAK mode from Triad Line mode enables the user to trace further without having to change the connection point used to energize the line.

Sonde Locating: As with line tracing, using PEAK mode while locating a sonde will provide greater detection depth. In Triad SONDE mode, the cylindrical sonde icon will tend to become less consistent and harder to pinpoint at greater depths. In this situation, the user can switch to PEAK mode. Again, because PEAK mode requires less available signal than Triad mode to perform its function, using it will allow the user to locate the sonde at a significantly greater depth.

Disadvantages of Using PEAK/NULL Modes

The obvious disadvantage of using PEAK or NULL mode is that it does not present the same kind of graphic as the Triad modes to assist in visually locating a target. Thus, to use PEAK/NULL modes requires the user to understand conventional locating techniques in order to accomplish a job. Another disadvantage is that the receiver does not provide an automatic depth report in PEAK or NULL mode. On the other hand, the user may wish to determine the depth of a target using conventional triangulation techniques. For these, PEAK and NULL mode are not only useful, but also recommended. Please see Appendix A for more about this.

APPENDICES

A ADVANCED LOCATING TECHNIQUES

A.1 Conventional Locating Using Peak And Null Modes

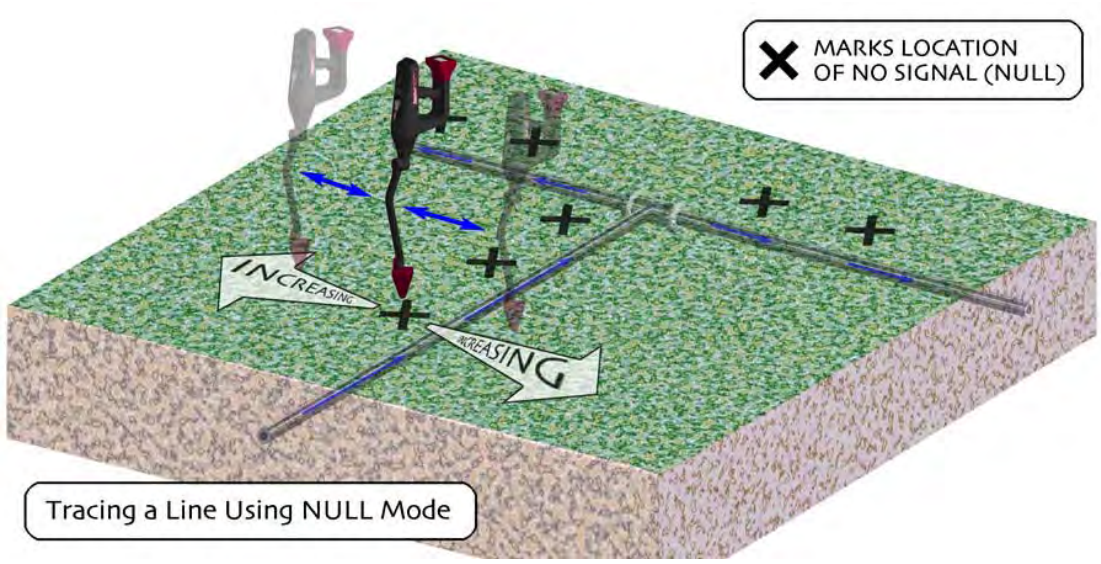
At times, the operator may wish to locate with traditional methods that have been used in the locating industry for decades. These methods exploit the fact that energized objects, whether they are lines or sondes, present well-defined response points around the object. By using a directional antenna, an experienced operator can easily find these points, and is then able to accurately determine location and depth of the object from the information obtained.

The PEAK and NULL modes have been included among the features of the Model 2310 Receiver, in order to allow an operator to perform locations using conventional methods. To use these modes effectively, the operator MUST become familiar with conventional techniques. A simple primer on these techniques follows here. Although the information here is not exhaustive by any means, it suffices for most locating jobs.

A.1.1 Conventional Methods – Line Tracing

Tracing by Nulls

To trace by nulls, the operator must first set the locating mode to "NULL", as described in Chapter 4 of this manual. Once this mode is selected, the receiver should be held roughly vertical while searching. The user will notice the flashing vertical arrow inside the pointer icon in the upper right corner of the display. This indicates that the receiver will respond to fields in the vertical direction.



(a) In the general area of the energized line, walk in whatever direction causes the ANR and the bar response to increase.

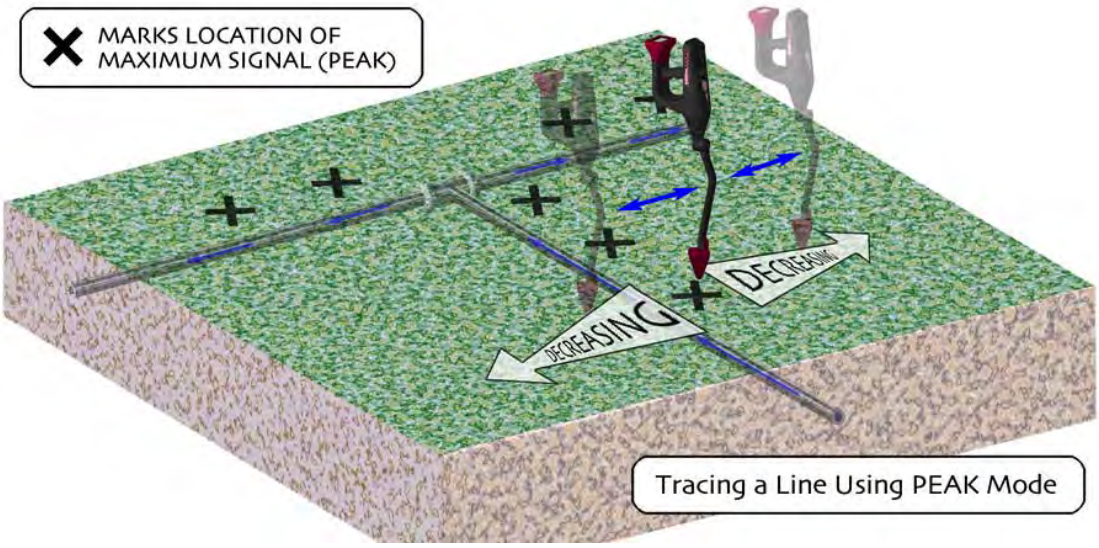
(b) Continue walking until the signal response sharply decreases, so that suddenly no signal is detected. At this point, you have found a "null", indicating that the pointer is directly above the buried line.

