



SeekTech® SR-60

Pipe, Cable and Sonde Locator

Patents Pending

Operator's Manual



⚠ WARNING!

Read this operator's manual carefully before using this tool. Failure to understand and follow the contents of this manual may result in electrical shock, fire and/or serious personal injury.

RIDGID®

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SR-60 Use and Care

- **Use equipment only as directed.** Do not operate the SR-60 unless you have read the operator's manual.
- **Do not immerse the antennas in water. Store in a dry place.** This will reduce the risk of electric shock and instrument damage.
- **Store idle equipment out of the reach of children and other untrained persons.** Equipment is dangerous in the hands of untrained users.
- **Maintain the instrument with care.** Properly maintained diagnostic instruments are less likely to cause injury.
- **Check for breakage of parts, and any other conditions that may affect the SR-60's operation.** If damaged, have the instrument serviced before using. Many accidents are caused by poorly maintained tools.
- **Use only accessories that are recommended by the manufacturer for the SR-60.** Accessories that may be suitable for one instrument may become hazardous when used on another.
- **Keep handles dry and clean, and free from oil and grease.** Allows for better control of the instrument.
- **Protect against excessive heat.** The product should be situated away from heat sources such as radiators, heat registers, stoves, or other products that produce heat.

Service

- **Diagnostic instrument service must be performed only by qualified repair personnel.** Service or maintenance performed by unqualified repair personnel could result in injury.
- **When servicing a diagnostic instrument, use only identical replacement parts.** Follow instructions in the maintenance section of this manual. Use of unauthorized parts or failure to follow maintenance

instructions may create a risk of electrical shock or injury.

- **Follow instructions for changing accessories.** Accidents are caused by poorly maintained equipment.
- **Provide proper cleaning.** Remove battery before cleaning. Do not use liquid cleaners or aerosol cleaners. Use a damp cloth for cleaning.
- **Conduct a safety check.** Upon completion of any service or repair of this product, ask the service technician to perform safety checks to determine that the product is in proper operating condition.
- **Damage to the product that requires service.** Remove the batteries and refer servicing to qualified service personnel under any of the following conditions:
 - o If liquid has been spilled or objects have fallen into product;
 - o If product does not operate normally by following the operating instructions;
 - o If the product has been dropped or damaged in any way;
 - o When the product exhibits a distinct change in performance.

CAUTION

Remove batteries entirely before shipping.

General Safety Information



WARNING

Read and understand all instructions. Failure to follow all instructions listed below may result in electric shock, fire, and/or serious personal injury!

SAVE THESE INSTRUCTIONS

Work Area Safety

- **Keep your work area clean and well lit.** Cluttered benches and dark areas may cause accidents.
- **Do not operate electrical devices or power tools in explosive atmospheres, such as in the presence of flammable liquids, gases, or heavy dust.** Electrical devices or power tools create sparks, which may ignite the dust or fumes.
- **Keep bystanders, children, and visitors away while operating tool.** Distractions can cause you to lose control.

Electrical Safety

- **Do not operate the system with electrical components removed.** Exposure to internal parts increases the risk of injury.
- **Avoid exposure to rain or wet conditions.** Keep battery out of direct contact with water. Water entering electrical devices increases the risk of electric shock.
- **Do not probe high voltage lines.**

Battery Precautions

- **Use only the size and type of battery specified. Do not mix cell types (e.g. do not use alkaline with rechargeable).** Do not use partly discharged and fully charged cells together (e.g. do not mix old and new).
- **Recharge batteries with charging units specified by the battery manufacturer.** Using an improper

charger can overheat and rupture the battery.

- **Properly dispose of the batteries.** Exposure to high temperatures can cause the battery to explode, so do not dispose of in a fire. Some countries have regulations concerning battery disposal. Please follow all applicable regulations.

Personal Safety

- **Stay alert, watch what you are doing, and use common sense.** Do not use diagnostic tools while tired or under the influence of drugs, alcohol, or medications. A moment of inattention while operating diagnostic instruments may result in serious personal injury.
- **Gloves should always be worn for health and safety reasons.** Sewer lines are unsanitary and may contain harmful bacteria and viruses.
- **Do not overreach. Keep proper footing and balance at all times.** Proper footing and balance enables better control of the tool in unexpected situations.
- **Use safety equipment.** Always wear eye protection. Dust mask, non-skid safety shoes, hardhat, or hearing protection must be used for appropriate conditions.
- **Use proper accessories.** Do not place this product on any unstable cart or surface. The product may fall causing serious injury to a child or adult or serious damage to the product.
- **Prevent object and liquid entry.** Never spill liquid of any kind on the product. Liquid increases the risk of electrical shock and damage to the product.
- **Avoid Traffic. Pay close attention to moving vehicles when using on or near roadways. Wear visible clothing or reflector vests.** Such precautions may prevent serious injury.

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 - o If the product has been dropped or damaged in any way;
 - o When the product exhibits a distinct change in performance.

CAUTION

Remove batteries entirely before shipping.

**DANGER****Important Notice**

The SR-60 is a diagnostic tool that senses electromagnetic fields emitted by objects underground. It is meant to aide the user in locating these objects by recognizing characteristics of the field lines and displaying them on the screen. As electromagnetic field lines can be distorted and interfered with, it is important to verify the location of underground objects before digging.

Several utilities may be underground in the same area. Be sure to follow local guidelines and one-call service procedures.

Exposing the utility is the only way to verify its existence, location, and depth.

Ridge Tool Co., its affiliates and suppliers, will not be liable for any injury or any direct, indirect, incidental or consequential damages sustained or incurred by reason of the use of the SR-60.

In any correspondence, please give all the information shown on the nameplate of your locator including model number and serial number.

**DANGER****Important Notice**

Always insert and connect the earth grounding rods before turning on the transmitter. Never pull out an earth grounding rod as long as the generator is switched on! Never pull the earth grounding rod or disconnect the ground lead if the other lead is connected to a utility.

SR-60 Components



Figure 1: SR-60 Components

Introduction to the SR-60

Getting Started

Installing/Changing Batteries

To install batteries into the SR-60, turn the unit over to access the battery compartment. Turn the knob on the battery cover counter clockwise. Pull straight up on the knob to remove the cover. Insert the batteries as shown on the inside decal and make sure they drop to full contact. Fit the cover into the case and turn the knob clockwise while lightly pressing down to close. The battery cover can be installed in either orientation.

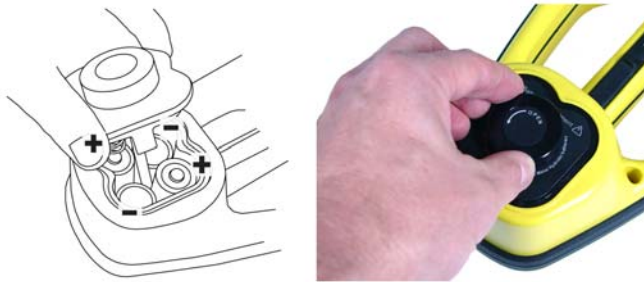


Figure 2: Battery Case

When the SR-60 is powered on, it takes a few seconds to check the batteries. Until then the battery level will show as “empty”.



Do not allow debris or moisture into battery compartment. Debris or moisture may short the battery contacts, leading to rapid discharge of the batteries, which could result in electrolyte leakage or risk of fire.

Folding Mast

To begin operation, unfold the antenna mast and lock the folding joint into place. When locating is complete, press the red release lever to fold the antenna mast for storage.

IMPORTANT

Do not snap or whip the SR-60 mast to open or close it. Open it and close it by hand only.

NOTE: Avoid dragging the lower antenna node on the ground while locating with the SR-60. It may cause signal noise which will interfere with results, and may eventually damage the antenna.

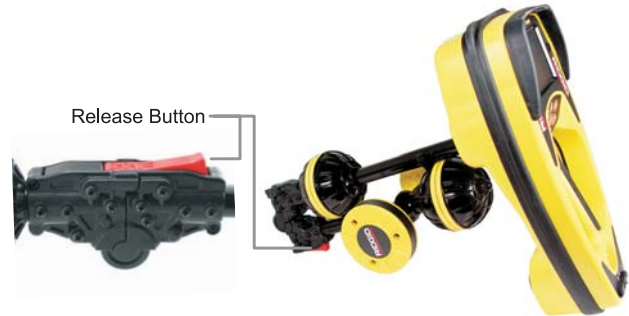


Figure 3: Folding Antenna Mast and Release Button

SR-60 Modes

The SR-60 operates in three distinct modes. They are:

1. **Active Line Trace Mode**, used when a chosen frequency can be put onto a long conductor using a Line Transmitter, for locating conductive pipes, lines, or cables.
2. **Passive Trace Mode**, used for tracing electrical lines that are already carrying 60 Hz current (U.S.), 50 Hz current (Europe), or radio frequencies.
3. **Sonde Mode**, used for locating Sondes in pipes, conduits, or tunnels that are non-conductive or cannot otherwise be traced.

Note that the two Tracing modes, Active and Passive, are identical except for the frequencies used. No transmitter is used in Passive Trace mode.

Display Elements

Beginning operators or experienced operators can use the SR-60 with equal ease. While the SR-60 offers advanced features that make the most complex locate easier, many of its features can be turned off or hidden, making the SR-60 simple to use in basic locating in uncomplicated situations.

The “basic features” of the SR-60 are on by default. They can be customized easily to suit the user’s requirements. The use of the various elements displayed is covered in later sections of this manual.

Common Display Elements

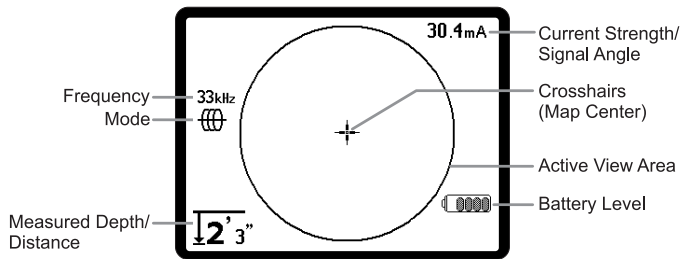






Figure 4: Common Display Elements

The display screen in Active Line Trace, Passive Line Trace or Sonde mode will show the following features:

- **Signal Angle:** Field tilt from the horizontal; angle toward the field's center; numeric value displayed in degrees.
- **Battery Level** – Indicates level of remaining battery capacity.
- **Measured Depth/Distance** – Displays the measured depth when receiver is touching the ground directly over signal source. Displays computed distance when the antenna mast is pointed at a signal source in some other manner. Displays feet/inches (U.S.A. default) or meters (European default).
- **Mode**– Icon for Sonde , Line Trace , Power (Passive Line Trace) , or Radio Frequency  mode.
- **Frequency** – Shows current frequency setting in hertz or kilohertz.
- **+ Crosshairs (Map Center)** - shows operator's position relative to the target center.

Display Elements: Line Trace Mode

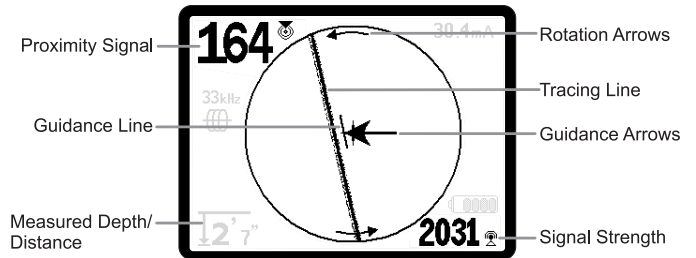


Figure 5: Display Elements (Line Trace Mode)

In Active Line Trace Mode, the following features will also be displayed:

- **Proximity Signal** – Numerical indication showing how close the signal source is to the locator. Displays from 1 to 999. (Line Trace modes only)
- **Signal Strength** – Strength of signal as sensed by the lower Omnidirectional antenna.
- **Tracing Line** – The Tracing Line represents the approximate axis of the detected field. It represents detected *distortion* in the field by appearing less focused. (See page 33 for information on setting the sensitivity and how to enable or disable the distortion response in the Tracing Line.)
- **Distortion Line** If the normal distortion response of the Tracing Line is disabled, a second line is shown, which represents the signal from the upper antenna node. By comparing the two lines, the user can estimate the degree of distortion present in a signal. (See page 35.)
- **Guidance Arrows** The Guidance Arrows serve to steer the operator toward the center of the detected field, by showing when the signals reaching the left and right Guidance Antennas are out of balance or equal. The two signals are equal when crossing the center of an undistorted field. If the signals are unequal, the Guidance Arrows show which way the field appears to be relative to the receiver.
- **mA Current Strength** – Proportional to current on the line. Switches to Signal Angle when Signal Angle is greater than 35°.

- **Guidance Line** Shows the alignment of the target line and helps determine when the locator is directly over the target line. It will be longest when directly aligned with the target line. **Rotation Arrows** will appear to indicate which way the SR-60 should be turned to align it with the field.

Note: The Tracing Line reflects the approximate axis of the conductor being traced, but is modified by a degree of “distortion” in the form of varying cloudiness, or loss of focus, in the Tracing Line. The Tracing Line will appear to grow unfocused in proportion to the distortion in the field being detected. It ranges from a clear line (no distortion present), through slightly distorted, to moderately un-focused, growing to a wide, cloud-like band of particles depending on the degree of distortion in the detected field. It represents the best possible calculation of the location and bearing of the line combined with the degree of distortion sensed by the receiver's Omnidirectional Antennas.

When the distortion response of the tracing line is turned off, a separate Distortion Line will be displayed. The Distortion Line can be used to analyze distortion when it is out of alignment with the Tracing Line. (The dashed line can be disabled separately, as well, which will leave a single Tracing Line displayed with no distortion response).

The default setting is to have the distortion response enabled in the Tracing Line. This incorporates the information provided by these two lines into a single, easy-to-read presentation, making the SR-60 easier to use.

(For more information about distortion, see pages 33 and 39.)

Note: The screen elements in Passive Trace Mode are the same as those seen in Active Line Trace mode. Mode is determined by the type of target source (Sonde or Line). For example, selecting the 512 Hz frequency from the Sonde mode section of the frequency menu puts the SR-60 into Sonde mode. (A frequency which appears in more than one category, such as 33 kHz, must be selected from the correct category).

Display Elements: Sonde Mode

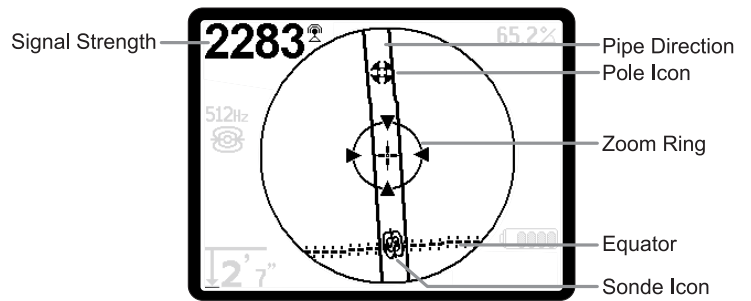


Figure 6: Display Elements: Sonde Mode

In Sonde mode, the screen elements include several features that are unique to Sonde locating.

- **Signal Strength** – Strength of signal as sensed by the lower Omnidirectional antenna.
- **Pipe Direction** – Represents the approximate direction of the pipe in which the Sonde is lying.
- **Sonde Icon** – Appears when approaching the location of a Sonde.
- **Equator** – Represents the mid-line of the Sonde's field perpendicular to the axis of the Poles. (See page 26).
- **Pole Icon** – Represents the location of either of the two Poles of the Sonde's dipole field. (See page 26).
- **Zoom Ring** – Appears when the locator moves close to a Pole.

The use of these features is described in the Active Line Tracing, Passive Line Tracing, and Sonde Locating sections.

Default Frequencies

The Master Frequency Menu contains a large set of frequencies, but only some of these are made currently available. They are made “Currently Available” by checking them in the Master Frequency Menu.

The frequencies which are currently available will appear on the Main Menu when the Menu Key is pressed.

Currently available frequencies can be checked in the Main Menu, in which case they will appear when using the Frequency Key **f**. If they are unchecked in

the Main Menu, they will not appear when using the Frequency Key to cycle through frequencies.

Frequencies which appear in the Main Menu and are checked for activation are called “Checked-Active”.

Frequencies that are “Checked-Active” can be cycled through simply by pressing the Frequency Key **f** (see Figure 7). A frequency chosen by pressing the Frequency Key becomes the “In Use” frequency.

Frequencies currently available by default include:

Sonde Mode

- 512 Hz*

Active Line Trace Mode:

- 128 Hz*
- 1 kHz*
- 8 kHz*
- 33 kHz*
- 93 kHz*
- 262 kHz*

Power (Passive Line Trace Mode):

- 60 Hz (9th) *
- < 4 kHz *

Radio Frequency

- 4 kHz—15 kHz (L) *
- 15 kHz – 35kHz (H) *

OmniSeek (multi-range <4kHz – 35kHz)*

(* = Checked-Active Frequencies)

Keypad

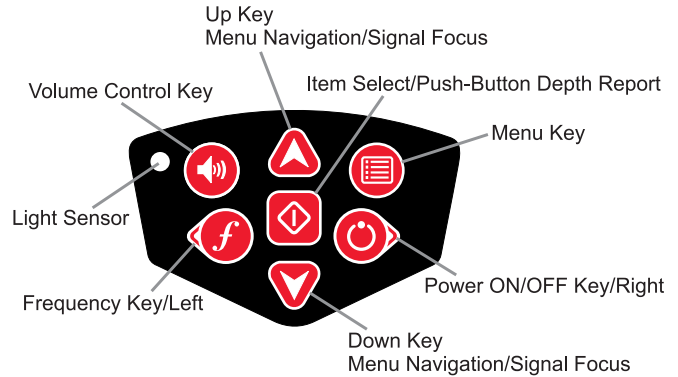


Figure 7: Keypad

- **Power/Right Key** – Powers SR-60 on. Powers the SR-60 down after a 3-second countdown. The countdown can be interrupted before shutdown by pressing any key. Used to move to the right in some screens.
- **Up and Down Keys** – Used for locating choices during menu selection; used for setting volume level when the Volume Control Key has been pressed. If Signal Focus is activated, the Up and Down Keys will change the Signal Focus setting up and down.
- **Select Key** – Used to make a choice during Menu selection; in normal operation, to force a Measured Depth reading and re-center audio tone. Can be used to force a “quick-check” trace-line and Measured Depth display.
- **Menu Key** – Used to display a “tree” of choices including frequency selections, display element choices, brightness and contrast, and restoring default settings. In a menu, will move up one level.
- **Volume Control Key** – Used to raise or lower the volume setting; will cycle the volume by steps, increasing to maximum and then mute. Pressing the Volume Key opens the volume control panel if it is closed. When open, the control panel will close after ten seconds if no keys are pressed. Volume can also be raised and lowered using the Up and Down Keys when the Volume screen is open.

- f Frequency / Left Key** – Used to set the In-Use Frequency of the SR-60 from the set of Checked-Active frequencies. Each short press cycles to the next Checked-Active frequency. (The list of frequencies that have been set to Checked-Active status can be modified via the Menu Key.)

A *long* press on the Frequency Key **f** will display a scrollable list of all currently active frequencies to choose from, by highlighting and pressing Select again.

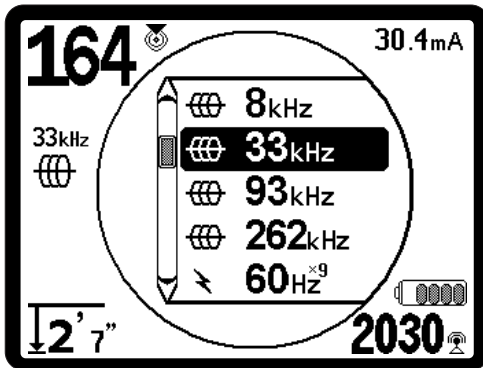


Figure 8: Scrollable List of Frequencies

- Light Sensor** – In Automatic mode, the light sensor controls when the backlight goes on or off depending on ambient light. Placing a thumb over the light sensor will force the backlight on.

Operation Time

Using alkaline cells, typical operation time is from about 12 to 24 hours depending on sound volume and how often the backlight is on. Other factors that affect the operation time will include chemistry of the battery (many of the new high performance batteries, such as the “Duracell® ULTRA” last 10%-20% longer than conventional alkaline cells under high demand applications). Operation at lower temperatures will also reduce battery life.

The SR-60 display can also show random symbols when the battery power is too low to drive the internal logic circuits correctly. This is remedied by simply putting fresh batteries into the unit.

To preserve battery life, the SR-60 will automatically shut down after 1 hour of no key presses. Simply power the unit on to resume use.

Low Battery Warning

When the battery gets low, a battery icon will periodically appear in the map area on the screen.

This indicates that the batteries need to be changed and that the unit will soon shut down. A tone will sound at ten-minute intervals.

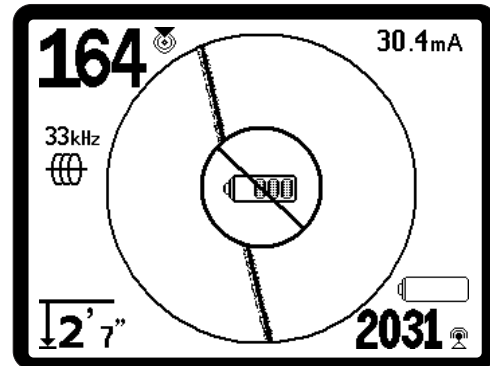



Figure 9: Low-Battery Warning

Just before complete shut down there will be a non-interruptible power down sequence. An extended buzz will sound when the SR-60 is about to go into shutdown sequence.

Note: Voltage on rechargeable batteries may sometimes drop so quickly that the unit will just shut down. The unit will power down and restart. Just replace the batteries and power the unit back on.

Starting Up

After pressing the Power Key  on the keypad, the RIDGID logo displays, and the software version number will appear in the lower right corner of the screen.

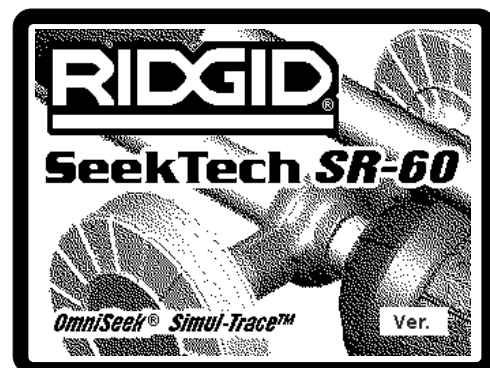


Figure 10: Start-up Screen

Make a note of the software version in the box on page 1. If technical support from Ridge is needed, it will be helpful to have it available.

Set up

Once the SR-60 is up and running, the next step is to set up the frequencies needed to match the transmitter frequency being used, or the frequency of the line to be located. Each frequency is selected for use by choosing it from a list in the Main Menu. If the box on the Main Menu for that frequency is checked, the frequency is "Checked-Active".

Checked-Active frequencies are already selected for use and appear in sequence when pressing the Frequency Key **f**. (For example, the line trace frequency of 33 kHz is available by pressing the Frequency Key and advancing through the list until 33 kHz is reached.)

NOTE: When a frequency is highlighted in the Main Menu, pressing the Frequency Key will display its exact frequency value. For example, 8 kHz = 8192 Hz.

A *long* press on the Frequency Key **f** will bring up a scrollable list of all Checked Active frequencies.



Figure 11: Frequency Key

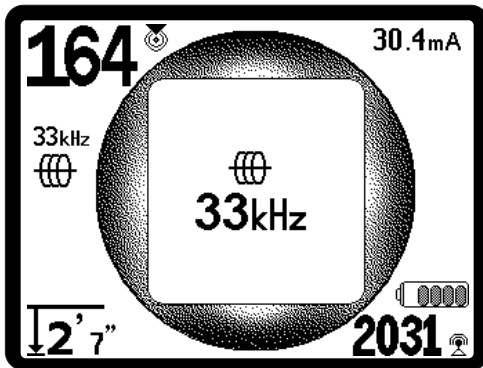


Figure 12: Line Trace Frequency Selected with Frequency Key

Activating Frequencies

Frequencies can be chosen for the set of Checked-Active frequencies so they will become available using the Frequency Key **f**. Frequencies can also be deactivated to keep the frequency set smaller.