(c) As you continue walking in the same direction, the response will sharply increase. Swing the receiver back over the original null spot. As you do the 2310 will automatically adjust itself to respond with the sharpest possible null.

(d) Having narrowed the null to a single location under the pointer antenna, mark that spot on the ground. Now, move away from that spot in order to locate other spots on the ground. As you locate the path of other null spots, you will be tracing the course of the line.

Tracing by Peaks

To trace using signal peaks, set the locating mode to "PEAK", according to the instructions given in Chapter 4. Hold the receiver approximately vertical when using PEAK mode. When PEAK mode is selected, the user will notice the horizontal flashing arrow inside the pointer icon in the upper right hand corner of the display. This indicates that the receiver will respond to fields in the horizontal direction.

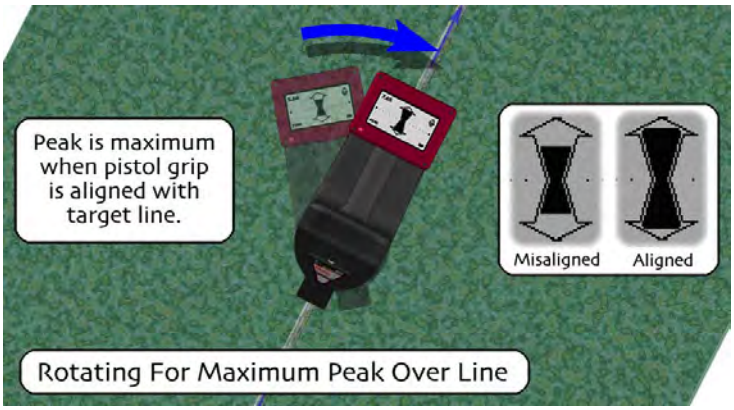


Tracing a Line Using PEAK Mode

(a) Walk around the general area of the energized line. The goal is to seek for increasing signal response, as presented by the ANR and the arrow-shaped bar graph. As you search, it is recommended that you occasionally rotate the pointer antenna, since the response of the antenna is now related to its positioning.

(b) As the response increases, continue walking until the response passes a maximum and begins to decrease. You have just passed a "peak" over the buried line. Position the 2310 vertically so that the pointer is directly over the spot where the peak is. The pointer antenna should now be pointing directly at the buried line.

(c) Next, rotate the receiver to obtain the maximum response over the line. When this is done, the receiver will be positioned so that the line passes directly beneath it from back to front, as shown.



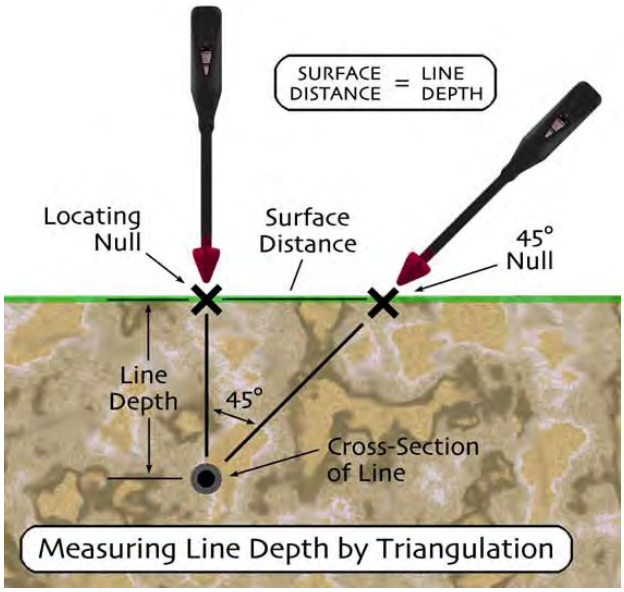
Rotating For Maximum Peak Over Line

(d) Having thus aligned the receiver, mark the spot on the ground directly below the pointer antenna. Now move forward and/or backward from that spot to locate peaks at other spots over the line. As you traced the peaks, you will be tracing the course of the line.

Determining Line Depth Using Triangulation

While tracing in conventional modes, you may wish to determine the approximate depth of the line being traced. Because the conventional locating modes do not provide automatic depth, the user must use triangulation based on response nulls around the line, as described below.

(a) During line tracing, mark the spot over the line where you desire to measure the depth. Locate this spot via the null or peak method described previously. It may be most convenient to use the NULL mode for this entire procedure.



(b) With the 2310 in NULL mode, angle the receiver at about 45° relative to the ground. Move the angled receiver laterally away from the line, until the response enters a null. While maintaining the 45° angle, move the pointer toward and away from the pipe, and narrow in on the precise null location. Mark this spot.

(c) Measure the distance between the surface location above the line and the 45° null. This distance is roughly equal to the depth of the line. It is wise to confirm this depth measurement by performing the same procedure on the opposite side of the line. If the pair of measurements is close to each other, then the determined depth is probably fairly accurate. If not, then the accuracy is questionable.