Each frequency is activated by choosing it from a list in the Main Menu (See Figure 14). Frequencies are grouped by category:

SimulTrace (512 Hz + 33 kHz) (if active)

Sonde

Active Line Trace

Power (Passive Line Trace)

Radio

OmniSeek (multi-RF bands)

1. Push the Menu Key .

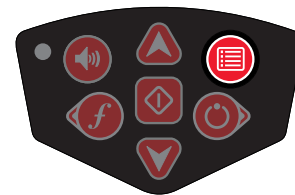


Figure 13: Menu Key

The Main Menu screen is then activated:

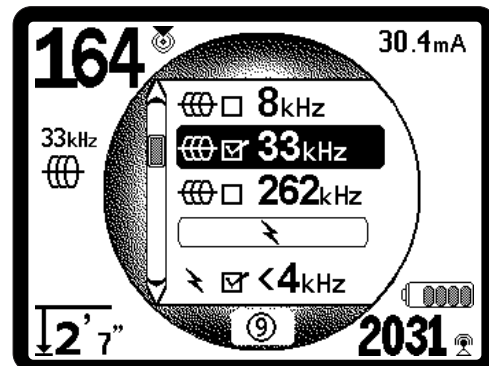


Figure 14: Main Menu

2. Using the Up and Down Keys, highlight the frequency desired (Figure 15). In this example, the operator is activating the 8 kHz frequency.

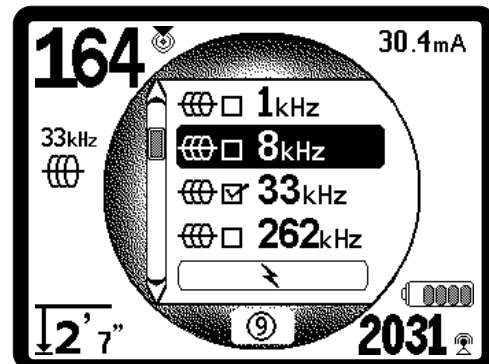



Figure 15: Highlighting a Desired Frequency (8 kHz)

3. **Press the Select Key**  (shown below) to check the box for each frequency to be used.

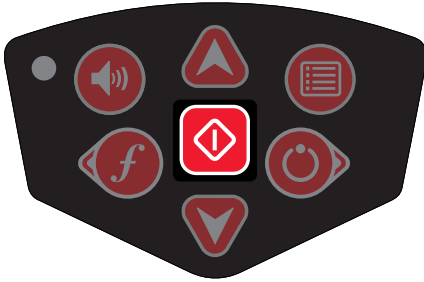


Figure 16: Select Key 

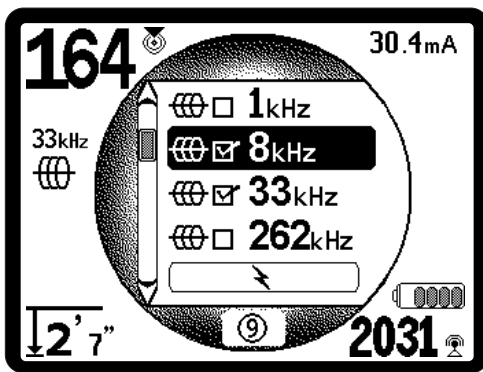


Figure 17: Desired Frequency Checked

Frequencies that have been selected for use will show a check in the box next to them.



4. **Press the Menu Key**  **again** to accept the choice and exit. Letting the unit countdown and exit automatically will have the same effect.



Figure 18: Menu Key 

The Main Menu lists all frequencies available for activation. For information on adding *additional* frequencies to the Main Menu so they can be chosen

for activation, see “Frequency Selection Control” on page 33.

A *long* press on the Frequency Key f will bring up a list of all Checked Active Frequencies. To use one, simply scroll down to it and press the Select Key .

Note on 93 kHz Frequency Use

The SR-60 offers two 93 kHz frequencies for Line Tracing. The default 93 kHz frequency has an actual cycle count of 93,623 cycles per second.

But some older transmitters use a different value for the nominal 93 kHz frequency, 93,696 cycles per second. This is found in the SR-60 listed as “93k-B”.

If you find that your transmitter signal at 93 kHz cannot be detected by the SR-60, set the locator’s frequency to 93-B kHz, which is set to the older value. Both 93 and 93-B frequencies can be found under the Line Trace category of the Frequency Selection sub-menu.

Sounds of the SR-60

The sound level is driven by the proximity to the target. The closer to the target, the higher the sound pitch will be. A rising tone indicates increasing signal.

In Active Line Trace or Passive Line Trace mode, sound is on one continuous curve and does not re-scale.

In Line Tracing modes, the default distortion response also activates an audio signal proportionate to the distortion in the detected field. When there is no distortion present, the sound of the SR-60 is a clear warbling sound when on the left side of the detected field, with a slight click added when on the right side of the detected field. If distortion is detected a sound similar to AM radio static sound can be heard, which gets stronger as the degree of distortion increases, similar to the unfocusing that signals distortion visually around the Tracing Line. If the distortion response feature is disabled, the static sound does not occur.

In Sonde Mode, if the sound level reaches its highest point, it will “re-scale” to a medium level and continue signaling from the new starting point.

In Sonde Mode, the pitch will “ratchet” upward. That is, it will rise and then re-scale (fall) in pitch while approaching the Sonde. Moving away from the Sonde, it will drop to a lower pitch and remain there as long as one moves away from the Sonde. Moving back toward the Sonde again it will resume rising in steps starting from the level it had reached previously. This serves as an indication when the

locator receiver is getting closer or further away from the Sonde.

If desired, force the sound to re-center at a medium level (in any mode) by pressing the Select Key during operation. See also the "Directional Sound" section, below.

Key Items in Using the SR-60

PROXIMITY SIGNAL reflects the proximity of the locator to the target utility; the closer the locator moves to the center of the detected field, the higher the Proximity Signal number gets. The Proximity Signal is calculated from the ratio of the signals received at the lower and upper antennas, adjusted for scalability.

SIGNAL STRENGTH represents the strength of the field being detected by the lower antenna node of the SR-60, converted mathematically for scalability. In a clear and undistorted field, you can locate based on Signal Strength alone.

DISTORTION is the degree to which the field detected is deformed. In an undistorted environment, current on a long conductor produces a field which is cylindrical, down the conductor. If multiple fields are present, the detected field is pushed or pulled out of shape and the different antennas will pick up different field strengths. On the SR-60, distortion is reflected by the Tracing Line growing unfocused instead of sharp, or by disagreement among the Guidance Arrows, Tracing Line, and Signal Strength.

TRACING LINE indicates the direction and degree of distortion in the detected field.

GUIDANCE ARROWS are driven by the signals received at the guidance antennas of the SR-60. When the fields detected by these side antennas are equal, the arrows will center. If one is receiving a stronger field signal than the other, the arrows will point toward the probable center of the target conductor. Moving in the direction indicated by the arrows will bring you closer to the center of the detected field. A small "guidance line" at the end of a guidance arrow indicates the degree of alignment with the conductor's field. It will be at its maximum length when correctly aligned with the conductor, with the guidance antenna axis crossing the field at 90°. Rotational guidance arrows on the perimeter of the screen will indicate the direction you need to turn to align with the detected conductor.

DIRECTIONAL SOUND from stereo speakers will let you follow a line by sound, while staying visually alert for nearby traffic or obstacles. The Sound Pointer speakers are designed to be clipped to a jacket or

vest on either shoulder. Stereo sound from the speakers will fade to the left or right. The louder side indicates the direction toward the center of the detected field. Sound will balance when over the center of the line. The operator can stay centered on the line using sound signals instead of the visual cues on the screen. The SR-60 comes with clip-on speakers designed to be attached to the left and right shoulders of a safety vest for this purpose.

Shutting Down

Pressing the Power Key at any time during operation will start a count-down of 3 seconds, during which the shut-down tone will sound. At the end of the count-down, the SR-60 will shut down.

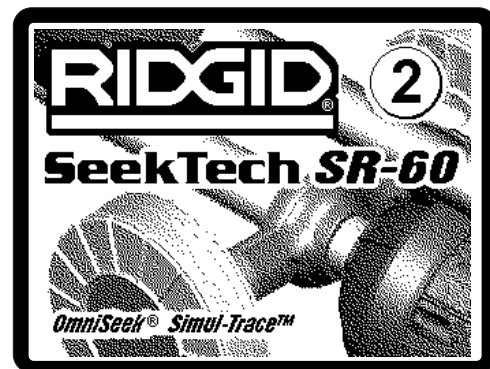


Figure 19: Count-Down Screen (Shutting Down)

Line Tracing with the SR-60

There are two major ways to look for lines underground with the SR-60. They are called Active and Passive. The difference is that in Active Line Tracing, a current is placed on a conductor using a transmitter, and that specific signal is then sought for using the locator. Passive tracing does not use a transmitter and seeks for any signal that may be picked up at particular frequencies.

Active Line Tracing

In active line tracing, underground lines are energized with a Line Transmitter. This active signal is then traced using the SR-60. A Line Transmitter is different from a Sonde in that it is used to energize a conducting target line, rather than acting as a target for a locate itself, the way a Sonde does. Line transmitters energize lines by direct connection with clips, or by directly inducing the signal using a clamp, or by inducing the signal using inductive coils built into the transmitter.

Direct Connect Mode: The transmitter is attached by direct metal-to-metal connection to the target conductor at some access point such as a valve, a

meter, or other point. **Important:** The connection between the transmitter and the conductor must be a clean, firm connection. The transmitter is also connected to a ground stake providing a strong open path to ground. **Important:** A weak ground connection is the most frequent cause of a poor tracing circuit. Make sure the transmitter is well connected to ground, and has enough exposure to the ground to allow current to flow through the circuit.

Inductive Clamp Mode: The transmitter is connected to an inductive clamp which is then closed around a pipe or cable. The transmitter energizes the clamp, which then induces a current in the conductor. **Important:** Make sure the SR-60 is set to trace mode and set to the same frequency as the transmitter. Do not clamp onto a live conductor. This mode works best when both ends of the conductor are grounded.

Inductive Mode: The transmitter is placed over the conductor. There is no direct connection; the internal coils of the transmitter generate a strong field through the ground which induces a current in the underground conductor of interest. **Important:** If the transmitter is too close to the SR-60 in this mode, it can cause "air-coupling" which means the locator is reading more on the signal from the transmitter's field, than on the target conductor. (See page 16). Note: When using Inductive Mode, it is always possible to move the transmitter to a different point along the target line. This will sometimes improve the circuit and provide a better signal.



WARNING

Connect ground and power leads of the transmitter *before* powering the transmitter on, to avoid electric shock. See warning on page 4.

1. Energize the target conductor according to the transmitter manufacturer's instructions, using one of the methods described above. Select the transmitter frequency. Set the frequency on the SR-60 to the same frequency used on the transmitter, using the Frequency Key f . Be sure the frequency has a line trace icon . Push the Menu Key to return to the operating screen. To activate frequencies not yet made active, see "Frequency Selection Control" on page 33.

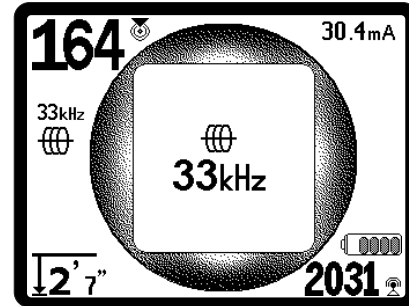


Figure 20: Line Trace Frequency Chosen with the Frequency Key (This screen will flash briefly when a new frequency is chosen.)

2. Observe the Proximity Signal to ensure that the receiver is picking up the transmitted signal. The Proximity Signal should peak over the line and drop off on either side.

When tracing, the direction of the detected field will be shown on the screen by the Tracing Line. The Tracing Line will be a clear, single line if the field being detected is undistorted.

If other fields are interfering in some way, the distortion caused by those fields will be reflected by a blurring of the Tracing Line. The more distorted the detected field, the broader the cloud around the Tracing Line will be. This alerts the operator that the apparent axis of the line may be influenced by other fields, and requires careful evaluation.

The Tracing Line has three important functions. It represents the location, and the direction, of the signal being traced. It reflects changes in direction of the target utility — when the utility makes a turn, for example. And it helps recognize signal distortion. It does this by becoming cloudier as distortion increases. Disagreement between different indicators can also indicate distortion.