A.1.2 Conventional Methods – Sonde Locating

Locating a Sonde by Nulls

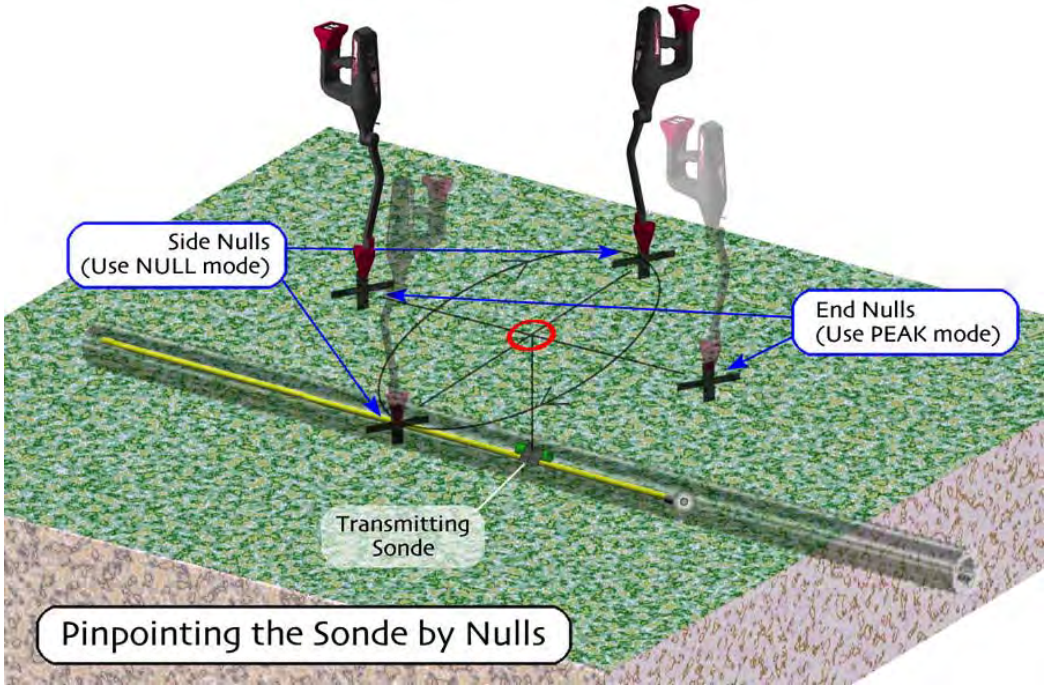
Begin by setting the locating mode to NULL, as described in Chapter 4 of this manual. While locating, hold the 2310 Receiver vertically.

(a) In the general area of signal response, walk about a 10 to 15 foot diameter circle, until the ANR and bar response sharply decline. At the location of decline (null), swing the pointer back a forth slowly in order to narrow the null spot. Mark the spot of the null.

(b) Now, walk a rough circle, perhaps 5 to 8 feet in diameter. The receiver should detect a second null away from the first null. Mark this spot. You have now located two "side nulls", so called because they are found

to the side of the transmitting sonde. Draw a straight line through these two null spots.

(c) Next, set the locating mode to PEAK, and hold the receiver vertical and rotated so that the line just drawn through the side nulls is oriented side-to-side with respect to the receiver. Also, the receiver should be offset forward or back from the line through the side null marks.



(d) With the receiver thus oriented, walk side-to-side and search for another null. Once you have located and marked the null on one side of the first line, mark the accompanying null on the other side of the line. You have now located two "end nulls", so called because they are found off of the ends of the sonde.

(e) Draw a straight line through the two end nulls. Assuming the sonde rests in a roughly horizontal position underground, the intersection of the two lines will mark the surface location directly above the sonde.

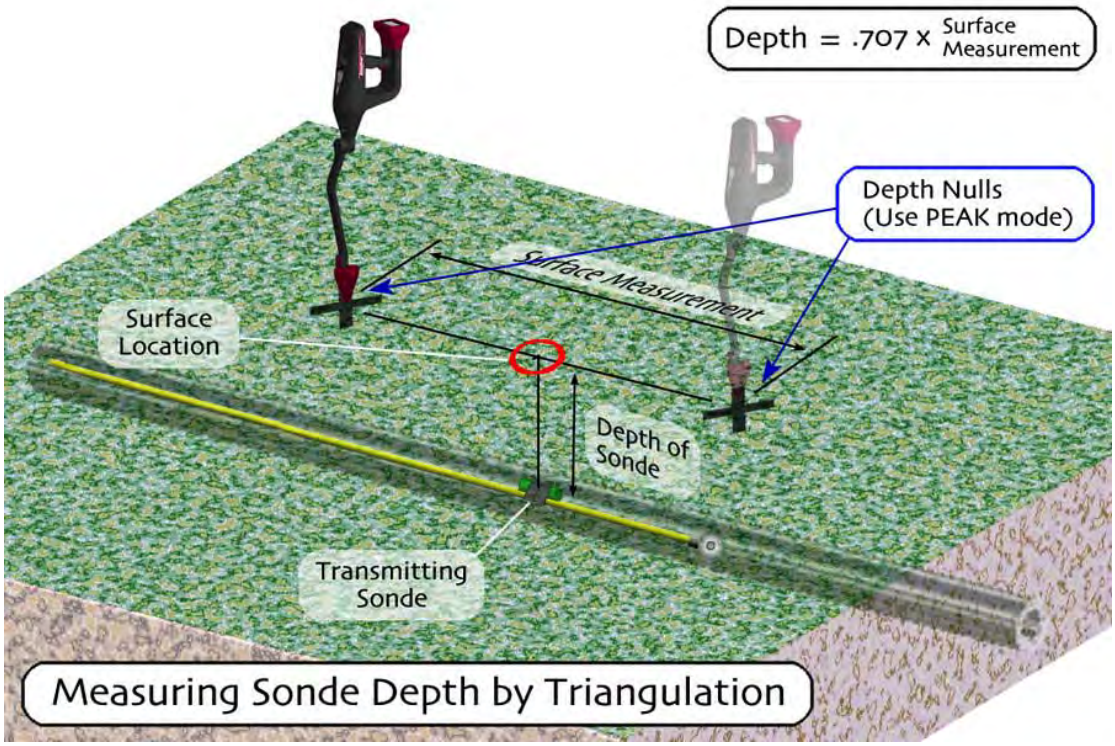
Determining Sonde Depth by Triangulation

Once the surface location of a sonde has been established using the null method, the operator may determine depth by triangulation. To do this, set the locating mode to PEAK. As before, hold the receiver vertically during this procedure.

(a) Position the receiver so that the pointer is directly above the surface location, and orient it so that the end-null line runs side-to-side.

(b) Move the receiver to the right or left along the end-null line until a null is detected. Narrow in on the null spot and mark it. Now move the receiver the opposite direction along the end-null line to mark the accompanying null spot. You have located the "depth nulls".

(c) Measure the distance between the two depth nulls. Multiply this surface measurement by 0.707 (71%) to calculate the depth of the transmitter. If the depth nulls are evenly spaced about the surface location of the sonde, then this calculated depth is very accurate. If they are not evenly spaced, or you cannot even find both depth nulls, then the calculated depth is not accurate.