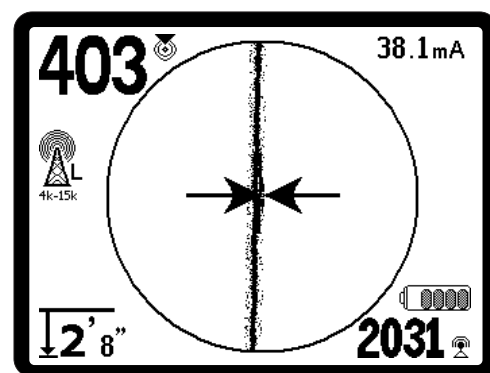


Figure 21: Tracing Line Showing Low Distortion

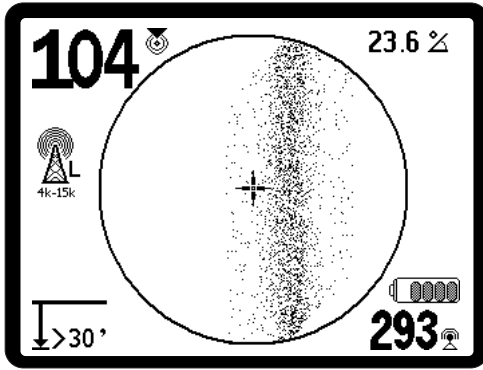


Figure 22: Tracing Line Showing High Distortion

3. **Use the Guidance Arrows, Proximity Number, Signal Strength, and Tracing Line** to guide the line trace. These pieces of information are generated from discrete signal characteristics to help the operator understand the quality of the locate. An **undistorted** signal emitted from a line is strongest directly over that line. (Note: Unlike the Signal Trace lines, the guidance arrows require that the user *orient the locator* so that the guidance arrows point 90 degrees to the Signal Trace line. (See Figure 23).

Note: an undistorted line will also be clear rather than blurred on the screen, and the sound accompanying the image will have no “static” in it.

Note: Confidence in the accuracy of a locate can be increased by maximizing the Proximity Signal (and/or Signal Strength), balancing the Guidance Arrows and centering the Tracing line on the screen. Confirm a locate by testing whether the Measured Depth reading is stable and reasonable. Agreement among all these indicators means the probability of an accurate locate is high.

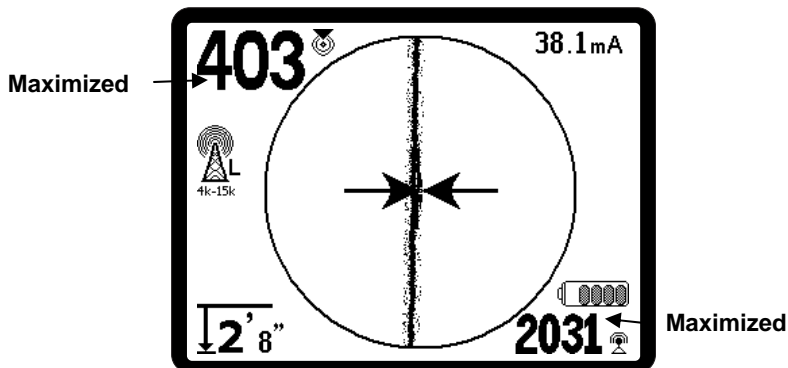


Figure 23: High Probability Locate

As always, the only way to be certain of the location of a utility is through visual confirmation by *exposing the utility*. The accuracy of position and depth measurement improves as the SR-60 lower antenna

node is placed closer and closer to the target utility. Rechecking the Measured Depth and position periodically during the excavation process can help avoid damage to a target utility and may identify additional utility signals that were not noticed prior to excavation.

When line tracing, it is important to remember that tees, curves, other conductors in the vicinity, and nearby masses of metal *can* add distortion to the field, requiring closer scrutiny of the data to determine the true path of the target utility.

Clarifying the situation can be done by assessing whether the distortion is due to a poor signal that needs to be improved, a local interference such as a near-by car, or a tee or turn in the line.

Circling the last location of a clear signal at a distance of about 20 feet (6.5 m) can clarify if the distortion is coming from a local turn or tee in the line, and enable the operator to again pick up the line nearby.

Always cross check the locate by ensuring that:

- The Tracing Line shows little or no distortion response (blurriness).
- The Proximity Signal and the Signal strength maximize when the Tracing Line crosses the map center.
- The Measured Depth increases appropriately as the unit is raised vertically and the Tracing Line remains aligned.

Measured Depth readings should be taken as estimates and actual depths should be independently verified by potholing or other means prior to excavating.



WARNING

Care should be taken to watch for signal interference that may give inaccurate readings. The Tracing Line is only representative of the position of the buried utility if the field is **UNDISTORTED**. Do NOT base a locate solely on the Tracing Line

If the signal is clear, the SR-60 will often show a straight signal line with very little distortion right up to a 90-degree tee, show a small amount of distortion as it follows around the curve, and then show a clear signal again as it resumes its travel after the tee. It shows very clearly when the line is turning.

Measuring Depth (Line Tracing Modes)

The SR-60 calculates Measured Depth by comparing the strength of the signal at the lower antenna to that at the upper antenna.

Measured Depth is measured correctly in an undistorted field when the bottom antenna is touching the ground directly above the signal source and the antenna mast is vertical.

1. To measure depth, place the locator on the ground, directly above the Sonde or the line.
2. Measured Depth will be shown in the lower left hand corner.
3. Measured Depth will be accurate only if the signal is undistorted and the antenna mast is held vertical.

Testing for the consistency of the Measured Depth reading can be done by raising the SR-60 a known distance (say, 12 inches (33 cm)) and observing whether the Measured Depth indicator increases by the same amount. Small variation is acceptable, but if the Measured Depth does not change, or changes drastically, it is an indication of a “distorted” field, or very low current on the line.

Push-Button Depth

Holding the Select Key will display a short count-down followed by a calculated depth report. This “Pushbutton Depth”, calculated on more signal samples, will be more precise than the running Depth indication.

Push-button Depth will generate a brief count-down screen followed by a calculation screen, which changes to a depth report screen when the calculation is complete.

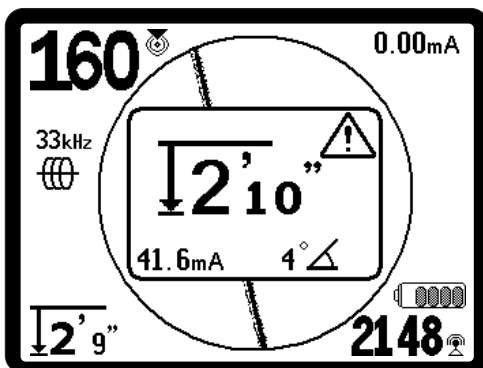


Figure 24: Push-Button Depth Report

Depth Warnings

NOTE: Exposing the utility is the only way to verify its existence, location, and depth.

Certain conditions make depth readings less precise or less reliable. When using Pushbutton Depth, a warning will appear when these conditions occur:

Motion of the SR-60 during sampling	
Depth is varying greatly	
Signal Strength is varying greatly.	
Extreme offset between guidance line and tracing line (right or left).	
Clipping (Signal too high). Averaged depth will be inaccurate.	
Distortion level too high to read depth accurately	

Current and Signal Angle Reading


The Current Strength (mA) and Signal Angle indicator ($^{\circ}\Delta$) in the upper right corner of the screen will display the current detected on the traced line, in milliamps, when the computed angle to the center of the detected field is less than 35° and the SR-60 crosses the center of the field.

When moving across the center of the field the current display will retain the displayed current value until the guidance arrows reverse again, at which point the display will be updated. The update occurs whenever the guidance arrows reverse.

When the angle to the center exceeds 35° , the Signal Angle indicator will again replace the Current indicator, and the display will show the computed angle to the center of the detected field.

Clipping (Tracing Modes)

Occasionally the Signal Strength will be strong enough that the receiver will be unable to process the whole signal, a condition known as “clipping”. When

this occurs, a warning symbol  will appear on the screen. It means that the signal is particularly strong. If clipping persists, remedy it by increasing the distance between the antennas and the target line OR by reducing the strength of the current from the transmitter.

Note: Measured Depth Display is disabled under clipping conditions.

When clipping occurs, the SR-60 will automatically attenuate the signal to dampen it. When the signal strength received falls below the clipping threshold, the attenuation stops automatically. The SR-60 screen will indicate the starting of attenuation and the stopping of attenuation by showing these images:

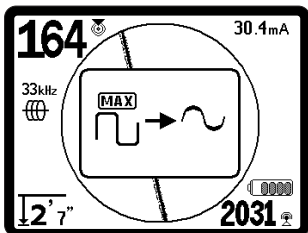


Figure 25: Attenuation On

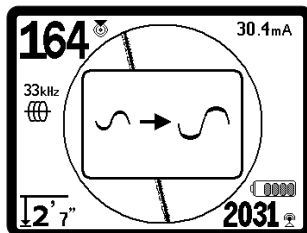


Figure 26: Attenuation Off

Operating Tips for Active Line Tracing

1. The SR-60 quickly identifies distorted fields. If the guidance arrows are centered on the screen, and the Trace Line is not centered (or if the Proximity Signal number and Signal Strength are not maximized), then distortion is creating a complex non-circular field. This is also reflected by the Tracing line dissolving, or growing unfocused in a cloudy pattern proportional to the distortion detected.
2. To improve the tracing circuit:
 - a. Move the ground stake position away from the line to be traced.
 - b. Use a larger ground contact surface (such as a shovel blade).
 - c. Make sure that the line is not commonly bonded to another utility. (Undo common bonds only if safe to do so).
 - d. Try changing the frequency used.
 - e. Move the transmitter to a different point on the line, if possible. Try locating from the other direction along the line, for example.
3. Circling the last location of a clear signal at a distance of about 20 feet (6.5 m) can clarify if the distortion is coming from a local turn or tee in the line, and enable the operator to again pick up the line nearby.
4. If the Tracing Line will not center or if it moves across the screen erratically, then the SR-60 may not be receiving a clear signal. The Measured Depth and the Proximity Signal may also be unstable under these circumstances.
 - a. Check the transmitter to be sure that it is operating and well grounded. Good connection and good grounding can remedy low current problems.
 - b. Test the circuit by pointing the lower antenna at either transmitter lead. If a strong signal is not shown, improve the circuit.
 - c. Check that the SR-60 and transmitter are operating on the same frequency.
 - d. Try a higher frequency, until the line can be picked up dependably. Using lower frequencies can overcome bleed-over problems. Higher frequencies can

overcome resistance and inject more current onto the line.

- e. Re-locate the ground connection for a better circuit. Ensure there is enough contact (ground stake is sufficiently deep) especially in dryer soils.
 - f. In extremely dry soil, wetting the area around the ground stake will improve the circuit. Be aware the moisture will dissipate and evaporate, reducing the quality of the circuit over time.
5. Using the numeric Signal Angle Indicator is another way to check for distorted signals. Move the SR-60 perpendicularly to both sides of the traced line until the numeric Signal Angle indicator reads 45 degrees. Be sure to keep the lower Omnidirectional antenna node at the same height, and the locator mast vertical. If there is little or no distortion the traced line should be in the middle and the distance to each 45 degree point should be approximately the same on either side. If the signal is undistorted, then the distance from the line center to the 45° point is approximately equal to the depth.

Note: Another technique is to move the same distance to the right and left of the traced line, say 24 inches (60 cm) and check that the Signal Strength readings are similar.

6. While tracing, the Proximity Signal and Signal Strength should maximize, and the Measured Depth minimize, at the same place where the guidance arrows center on the display. If this is not the case, the utility may be changing direction or other coupled signals may be present.

7. Higher frequencies bleed over to adjacent utilities more readily, but may be needed to overcome breaks in tracer wires or go over insulating couplers. If the line is ungrounded at the far end, higher frequencies may be the only means to make the line traceable. (See Informational Locating, on page 39).
8. When using the transmitter inductively, be sure to begin the locate about 30 feet (10m) away to avoid “direct coupling” (also know as air coupling). This occurs when the SR-60 picks up the signal from the transmitter directly through the air and not from the line to be traced. An unrealistic Measured Depth reading when over the line can also indicate air coupling is occurring.
9. While tracing, the mapping display operates best under the following conditions:
 - a. The line is level
 - b. The SR-60 Locator is above the target utility elevation
 - c. The SR-60 antenna mast is held approximately vertical

If these conditions are not met, pay close attention to maximizing Signal Strength.

In general, if the SR-60 is used in a zone over the target line within a sweep area of about two “depths” of the line, the map will be useful and accurate. Be aware of this when using the map if the target or line is very shallow. The width of the useful search area for the map can be small if the line is extremely shallow.

See the section on Suppression on page 32 for information on noise suppression options.