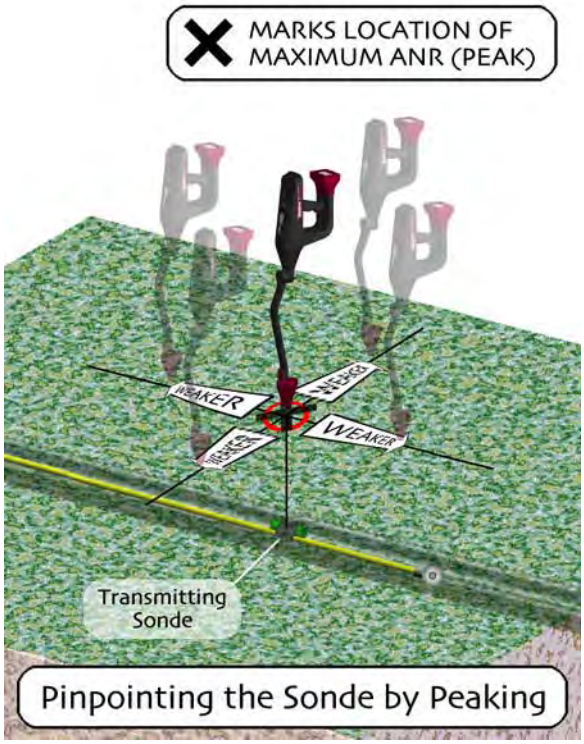
Locating a Sonde by Peaking

Set the locating mode to PEAK, and hold the receiver vertical while searching.

(a) Walk the area wherein the sonde is suspected to be. As the signal is detected, move so that the ANR and bar response increase.

(b) While searching, rotate the pointer to maximize the response as well. Assuming the sonde is resting roughly horizontal, the maximum response should occur when the pointer is directly above the sonde and rotated so that the direction of the sonde is side-to-side.

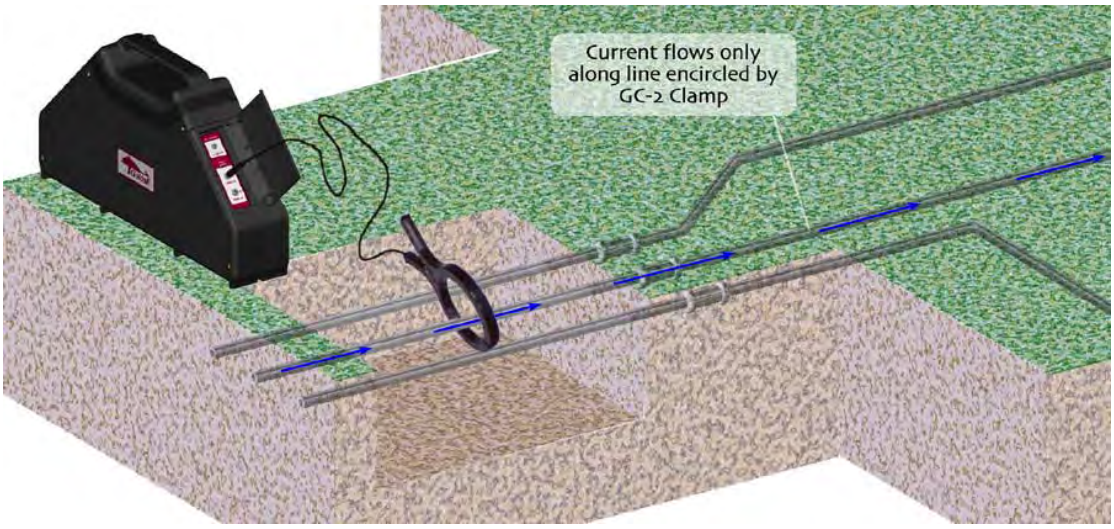
If the sonde is positioned vertically underground, then a similar procedure may be used, setting the locating mode to NULL.



A.2 Alternative Methods to Energize A Line For Tracing

A.2.1 Using A Gc-2 Inductive Clamp

Sometimes it may be difficult to isolate a line for the purpose of energizing it for tracing. Perhaps the line has no electrically exposed access point; or it is bundled with a number of other lines, making it hard to energize using the normal inductive method. The Model GC-2 inductive clamp makes it possible to induce a signal into a specific line without significantly energizing surrounding lines. Also, because the clamp works inductively, using it requires no electrically exposed portion of the line.



To use the GC-2 Clamp, simply plug it into one of the DIRECT output jacks (*SIGNAL[1]* or *SIGNAL[2]*), and encircle the target line with the clamp. Activate the 23X transmitter, and select the tracing frequency. It is recommended to use the clamp with RF frequencies only (33 KHz and higher). Only the line(s) enclosed inside the clamp will be energized.

Once the line is energized with the GC-2, proceed with the locating job as you normally would.

A.2.2 Creating A Tracing Loop

A very effective way to isolate a single line for tracing is to construct a "loop". A loop is simply a closed circuit, which allows current to flow only along the desired target line.

To set up a loop, the user needs a long insulated wire run, electrically exposed on both ends of the run. Preferably, this wire will have some kind of attachment clip on at least one end of it. Also, the target line needs to be electrically exposed on both ends of the intended tracing run.

(a) Plug a direct-connection cable (DCC) into one of the DIRECT output jacks of the 23X transmitter.