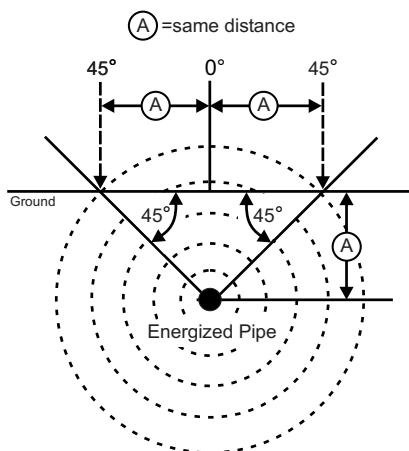


Figure 27: Checking for Distortion

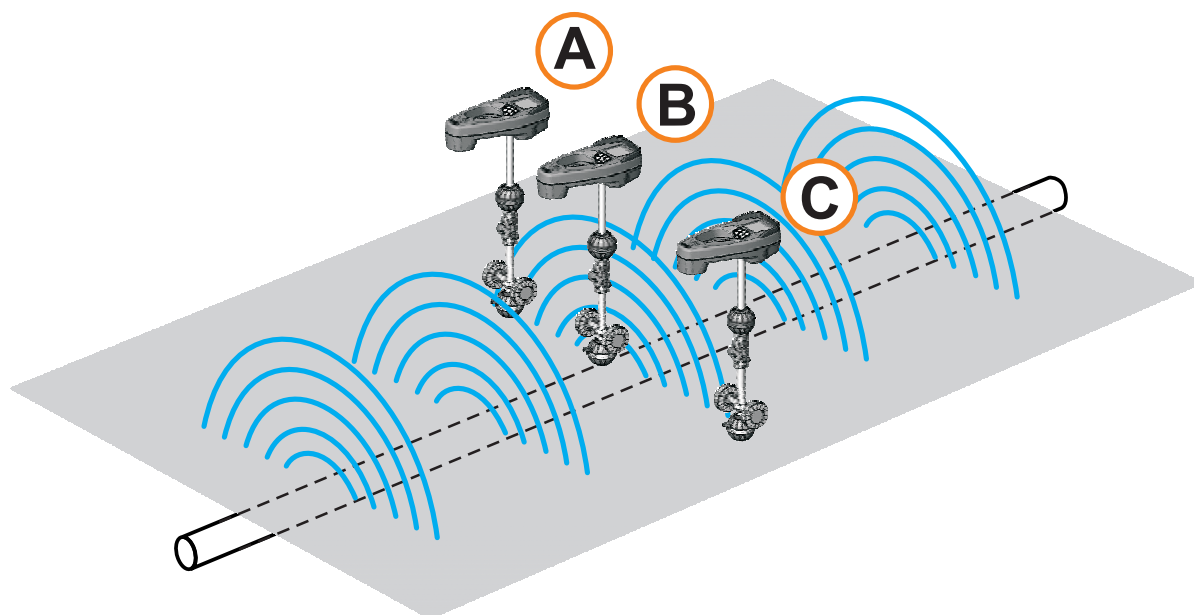
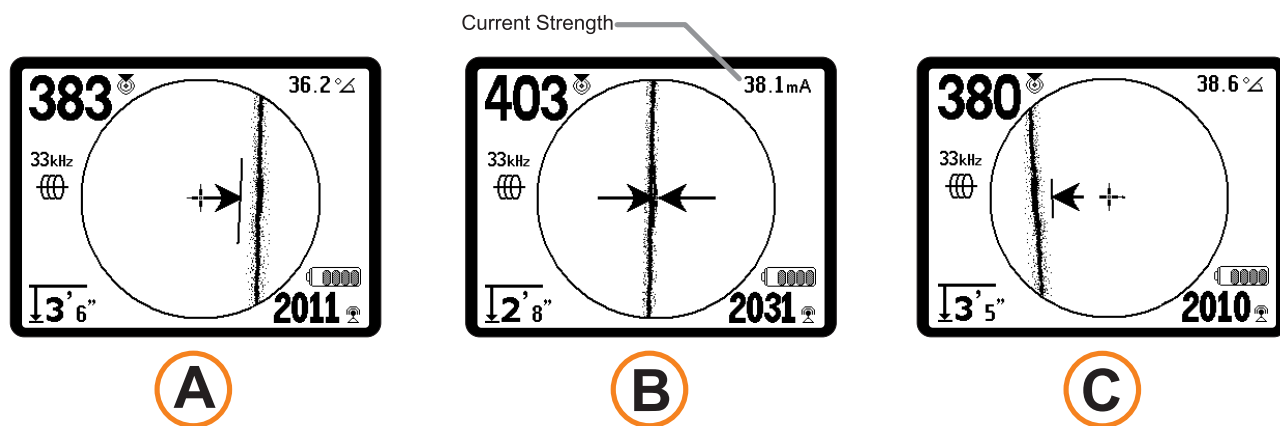


Figure 28: Screen Display in Different Locations (Line Tracing)

Passive Line Tracing

In passive mode, the SR-60 is looking for electromagnetic “noise” that has found its way onto a buried utility line by any available means. Electromagnetic signals can get onto buried utility lines in a variety of ways.

The most common way is by means of direct connection to some signal source. All operating electronic devices that are connected to AC power will radiate a certain amount of electronic “noise” back onto the power lines they are connected to. Examples of such devices include computers, copy machines, refrigerators, anything with an electric motor, TV sets, air conditioning units, etc.

Another common way electromagnetic noise can get onto the line is by way of induction that can operate without any direct physical connection to the buried line. In some areas for example, buried utilities act as antennas for high powered, low frequency radio transmissions (submarine navigational and communication signals in the UK for example) and will reradiate these signals. These reradiated signals can be very useful for locating.

Similarly, buried lines that run side by side near each other, particularly for longer distances will tend to bleed signals onto each other. This effect is more pronounced for higher frequencies. Due to coupling, all metallic lines in an area may be energized. Because of this, it is possible to locate lines passively, but it is difficult to identify *which* line the locator is tracing.

Pipes can also have 60 Hz signal randomly induced into them by nearby power-line fields, and other frequencies can be picked up on phone lines, for example, from the energy of radio-broadcast towers in the vicinity. In short, frequencies can show up on buried conductors in numerous ways, and these can be picked up passively, if the fields are strong enough.

1. Select a Passive Line Trace Frequency (⚡ or 📶 icon).
2. Choose an orderly pattern of search that will cover the area you are interested in.
3. Use the Tracing Line, Depth, and Signal Strength to steer you to the lines which have that frequency energizing them.
4. If possible, once you have found a target of interest, find an accessible point and do an Active Trace on it to confirm your results.

The SR-60 has multiple **Passive Line Trace frequency settings**. Power frequencies (identified with the power icon ⚡) are used to locate signals generated as the result of power transmissions, usually 50 or 60 Hz. To reduce the effects of inherent noise from line-load or neighboring devices the SR-60 can be set to locate various multiples (or harmonics) of the base 50/60 Hz frequency up to 4,000 Hz. (<4kHz setting).

The 50/60 Hz 9x multiple is the setting most commonly used to locate 50/60 Hz signal. In well-balanced high voltage electric distribution systems, the 5x multiple may work better. The 100 Hz (in 50 Hz countries) and 120 Hz (in 60 Hz countries) frequency settings are particularly useful for pipelines that have been equipped with cathodic protection using rectifiers.

As in Active Line Tracing, the Tracing Line will reflect distortion in the detected field by appearing unfocused or cloudy in proportion to the distortion. This “distortion response” is useful in recognizing when the field being traced is being distorted by other fields of metallic objects in the vicinity.

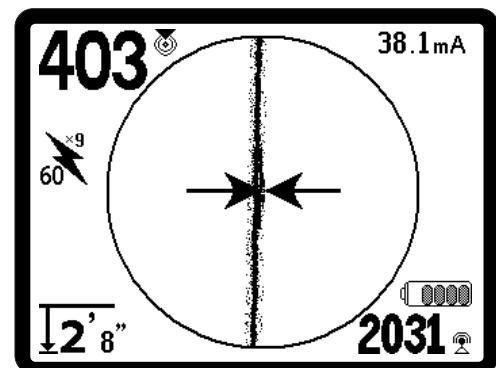


Figure 29: 60th Hz Passive Trace Frequency

There are also two higher radio frequency bands 📶 to help locate lines passively. They are:

- 4 kHz to 15 kHz (LF)
- 15 kHz to 35 kHz (HF)

The Radio Frequency and <4 kHz bands can be useful in discriminating when tracing in a noisy environment. They are also very helpful in finding lines on blind searches. When searching over a wide area where the location of targets is unknown, one useful approach is to have multiple frequencies selected for use and to check the area at a number of frequencies in sequence looking for meaningful signals. Even more convenient is to use the OmniSeek setting described below.

In general, directly connected Active Line Tracing is more reliable than Passive Line Tracing.



WARNING

In Passive Line tracing, or when signals are extremely weak, the Measured Depth will generally read too deep, and the actual buried depth may be much shallower.

OmniSeek Locating

The SR-60 has an advanced capability for passive locating called OmniSeek. The OmniSeek mode ∞ is a universal passive search mode that can simultaneously detect frequencies in *three passive search bands* (<4 kHz, 4-15 kHz, and >15 kHz). Whichever signal has the highest Proximity \odot will be displayed. This enables you to sweep an area without having to switch between frequency bands.

To use OmniSeek, select it from the Main Menu:

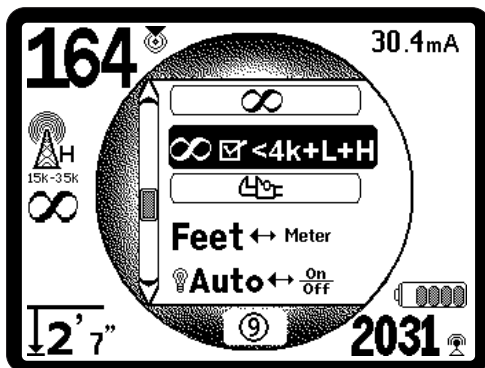


Figure 30: Selecting ∞ OmniSeek

The SR-60 will then search all three passive frequency bands simultaneously. The trace with the closest proximity value will be displayed more prominently on the screen, and its corresponding frequency will appear on the left of the main screen. The OmniSeek symbol ∞ on the screen indicates the other filters are also running. If a closer proximity is detected from another frequency band, the displayed frequency value will shift to that band.

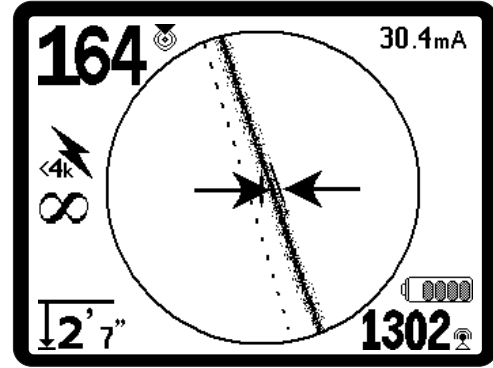


Figure 31: OmniSeek with Secondary Tracing Line

The display will show the main tracing line and identify the band in which it is found. In Figure 31, the <4 kHz band is being displayed as the closest signal being seen by the locator. Notice there is also a dashed secondary tracing line being shown. If signals are also being detected from other frequency bands, dashed lines (called Secondary Trace Lines) will indicate their apparent location.

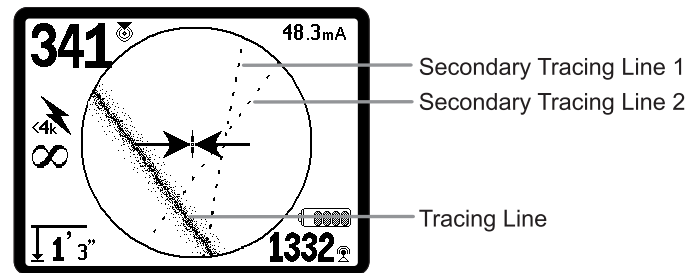


Figure 32: ∞ OmniSeek 15-35kHz Band

In Figure 32, the Tracing Line, in the <4 kHz band, is showing some distortion. Two other signals are being detected in the bands 15-35 kHz and 4-15 kHz. If the operator wants to follow these secondary signals up more closely, he can switch to the particular bands to see which one is being picked up in each band.

This enables you to do a Passive Locate more effectively if there is, for example, a lot of 60 Hz noise in the environment. It is important to keep in mind that what you are seeing are traces of signals from the various broadband frequencies. The operator has to use the data to develop an understanding of what he is seeing. If one or two secondary tracing lines are showing out of alignment with the main tracing line, this can be an indication of another utility, especially if it is at a deeper depth. But it can also be due to simple signal energy on the same utility in different frequency bands. Often greater distortion will be present on other frequencies bands and this may cause the secondary tracing lines to appear out of alignment with the main tracing line.