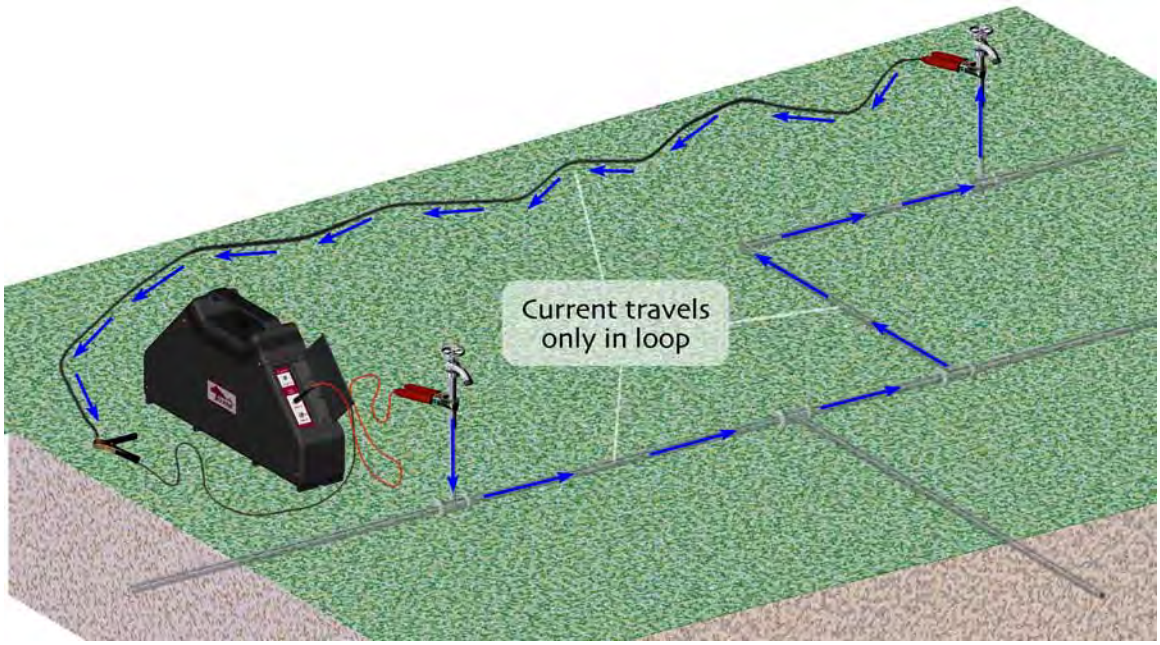
(b) Attach the red clip of the DCC to one exposed end of the target line.

(c) Attach the black clip of the DCC to one exposed end of the insulated wire.

(d) Uncoil the wire and walk the other exposed end of the wire to the other exposed area of the target line. Clip the second end of the wire to the second exposed portion of the target line. NOTE: IT IS IMPORTANT THAT THE WIRE BE LAID AWAY FROM THE SUSPECTED PATH OF THE TARGET LINE, BECAUSE THE WIRE ITSELF WILL CARRY A TRACING CURRENT.

(e) Activate the transmitter case, and select an appropriate frequency. It is recommended that this frequency be 8 KHz or lower.

(f) The target line should now be energized. Proceed with the locating job as you normally would. However, as mentioned above, understand that the looping wire itself will be energized, so that care should be taken not to trace that instead of the target line.



A.3 Energizing Two Lines at the Same Time

As a matter of convenience, the Model 23X Transmitter Case has been designed with two DIRECT output ports, SIGNAL[1] and SIGNAL[2]. Having two ports enables the user to directly energize two separate lines at the same time (at different frequencies, of course).

Although this feature is available to the user, the user must exercise care when using it. Not all job situations lend themselves to dual energizing. The network of underground utilities in any given area may be convoluted. For example, it is not unusual for gas and water utilities to be somehow electrically connected. It is very common for electrical services to be grounded to another utility like water. A few simple rules should be applied to determine whether using dual energizing is feasible:

(a) Check to make sure that the target lines are not electrically connected. Using an ohmmeter, check the resistance from line to line. Measure from the exposed area of one line to the exposed area of the other line. If you measure a low resistance, then dual energizing will not work. Instead, both lines will be energized at both frequencies.

(b) Try to energize the lines with lower frequencies. Using low (33 KHz and lower) frequencies will prevent "induction slopover" or cross-talk between lines.

(c) Use an appropriate output level for the tracing situation. Applying an excessive amount of power to the target lines can cause signal flooding. It is recommended to start at the lowest output level (10%), and then increase it if more power is needed for the trace.

A.4 Optimizing the Use of the Multi-Frequency Capability

The Model 23X Transmitter and the Model 2310 Receiver are equipped with a wide variety of frequency and power output options. This is so in order to address the variety of conditions encountered in actual line tracing situations. A user might best energize one type of utility with a low frequency and a high output power. Another type of utility might be better suited to a high frequency and lower power, and so on. Becoming familiar with the basic techniques for optimizing a trace will enable the user to best exploit the flexible capabilities of the Triad Locating System. Many line tracing situations will differ from one another, and an operator will acquire expert knowledge of what works best only by use and experience. However, following here are a few general guidelines to get the user started.

Higher frequencies (RF) have a tendency to travel further while requiring less power to do so. They are well suited for direct burial lines, which typically have relatively low impedance to ground. Compared to low (audio) frequencies, high frequencies can operate with a less solid ground. In fact, RF frequencies are often used to energize "off ground", in which the ground lead is allowed to float to provide a soft ground return. Higher frequencies are excellent for introducing a signal into a line without any contact point whatsoever (inductive energizing).

One disadvantage of using RF frequencies is that of "induction slopover". Their strength is also their weakness. Because RF frequencies so easily induce signal into adjacent lines, they often energize lines and structures besides the user's intended target.

Lower frequencies, on the other hand, are poor at inducing a tracing signal. But their weakness is also their strength. They are much better at energizing only the target line, without the concern of induction slopover. Audio frequencies often require greater amounts of power for long-distance tracing jobs. Low frequencies are well suited for insulated lines, which have relatively high impedance to ground. Wrapped lines and tracer wires fall into this category.

As mentioned above, although these guidelines apply in many situations, nothing is absolute. Tracing conditions will vary from job site to job site. However, the Triad Locating System puts many options at your fingertips to address any locating situation you might face.

A.5 Explanation of the "OVERHEAD" Report

In general, the Model 2310 reports OVERHEAD when it calculates that the field source is closer to the receiver chassis than it is to the pointer head. In practice, in a real-world locating situation, the OVERHEAD report can mean several things.

Obviously, the OVERHEAD report can mean that the line or sonde being sought is literally overhead with respect to the receiver. For example, during an indoor line trace, it can mean that the line is actually in the ceiling instead of the floor. If this is the case, the user need only swing the receiver 180° to achieve the correct result.

The OVERHEAD report could also mean that "competing fields" are present. Competing fields come from sources other than the intended target. They can result from external interference. Also, they can emanate from lines that have been unintentionally energized by induction "slopover". In this case, swinging the receiver 180° may not result in any improvement to the locating result.

Finally, the 2310 Receiver may report OVERHEAD when there simply is not much signal available with which to work. The better the signal strength, the better the receiver is able to perform its job. The receiver may have difficultly making accurate calculations in a low-signal situation. Also, it is very likely for competing fields to be present in a low-signal situation. In such cases, the user is encouraged to improve the strength of the transmitter signal, if possible. For instance, this may be done during a line tracing job by moving the energizing point closer to the area where the line is being traced.

A.6 Helpful Hints while Locating around Sources of Interference

If, while locating, you experience difficulty pinpointing the targeted transmitter, it is likely that you are in an area of excessive interference. Interference originates from sources other than your transmitting device that emit frequency components at or near the frequency of the transmitter. For instance, audio frequency settings like 512 Hz can be susceptible to interference because there are many possible sources of audio frequency field interference in typical locating environments. Among these sources of interference are equipment power supplies (such as are in computers and monitors), power transformers, and power transmission lines that carry large currents. Another example of a source that can cause white noise (frequency components in all ranges) is an active dimmer switch in a home lighting system.

One symptom of significant interference is erratic behavior of the cylindrical icon in SONDE mode. The icon may flash on and off the screen intermittently, or "jump" around the center inconsistently. If this occurs, we recommend the user to try the following: (1) Reduce the volume, or (2) use a headset, via the headset jack on the underside of the 2310.

In high interference situations, it may be helpful or even necessary to use the PEAK or NULL mode, and to use conventional locating techniques (triangulation, etc.). Refer to section A.1 of this appendix for more about conventional locating methods.

A.7 Using PEAK Mode and the Absolute Numeric Response (ANR) in Congested Areas

Often a user will find himself performing a locating job in a congested area, in which multiple lines in a confined space all carry the tracing signal in varying amounts. Common examples of this are: directly beneath an electrical panel; beside a transformer with an inlet and multiple outlets; a phone pedestal; or a soft-copper manifold. In such instances, the receiver will not present an accurate representation of the lines in question when using Triad LINE mode. In LINE mode, the receiver displays a single line representation, based on the field sum of all the energized lines present; the receiver cannot graphically display multiple lines carrying the same tracing signal.

To isolate individual lines in a congested area, use PEAK mode. To operate the receiver in PEAK mode, follow the set up instructions in Chapter 4 of this manual. REMEMBER: PEAK mode responds to the signal field directionally, which means that the signal response is optimum as the line passes underneath the pointer head from the rear to the front. In PEAK mode, the receiver is able to sharply distinguish the side-by-side lines. As you pass the pointer head over the individual lines, you will notice the double-arrow peaking bar and the ANR increasing and decreasing. The bar response is relative, because its purpose is to aid the user in determining the maximum relative response over a particular line. The ANR is absolute; its value directly corresponds to the actual amount of signal being received. Because the ANR is absolute, this number can aid in identifying the target line. Usually, but not always, the target line is the one carrying the greatest amount of signal. So, the user typically can not only isolate all the lines in a manifold, but also determine the relative amounts of current that they are carrying, all without even touching a gain control. For more information about using PEAK mode to trace lines, refer to section A.1 of this appendix.

A FINAL CAUTION: Because parameters can significantly vary from one locating job to the next, the user should understand that the highest ANR does not always correspond to the target line. Lines carrying the signal of interest may be of differing depths and continuities. Lines can be electrically linked underground in ways that may not be conventional or anticipated. The user must always be the final interpreter of the results obtained during any given locating job, and the responsibility of forming appropriate conclusions falls to the user. Nonetheless, the 2310 Receiver has been designed to make this process of interpretation easier.

A.8 Using the ANR to Determine Signal Strength on an Energized Line

While using the 2310 Receiver, the operator will find the ANR (Absolute Numeric Response) useful information for a variety of tasks. Among these tasks is that of determining whether or not a line is carrying a strong tracing current from a DIRECT connection.

To test the tracing current strength, hold the pointer antenna near the connection point of the red clip lead from the DCC. You may hold the pointer either near the red cable itself, or on the other side of the connection around where the line enters the ground. If you have not already set the appropriate receiver frequency BY SCAN or BY CATALOG, you may do so now.

The receiver should be responding to the active signal to some degree. Of course, the strength of the response corresponds to the strength of the tracing current. Below is a chart that will help to qualitatively determine the strength of the signal on the line to be traced.

ANR Condition	Quality of Tracing Signal
ANR < 1.00	Very poor; probably unusable.
1.00 < ANR < 5.00	Weak, but probably usable for short tracing distances.
5.00 < ANR < 100.0	Fair to strong; probably adequate for most tracing jobs.
ANR = 100's	Very strong; probably more than enough signal for most tracing jobs.
ANR = 1000's	Extremely strong; possibly too strong, so that user may want to reduce the transmitter output.

Although the ANR is a useful number for estimating the strength of the tracing signal at the connection point, the user should understand that conditions vary from one locating situation to another. A large ANR at the connection point does not necessarily mean a long tracing distance. The tracing distance always varies with ground conditions (moisture, mineral composition, etc.). Likewise, a small ANR at the source may actually result in a fairly long trace.

B CARE AND MAINTENANCE

B.1 Power Consumption & Replacing Batteries

Both the 2310 Digital Receiver and the 23X Transmitter Case are designed to be completely portable. Each instrument is powered by internal batteries. Because batteries are limited-capacity supplies, they will need replacing from time to time. How often they need replacing depends upon how often and how long the instruments are used, and also upon the conditions under which they are used.

Under normal conditions, the 2310 Receiver continues to operate for tens of hours on one set of batteries. However, some features will consume power at an accelerated rate if they are used all the time. One such feature is the LCD backlight. It can be set to stay on all of the time; if it does stay on all of the time, battery life will be considerably reduced. Setting the speaker volume to maximum output can also drain the batteries more rapidly.

Likewise, the 23X Transmitter can be used in a way that consumes only a little or a lot of power. Using the transmitter at a 25% output level is generally power-efficient, and usually is more than enough for most tracing jobs. However, there are jobs that will put a heavy load on the transmitter and perhaps require higher output levels. Under such conditions, the 23X may be putting out 5 to 10 Watts of power. A high demand like this will quickly sap the internal battery. Therefore, for high-demand jobs, Goldak recommends that the user use an external power source, such as a car adapter, an AC wall adapter, or a high-capacity rechargeable battery system.

Replacing the Batteries in the 2310 Receiver

The 2310 Digital Locating Receiver requires eight (8) alkaline "AA" cells to operate. Carbon batteries are NOT recommended. The user will know that the batteries need to be replaced with fresh ones when the battery "fuel gauge" icon in the lower right corner of the display is completely empty. Although the 2310 will probably still function properly for a little while under a low-battery condition, it is recommended to assure that the batteries are sound for best results. To replace the batteries:

(a) Make sure the 2310 Receiver is OFF.