Operating Tips for Passive Line Tracing

1. In Passive Locating if you are looking for a known line, be sure you are using the best frequency for the line in question. This may be, for example, 60 Hz (1) for a power line, or it may turn out that 60 Hz (9) produces a more reliable response on a particular line.
2. If seeking a cathode-protected pipe in Passive Mode, use higher-frequency (greater than 4 kHz) to pick up harmonics.
3. Remember that pipes can carry currents that will show up on a Passive Trace as well as cables will; the only guarantee of a locate is exposure and visual inspection.
4. In general, Passive Trace locating is less reliable than Active Line Tracing because Active Line Tracing offers the positive identification of the signal from the transmitter.
5. Especially in Passive Line Tracing, knowing that you have found something is not the same as knowing what you have found. It is essential to use all the indicators available, such as Measured Depth, Signal Strength, etc., to confirm a locate. If it is possible to access part of a passively-located cable, it can then be energized using a transmitter and positively traced.
6. While Passive Line Trace is most often used on 50/60Hz power lines, other cables such as phone lines, CATV lines, etc., can be energized in operation, or by transient radio frequencies in the region and may appear on Passive Line Trace searches.
7. Verify a passive locate by finding a known termination point and hooking up a transmitter to it to do an active locate on the line, if this is possible.

Sonde Locating

The SR-60 can be used to locate the signal of a Sonde (transmitter) in a pipe, so that its location can be identified above ground. Sondes can be placed at a problem point in the pipe using a camera, push rod, or cable. They can also be flushed down the pipe. A Sonde is often used for locating non-conducting pipe and conduit.

Important!

Signal strength is the key factor in determining the Sonde's location. Take care to maximize the Signal Strength prior to marking an area for excavation.

The following assumes that the Sonde is in a horizontal pipe, the ground is approximately level and the SR-60 is held with the antenna mast vertical.

The field of a Sonde is different in form from the circular field around a long conductor such as a pipe or cable. It is a dipole field like the field around the Earth, with a north Pole and a south Pole.

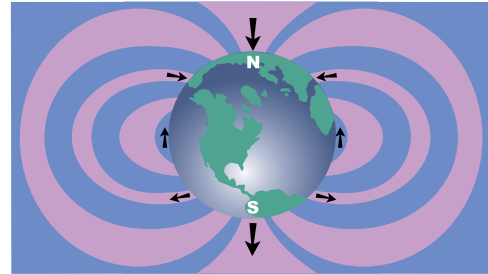


Figure 33: Earth's Dipole Field

In the Sonde's field, the SR-60 will detect the points at either end where the field lines curve down toward the vertical, and it will mark these points on the map display with a "Pole" icon (⊕). The SR-60 will also show a line at 90 degrees to the Sonde, centered between the Poles, known as the "Equator", much like the Equator on a map of the Earth if the planet were viewed sideways (See Figure 33).

Note that because of the SR-60's Omnidirectional antennas, the signal stays stable regardless of orientation. This means the signal will increase smoothly when approaching the Sonde, and decrease smoothly moving away.

Note: A Pole is found where field lines turn vertical. The Equator occurs when the field lines are horizontal.

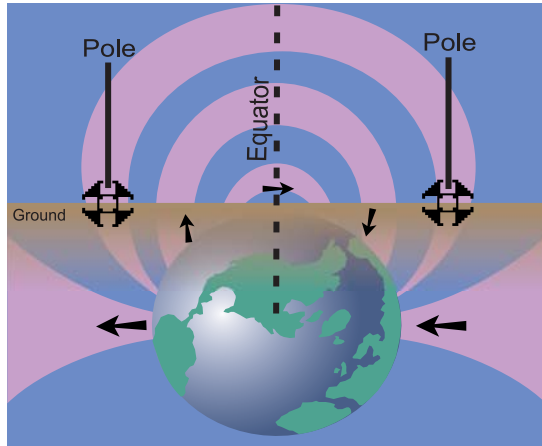


Figure 34: Dipole Field

When locating a Sonde, first set up the locate:

- Activate the Sonde **before** putting it in the line. Select the same Sonde frequency on the SR-60 and make sure it is receiving the signal.

After the Sonde has been sent into the pipe, go to the suspected Sonde location. If the direction of the pipe is unknown, push the Sonde a shorter distance into the line (~15 feet (5m) from the access is a good starting point).

Location Methods

There are three major parts to locating a Sonde. The first step is to localize the sonde. The second part is pinpointing. The third is verifying its location.

Step 1: Localize the sonde

- Hold the SR-60 so the mast is pointing outward. Sweep the antenna mast in the suspected direction of the Sonde while observing the Signal Strength and listening to the sound. The signal will be highest when the mast is pointing toward the Sonde.
- Lower the SR-60 to its normal operating position (antenna mast vertical) and walk in the direction of the Sonde. Approaching the Sonde, the Signal Strength will increase and the audio tone will rise in pitch. Use the Signal Strength and the sound to maximize the signal.
- Maximize the Signal Strength. When it appears to be at its highest point, place the SR-60 close to the ground over the high-signal point. Be careful to hold the receiver at

a constant height above the ground as distance affects Signal Strength.

- Note the Signal Strength and move away from the high point in all directions. Move the SR-60 far enough in all directions to verify that the Signal Strength drops significantly on all sides. Mark the point of highest Signal Strength with a yellow Sonde Marker (clipped to antenna mast for convenience). This is the suspected Sonde location.

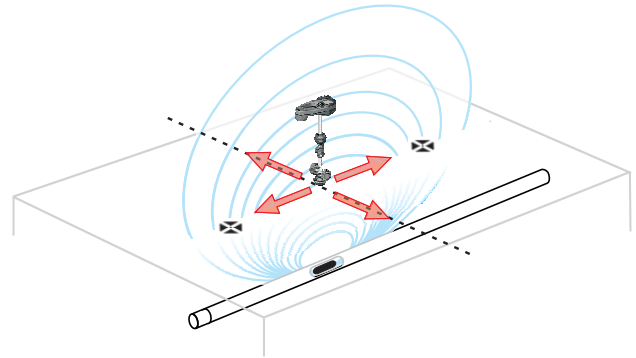


Figure 35: Poles and Equator of a Sonde

If while “getting closer” the Equator appears on the screen, follow it in the direction of an increasing Signal Strength to localize the Sonde.

If a Pole appears before the Equator appears, localize the Sonde by centering the Pole in the cross-hairs.

Step 2: Pinpoint the Sonde

The Poles should appear on either side of the maximum signal point, an equal distance on either side if the Sonde is level. If they are not visible on the screen at the point of maximum Signal Strength, move from the maximum point perpendicular to the dotted line (Equator) until one appears. Center the locator over the Pole.

Where the Poles occur depends on the Sonde’s depth. The deeper the Sonde, the further away from it the Poles will be.

The dotted line represents the Equator of the Sonde. If the Sonde is not tilted, the Equator will intersect the Sonde at maximum Signal Strength and minimum Measured Depth.

Note: being on the Equator does *not* mean that the locator is over the Sonde. Always verify the locate by maximizing Signal Strength and marking both Poles.

- Mark the first Pole location found with a red triangular Pole marker. After centering on the Pole, a double-line indicator will appear. This line represents how the Sonde is lying underground, and in most cases also represents the pipe's approximate direction.
- When the locator gets close to a Pole, a zoom ring will appear centered on the Pole, allowing precision centering.
- The second Pole will be a similar distance from the Sonde location in the opposite direction. Locate it in the same manner and mark it with a red triangular marker.
- If the Sonde is level, the three markers should be aligned and the red Pole markers should be similar distances from the yellow Sonde marker. If they are not, a tilted Sonde may be indicated. (See "Tilted Sondes", below.) It is generally true that the Sonde will be on the line between the two Poles, unless there is extreme distortion present.

Step 3: Verify the locate

- It is important to verify the Sonde's location by crosschecking the receiver's information and maximizing Signal Strength. Move the SR-60 away from the maximum Signal Strength, to make sure that the signal drops off on all sides. Make sure to move the unit far enough to see a significant signal drop in each direction.

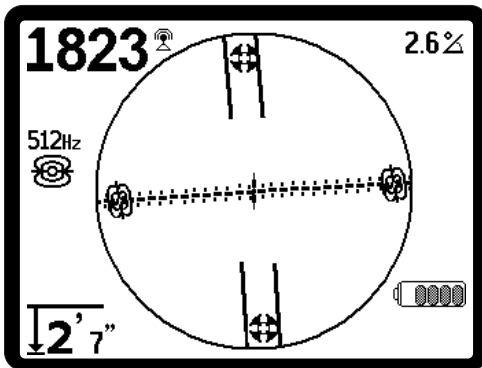


Figure 36: Sonde Locate: Equator

- Double-check the two Pole locations.
- Notice that the Measured Depth reading at the maximum Signal Strength location is reasonable and consistent. If it seems far too deep or too shallow, recheck that there is an actual maximum Signal Strength at that location.

- Notice that the poles and the point of highest Signal Strength lie on a straight line.

Important!

Being on the Equator does *not* mean one is over the Sonde. Seeing two Poles aligned on the display is not a substitute for centering over each Pole separately and marking their locations as described above.

For best accuracy, the SR-60 should be held with the mast oriented vertically. The antenna mast must be vertical when marking the Poles and Equator, or their locations will be less accurate.

It doesn't matter whether you locate the Poles first, or the Equator first, and then the Poles, or one Pole, then the Equator, and then the other Pole. You can even locate the Sonde using just the Signal Strength, and then verify your result with the Poles and Equator. What is important is that you verify all the data points, and mark the Sonde's position where the signal is highest

Tilted Sondes

If the Sonde is tilted, one Pole will move closer to the Sonde and the other farther away so that the Sonde location no longer lies midway between the two Poles. The Signal Strength of the nearer Pole becomes much higher than that of the more distant Pole if the Sonde is vertical (as it could be if it fell into a break in the line); however, it can still be located.

If the Sonde is *vertical* what is seen on the screen is a single Pole at the point of maximum Signal Strength. (The Ridgid Floating Sonde is designed to have a single Pole "visible" and is weighted to maintain the Sonde on a vertical axis. See Note below.)

It is important to realize that a severely tilted Sonde can cause the Pole locations and the Equator to appear offset because of the angle of the Sonde; but maximizing the Signal Strength will still guide to the best location for the Sonde.

Floating Sondes

Some Sondes are designed to be flushed or to drift down a pipe pushed by water flow. Because these Sondes swing much more freely than a torpedo-shaped Sonde in a pipe, they can be oriented any which way. This means the Equator may be distorted by tilting, and the location of the Poles may vary. The only guarantee of having located a floating Sonde is maximizing the Signal Strength and double-checking

that the signal falls away on every side of the maximum signal location.

Note: If following a moving Sonde, it may be easiest to “chase” a pole, and then to pinpoint the actual position of the Sonde only after the Sonde has stopped moving.


Measuring Depth (Sonde Mode)

The SR-60 calculates Measured Depth by comparing the strength of the signal at the lower antenna to the upper antenna. Measured Depth is approximate; it will usually reflect the physical depth when the mast is held vertical and the bottom antenna is touching the ground directly above the signal source, *assuming no distortion is present*.

1. To measure depth, place the locator on the ground, directly above the Sonde or the line.
2. Measured Depth will be shown in the lower left hand corner of the SR-60's display screen.
3. Measured Depth will be accurate only if the signal is undistorted. Measured Depth Display is disabled under clipping conditions.

Note: Holding the Select Key will display a short count-down followed by a calculated depth report. This “Pushbutton Depth”, calculated on more signal samples, will be more precise than the running Depth indication. (See **Depth Warnings** on page 16).

Clipping (Sonde Mode)


Occasionally the Signal Strength will be strong enough that the receiver will be unable to process the entire signal, a condition known as “clipping”. When this occurs, a warning symbol  will appear on the screen. It means that the signal is particularly strong.



SimulTrace

The SR-60 has a new capability for use in specialized locating situations which enables you to trace a pushcable and a Sonde simultaneously. This capability is called SimulTrace. When it is activated, the SR-60 will display a tracing line tuned to 33 kHz at the same time as it seeks on the 512 Hz frequency for a Sonde. By following the 33 kHz signal, the locator can follow the pushcable along a pipe, for example, and can simultaneously detect the Sonde emitting a 512 Hz signal when it is within detection range.