(b) With the receiver in the fully extended position, remove the battery cover on the underside of the unit. Place the base of your palm on the tail end of the chassis and two or three fingers into the grip cavity of the battery cover.

(c) Pull the battery cover toward the chassis tail, and it will "pop" out of the battery cavity.

(d) Remove the four cells in the battery cover and the four cells in the chassis, and replace them with new ones, observing the polarity markings molded into the plastic.

(e) Reinstall the battery cover, sliding in the guide tab and pressing down on the base of the cover at both corners. The cover should "pop" and resettle into its original position.

(f) Activate the 2310 to make sure that the batteries are properly installed and that the internal spring contacts are properly connected.

Replacing the Batteries in the 23X Transmitter

The Model 23X Transmitter Case can be powered several ways. The most common way is via the internal battery, which consists of eight (8) alkaline "C" cells. Goldak does NOT recommend using batteries of a lower capacity, such as carbon cells, or Ni-Cad rechargeables. The user will know when to replace the batteries by monitoring the LCD display on the 23X control panel. When the symbol "bAt" intermittently flashes, it is time to replace the internal battery. The user may also check battery condition by pressing and holding down the "PULSE" button. To replace the internal batteries:

(a) Make sure the transmitter is OFF.

(b) Lay the case open. On the same half as the control panel you will see the battery cover, held on with two captive thumb screws.

(c) Unscrew the thumb screws and remove the battery cover.

(d) Pull out the 8-cell battery module inside the cavity. You may remove the entire module at the snap if this proves to be convenient.

(e) Remove the eight cells and replace them with fresh ones, observing proper polarity as indicated on the module itself.

(f) Replace the battery snap and lay the module into the cavity. Be sure to lay the battery wires fully to the side of the module, so that the module does not rest on top of the wires.

(g) Return the battery cover to its original position. NOTE: the battery cover can only be installed one way, with the label oriented right-side-up. Do not try to force the cover on upside-down.

Of course, the 23X Transmitter may also be powered via the external DC power jack. The user may then use a car battery source, an AC wall source, or a high-capacity rechargeable source. Refer to any instructions that may have come with these accessories to understand their care and maintenance requirements.

B.2 Handling

The 2310 Receiver and 23X Transmitter are both ruggedly constructed and resistant to damage from shock. Nonetheless, they should be handled with care, as should all electronic instruments. To prevent exposing the receiver to excessive shock, the operator should avoid striking objects with the pointer antenna or chassis body. Likewise, the receiver should not be intentionally dropped from any distance onto a hard surface. Also, avoid piling very heavy articles on top of the receiver. It is always best to return the receiver to its storage case when you are done using it.

Although the 23X Transmitter Case is very rugged, one should always refrain from throwing or dropping it. Keep the latch covers closed at all times while the Triad system is not in use.

B.3 Inclement Weather

Both the 2310 Receiver and 23X Transmitter are water-*resistant*, not water-*proof*. Therefore, neither instrument should be submerged in water, although they can be used in wet conditions.

Also, although the circuitry is rated to operate from to –4°F to +158°F, extreme temperatures are not ideal conditions for usage. It is preferable to operate the Triad Locating System in conditions ranging from several degrees below freezing (14°F) to about 120°F.

B.4 Storage

As an absolute range, the Triad System may be stored in temperatures ranging from –40°F to 250°F. That is, storing the system in temperature conditions outside this range may irreparably damage the product. Also, the system may be stored in relative humidity conditions up to 95% (non-condensing).

However, just as there are recommended usage conditions, so also there are desirable storage conditions. Ideally, the product should be stored in a cool, dry place (freezing to 100°F, low humidity).

The user should also understand that storing the system in extreme conditions is also not desirable from an operating viewpoint. For instance, suppose the system is stored in the trunk of the vehicle on a very hot day. The temperature inside the trunk could easily reach over 200°F. Although the product will not be damaged by these conditions, it also will not operate properly right out of the trunk. The reason is that 200°F exceeds the operating temperature of the product. In fact, the circuitry has built-in protection to prevent it from activating in a dangerously overheated condition. The user will have to allow the product to cool down to the ambient temperature before using it. Therefore, it is better to store the product within the operating temperature range in the first place.

C TROUBLESHOOTING

The following is a simple guide, intended to instruct the user in simple procedures that may be attempted should equipment problems arise. This guide is not exhaustive. Should the user encounter problems outside the scope of this guide, then he should consult the factory and/or consider sending the equipment in for repair.

Troubleshooting for the 2310 Receiver

Problem: *The 2310 fails to activate when the trigger is pulled.*

- Poke the end of a bent paperclip into the RESET hole on the underside of the 2310 on the port panel. Depress the internal pushbutton switch.
- Check the batteries to make sure that they are sound and that they are properly installed. Make sure all battery springs and contacts are making good connections.

Problem: *The 2310 LCD display does not present an image.*

If the 2310 successfully activated, the display contrast may be set too low. In bright light (preferably sunlight), see whether the operating screen is faintly drawn. If so, select "SET CONTRAST" from the control strip, and raise the contrast level until the screen is clearly seen.

Problem: *The 2310 does not make a sound other than the start-up and shutdown sounds.*

The volume is turned all the way down. Use the "SET VOLUME" option in the control strip to adjust it.

Problem: *The 2310 behaves erratically.*

Excessive interference can cause the 2310 to respond erratically. Try to eliminate sources of interference. This can be done by turning off potential culprits, like computers and monitors, dimmer switches, industrial equipment, etc. If these measures do not remedy the problem, try using the 2310 in one of the conventional modes (PEAK or NULL).

Problem: *The 2310 seems unable to SCAN properly to an active transmitter*

Symptom	Probable Cause	Solution
SCAN results in low-pitched tone with no result.	• Transmitter is not emitting a signal. Either the battery is dead, or inserted backward, or there is no battery. • Pointer is too far away from transmitting sonde.	• Make sure battery is "good" and is properly installed in transmitting unit. • Hold the pointer at a distance of 2 to 4 feet from the transmitter, and retry SCAN.