Some modern pushcable and camera systems are equipped to inject the 33 kHz signal onto the pushcable automatically. If you are using an earlier pushcable and camera system, you can inject the 33 kHz signal onto the pushcable by using an Inductive Clamp with several turns of the pushcable looped around the jaws. Plug the Inductive Clamp into a transmitter set to 33 kHz and turn it on.

To activate the SimulTrace mode, select it from the Main Menu frequency list and toggle it into Active Status (it is off by default). Then, select SimulTrace  from the menu of frequencies.

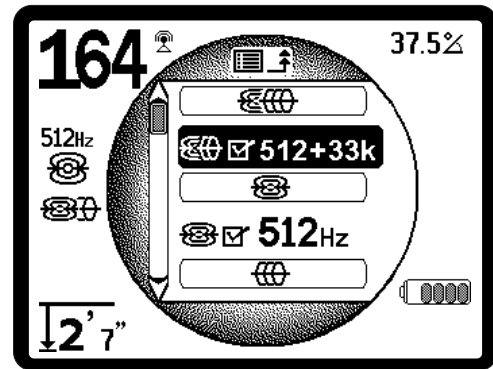


Figure 37: Selecting SimulTrace Mode

Once you have activated the SimulTrace mode, follow the general rules of active line tracing to find and follow the pushcable.

When you are within detection distance of the Sonde, the screen will automatically shift to Sonde mode and will display the equator and the poles as described above. When SimulTrace is active, the screen will continue to display a faint tracing line representing the pushcable on 33 kHz even when it is in Sonde mode. This is especially useful if you are following a pipeline whose location and bearing is questionable. Note: If no signal from either a line at 33 kHz or a 512 Hz Sonde can be detected, the magnifying glass will appear to indicate the unit is seeking for a signal.

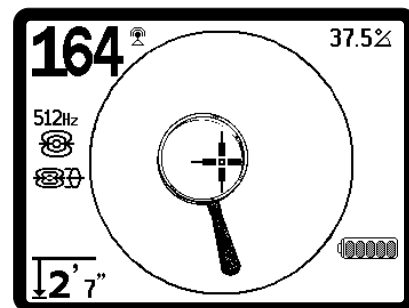
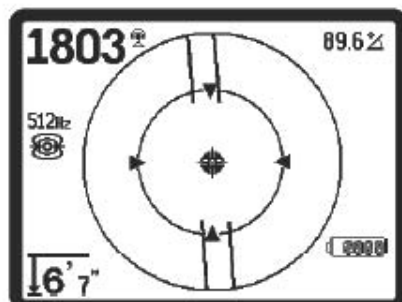
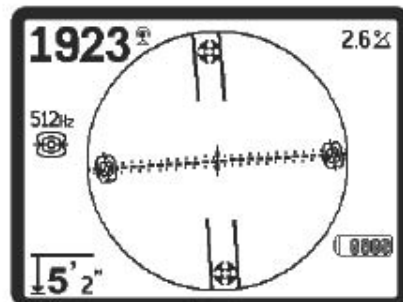


Figure 38:  SimulTrace Mode: No-Signal Icon



A

On the Pole



B

On the Equator



C

Approaching the 2nd Pole

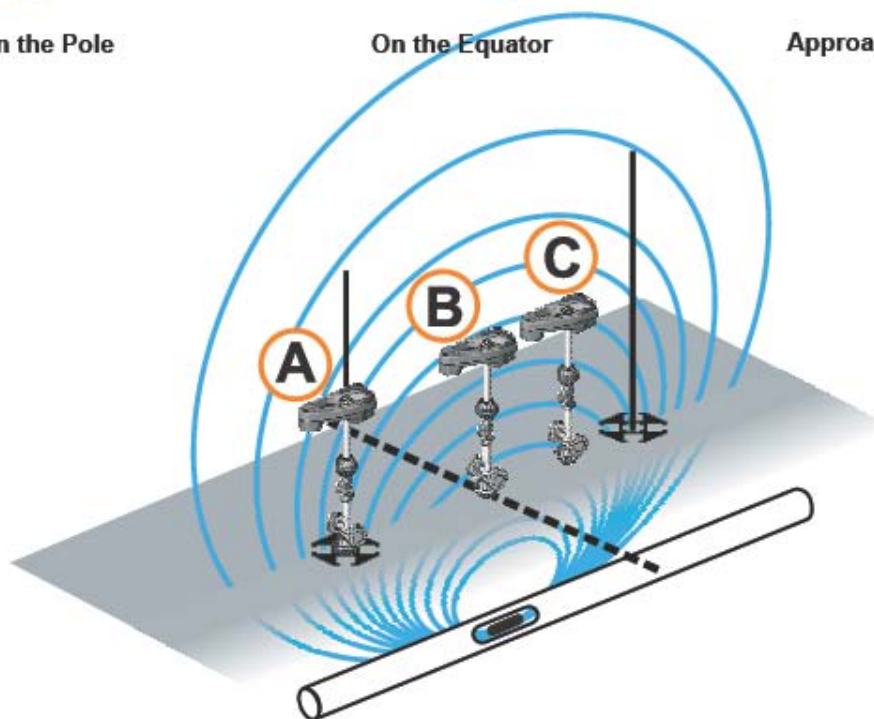


Figure 39: Screen Display in Different Locations (Sonde)

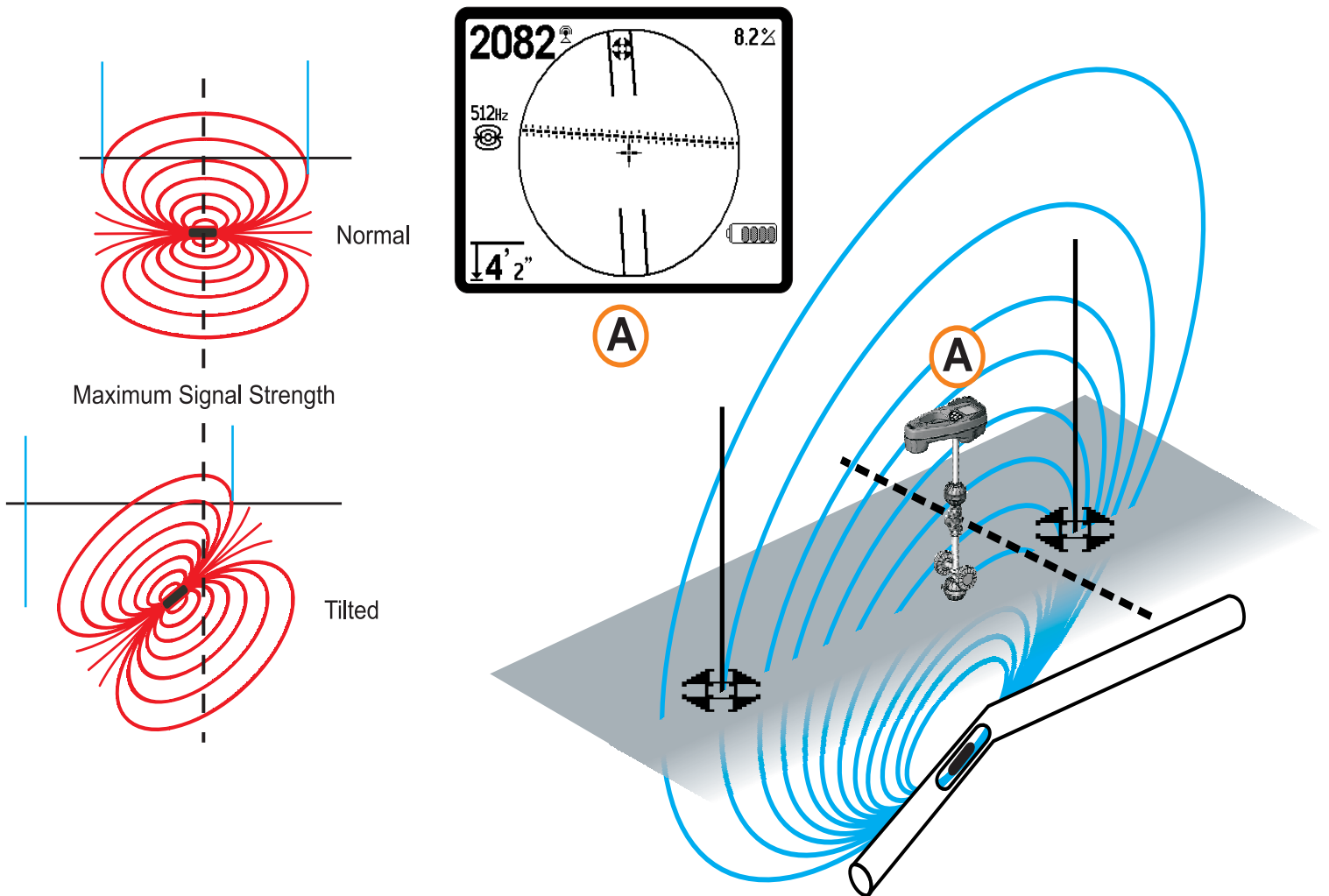


Figure 40: Tilted Sonde, Poles, and Equator

Note the right-hand Pole is closer to the Equator, due to tilt.

Custom User Frequencies

SR-60 users can set and use custom frequencies. By setting the SR-60 to a user-defined frequency, you can use it with transmitters from any manufacturer, even if the transmitter has unusual frequencies or has drifted from its nominal frequencies.

Up to 30 user-defined frequencies can be created, changed, stored, and deleted as needed.

To create a new frequency, scroll down the Main Menu to **Frequency Selection Control**. Then select the **Sonde**, **Line Trace**, or **Power** category for your user-defined frequency. The first option on the category list will be User-Defined Frequency option. To manage User-Defined Frequencies, highlight it and press Select.

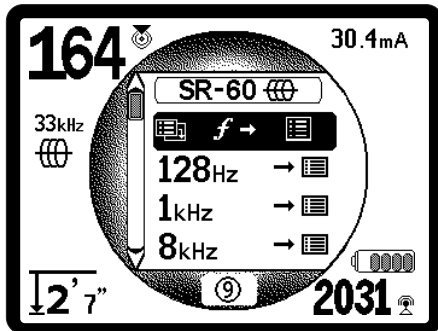


Figure 41: User-Defined Frequency (Line Trace Mode)

A screen with spaces for a six-digit frequency will appear. It can accept frequencies from 00000 to 490,000 Hz. For each digit, the Up Arrow increases the number and the Down Arrow decreases it. The Left and Right Arrow Keys move you from column to column.

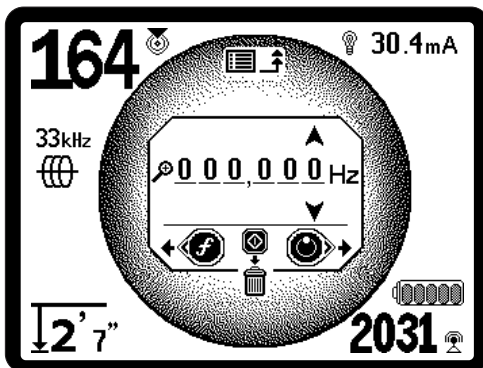


Figure 42: Custom Frequency Setting

By moving all the way to the left, using the Left Arrow Key, you can highlight the icon of the magnifying glass. This will reveal a drop-down list of frequencies (Figure 43) which are used by manufacturers of other

transmitters. Pressing Select will automatically fill in the user-defined frequency values with the highlighted number.

A list of frequencies used by various manufacturers' transmitters and locators is included in the User Manual.

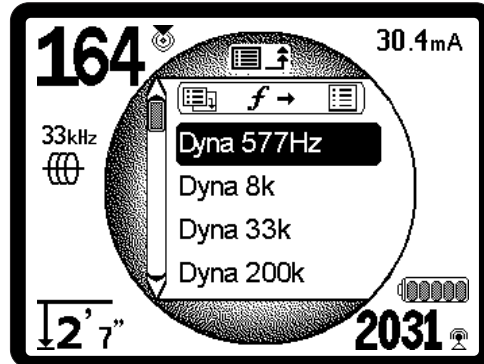


Figure 43: Choosing a Frequency Value

Alternatively, you can define a user-defined frequency by setting each digit in turn from right to left with the arrow keys.

Press the Select Key to save the user-defined frequency you have set. Custom frequencies can be easily identified by a "+" in their menu list name.