SCAN resulted in a frequency other than that of the known transmitter frequency.	Pointer antenna is too close to the transmitter.	Hold the pointer antenna *at least* 2 or 3 feet away from the transmitting sonde, and retry SCAN.
Receiver does not SCAN to camera head.	Either the camera head does not have a built-in 512-Hz transmitter, or the transmitter is not active.	Verify that the camera does in fact have a built-in transmitting sonde. If so, make sure the sonde is activated from the television unit.
SCAN results in a frequency other than the known frequency of the camera head (e.g., 512 Hz)	The pointer antenna might be too close to the actual camera head, instead of the transmitting sonde. The camera head itself may emit high-frequency interference at a close range.	Hold the receiver with the pointer 2 to 4 feet away from the camera, and point toward the back of the spring head, rather than toward the tip of the camera head, and retry SCAN.
Transmitter is properly connected to line, but SCAN resulted in low-pitched tone.	The line in question probably is not carrying a sufficient amount of current for the receiver to detect and SCAN for the signal.	Increase the output level of the transmitter. If this still does not work, the line to be traced may not be conductive and cannot be traced via a signal current. Try setting frequency BY CATALOG to see if a signal can be detected and traced at all.
SCAN resulted in a frequency other than that of the known transmitter setting.	The energized line is carrying a large signal current, which is flooding the receiver detection circuitry.	Do any of the following: • Decrease the output level of the transmitter. • Bring the pointer further away from the target line, and retry SCAN. • Manually set the frequency BY CATALOG.

Troubleshooting for the 23X Transmitter Case

Problem: *The 23X Transmitter does not activate.*

- The internal batteries may be weak. Try replacing them
- Make sure that you hold the "ON" button for at least a second during startup.

Problem: *The 23X Transmitter activates but does not seem to energize a line via a DIRECT output jack.*

- Make sure the DCC is sound. Check for continuity from the red clip to the center of the plug, and from the black lead to the outside of the plug. Also, make sure that there is no short between the red and black leads.
- Make sure the DCC is properly inserted into the output jack.
- Make sure the line to be energized is conductive and traceable.

Problem: *The 23X Transmitter does not seem to energize a line inductively.*

- Make sure the output jacks are empty.

- Check the transmission from the case itself using the 2310 receiver. There should be direct air transmission at close proximity (say, within 8 feet).

Problem: *The 23X suddenly turns OFF during tracing, or when a control button is pressed.*

- The internal batteries are weak, even though the "bAt" symbol may not yet be flashing on the display. Either try to use the 23X at a lower power level, or replace the batteries.

D SAFETY

IMPORTANT SAFETY INFORMATION

Be sure to read these instructions before operating your Triad Locating System. When using any electronic equipment, and when working around pipelines, cables, and associated fixtures, one should always follow basic safety precautions to minimize the risk of fire, electric shock or other personal injury. It is recommended that the operator:

- Read and understand these and all related safety instructions.
- Attend to all warnings marked on this and related products.
- Avoid as much as possible using this and other electronic equipment near water (e.g. filled bathtubs, pools, a flooded basement).
- Avoid placing the receiver or transmitter on a precarious support, where it may fall and get damaged or injure someone.
- To reduce the risk of personal electrical shock and damage to the equipment, avoid connecting the energizing cables to live power or phone lines. Avoid touching non-insulated wires on power or telephone systems. Also, it is best to connect/disconnect the energizing cables while the transmitter is OFF.
- Avoid doing locating jobs or working with pipes or cables in a lightning storm.

E GLOSSARY OF TERMS

ANR (Absolute Numeric Response): The number in the upper left corner of the Triad 2310 Receiver display, which indicates the amount of signal being received, referenced to an absolute internal scale. The number always corresponds to the absolute physical strength of the signal being received, and ranges from 0.00 to 15000.0 (dynamic range > 110 dB).

Conductive: In general, the ability of an object to carry an electrical current. In line tracing, "conductive" refers to any line that can carry a current (typically metallic). Also, "conductive" refers to the method of energizing a line via direct connection.

Current: A physical quantity that indicates the rate of electron flow in a conductive line.

DCC: Acronym that stands for Direct-Connection Cable, which is used to energize a line via electrical contact.

Energizing: Causing a line to carry a tracing current. Normally, this is done either by direct connection or by indirect induction.

Frequency: The cycle rate of an electronic signal. In locating applications, the frequency is used to identify the target line or sonde.

Ground: A reference point with respect to some active voltage level. In line tracing applications, ground represents the return point for current flow along an energized line.

Ground Rod: A metallic probe that is typically plunged into ground soil to provide a return point for tracing current. Typically, the user connects the ground lead (black) of the DCC to the inserted ground rod.

Inductive: The method of energizing a line without touching it, using an energizing field.

Induction Slopover: Unwanted inductive energizing of lines that are in the proximity of an active inductive transmitter or a nearby energized line.

Line: Any wire, cable, pipe, or conduit. In general, a line must be conductive in order to qualify for energizing and tracing.

Loop: A closed conductive circuit that typically allows energizing current to flow only along the conductors that make up the circuit itself.

Manifold: Multiple lines, typically joined at a common junction, often running parallel with respect to each other, and usually in close proximity of each other.

Null: Conventionally used method of location, in which the signal response vanishes, indicating tell-tale locations around the target of interest. Like PEAK mode, NULL mode is directional, referenced vertically.

Passive: In the locating industry, this refers to lines that are energized without user intervention. Most often, a line becomes passively energized because it is carrying powerline (60 Hz) current.

Peak: Conventionally used method of location, in which the relative maximum signal around the target is used to locate it. For the Model 2310, PEAK mode is directional, reference to the side-to-side direction of the pointer antenna.

Scan: The feature of the 2310 Receiver that allows the user to automatically tune to an active transmitting source.

Signal: That which emerges from energized targets and is used to identify the target being located.

Sonde: (Lit., "sender") Commonly accepted industry name for any coil-type transmitter. Sondes are more often than not self-contained and battery-operated.

Receiver: Another term for the portable instrument (locator) that is used to search for energized targets.

Target: The object that is being located.

Transmitter: Anything that generates an active locating signal.

Triangulation: The method of using well-defined "tell-tale" locations around a transmitting target to make measurements. The locations and measurements are then used to calculate the location and the depth of the target.

Trigger: The gun-style switch that controls the Model 2310 Receiver.