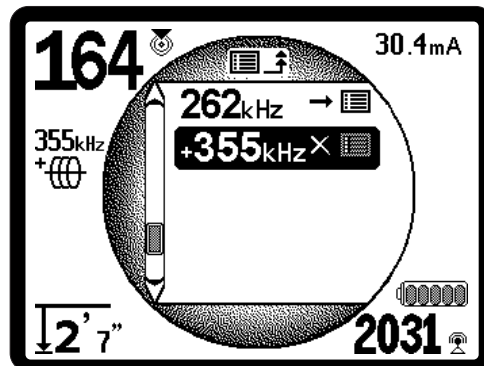


Figure 44: User-Defined Frequency in Main Menu

Changing a User-Defined Frequency

To edit a user-defined frequency:

1. Press the Menu Key to show the list of available frequencies. Scroll down to the user-defined frequency you wish to edit.
2. Press the Frequency Key f . The user-defined frequency window with the frequency you selected will appear.

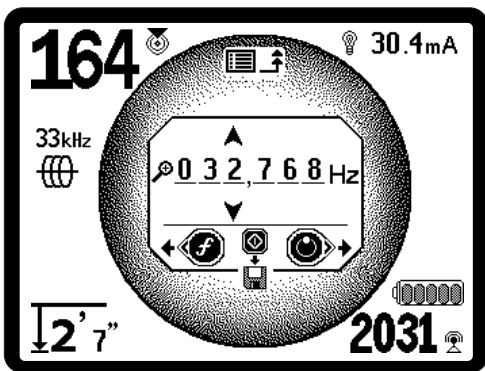






Figure 45: Editing a User-Defined Frequency
(Note: Trash Icon for deleting Frequency appears when Frequency is set to 0).

3. Use the arrow keys to move through the digits and increase or decrease them.
4. When the frequency is correct, press the Select Key  to save the new value.

To delete a user-defined frequency:

1. Press the Menu Key  to show the list of active frequencies. Scroll down to the user-defined frequency you wish to edit.
2. Press the Frequency Key . The user-defined frequency window with the frequency you selected will appear.
3. For each digit that is not set to zero, select the digit and use the Down arrow key to reduce it to zero.
4. When all digits in the frequency are set to zero, the “trash can” icon will appear. Press the Select Key . The user-defined frequency will be deleted.

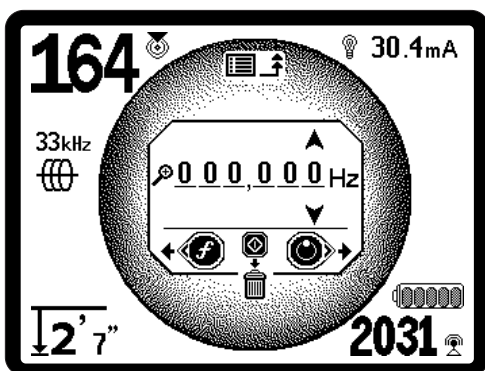


Figure 46: User-Defined Frequency Screen

Menus and Settings

Pressing the Menu Key brings up a series of choices which let the operator configure the SR-60 as preferred (see Figure 47). The menu is a context-sensitive list of options. The entry point into the menu list is set to the currently active frequency.

③ Auto Menu Exit Count-down Timer

While traversing the menu tree, a counter appears at the bottom of the screen counting down. When it reaches zero, it will automatically move back up one level of the menu tree until it reaches the operating screen again. It resets to nine with each key press, or each time it goes up one menu level, until it reaches the operating screen.

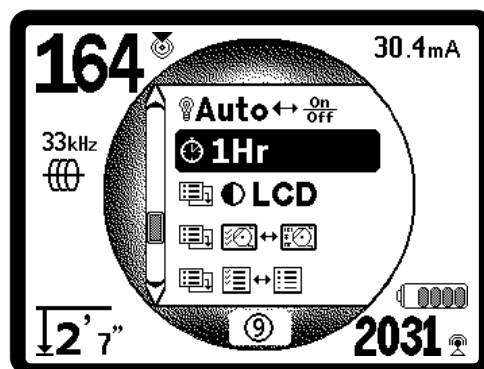









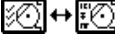




Figure 47: Main Menu

In sequence from the top of the menu down, the Main Menu presents the following items:

1.  **SimulTrace (512 Hz + 33 kHz)** (If activated).
2.  **Currently Available Sonde frequencies** (Checked-Active or not).
3.  **Currently Available Active Line Trace frequencies** (Checked-Active or not).
4.  **Currently Available Power (Passive Line Trace) frequencies** (Checked-Active or not).
5.  **Currently Available Radio Frequencies (Low and High)** (Checked-Active or not).
6.  **OmniSeek Mode**
7.  **Depth Measurement Units Setting**
8.  **Backlight Control.**
9. **Auto-Shutdown Control**
10.  **LCD Contrast Control**

11.  **Display Elements Control** (Sub-menus will display when selected for Sonde or line tracing modes.)
12.  **Frequency Selection Control** (Sub-menus will display for categories of frequencies that can be selected.)
13.  **Information Menu** including software version and unit serial number (sub-menu for restoring factory defaults will display on Information screen).

See the Menu Tree on page 35 for a complete list.

SimulTrace Mode

The SimulTrace mode is off by default and can be activated by selecting it in the Frequency Selection Control sub-menu. It provides simultaneous tracing of a 512 Hz Sonde and a 33 kHz line for easier tracking of underground pipes using a Sonde.

Currently Available Sonde Frequencies

Frequencies that have been set to “Checked-Active” status appear with a check box next to them. If the checkbox is checked, the frequency can be accessed using the Frequency Key **f**. Frequencies are checked or unchecked by highlighting them and pressing the Select Key. To return to the operating screen, press the Menu Key.

See the Frequency List on page 9.

Currently Available Active Line Trace Frequencies

Frequencies that have been set to “Checked-Active” status appear with a check box next to them. If the checkbox is checked, the frequency will be activated and can then be accessed using the Frequency Key **f**. Frequencies are checked or unchecked by highlighting them and pressing the Select Key. To return to the operating screen, press the Menu Key.

See the Frequency List on page 9.

Currently Available Passive Line Trace Frequencies

As with other frequency categories, these items will appear in the “Checked-Active” set when checked.

See the Frequency List on page 9.

Currently Available Radio Frequencies

As with other frequency categories, these items will appear in the “Checked-Active” set when checked.

See the Frequency List on page 9.

OmniSeek Mode

The OmniSeek mode allows simultaneous tracing in multiple high-frequency bands: <4 kHz, 4-15 kHz, and 15-35 kHz.

Change of Depth Units

The SR-60 can display Measured Depth in either Feet or Meters (Figure 48). Feet are shown in feet-and-inches format; meters are in decimal format. To change these settings, highlight the Depth Units selection in the menu and press the Select Key to toggle between feet or meters. Use the Menu Key to save the section and exit.

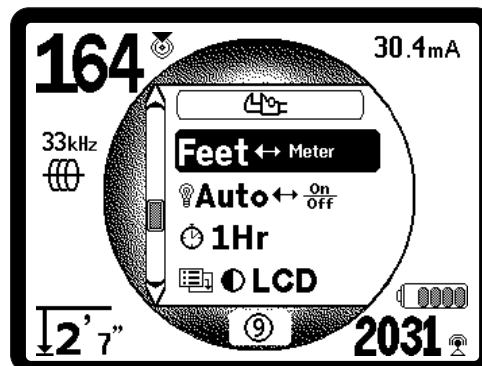


Figure 48: Selecting Units (Feet/Meters)

Back Light Control

A light detector built into the upper left corner of the keypad senses low light levels. The backlight can be forced on by blocking the light to this sensor.

The automatic LCD backlight is factory set to only switch on under fairly dark conditions. This is to conserve battery power. As the batteries near depletion, the backlight will appear dim.

To set the backlight to be always off, highlight the light bulb icon in the tools section of the menu. Press the Select Key to toggle it between Auto, always ON and always OFF.

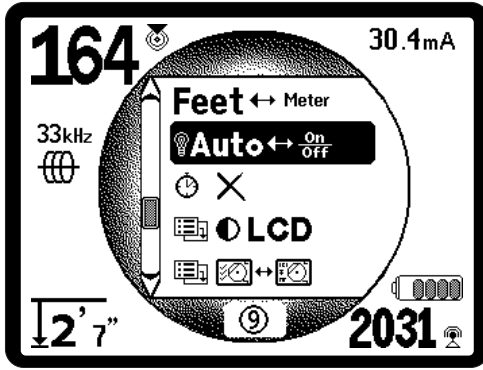


Figure 49: Setting Backlight Mode (On/Off/Auto)

● LCD Contrast

When this is selected by pressing the Select Key, the contrast can be adjusted (Figure 50). Use the Up and Down Keys to make the screen lighter or darker (Figure 51). Extreme temperature changes may make the LCD appear dark (hot) or light (cold). Setting the contrast to extreme dark or light may make the LCD difficult to read.

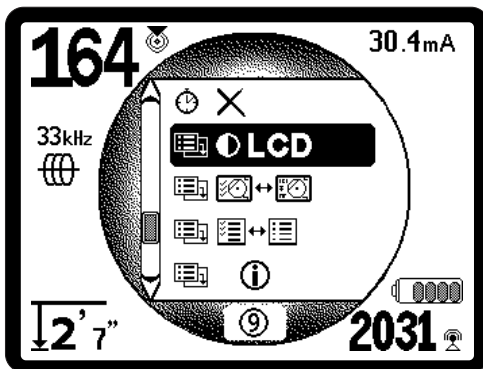


Figure 50: Contrast Setting Option

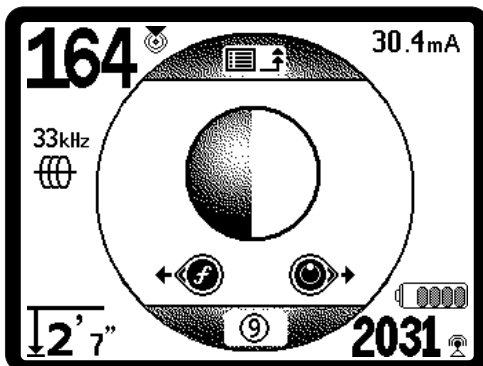


Figure 51: Increasing/Decreasing Contrast

Use the Menu Key to save the setting and exit. In this menu, one can also exit by pressing the Select Key to save the setting and exit.

Display Elements Menu

Advanced features of the SR-60 can be enabled by using the Menu Key to show the menu tree. Select the Display Elements selection menu. Then select the mode (Line Trace or Sonde) you want to change.

Selecting the icon representing two small display screens will bring up the Display Elements Menu for either Trace or Sonde mode. The SR-60 is shipped with some of the elements switched off for simplicity. To toggle an element on or off, press the Up or Down Key to highlight the screen element icon for that feature. Then use the Select Key to check or uncheck the box. Checked display elements are selected to be on for that mode. Personal preferences and the type of locating being done will dictate which optional elements the operator wants displayed.

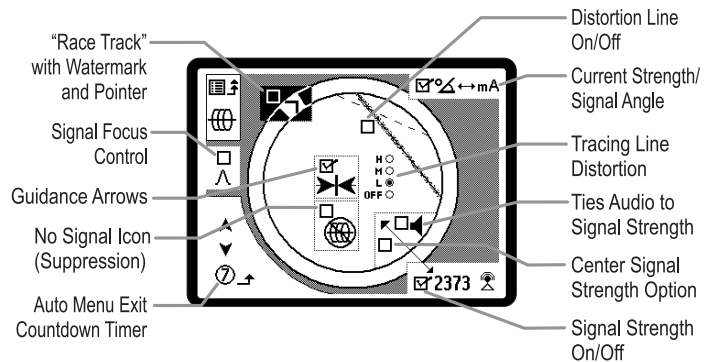


Figure 52: Display Elements (Line Trace Modes)

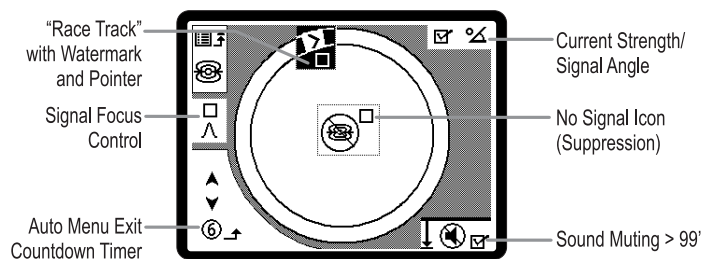



Figure 53: Display Elements (Sonde Mode)

Optional Features

Optional Features in the Display Elements Menu include:

Race Track and Watermark

The "Race Track" is a circular track around the center of the Active View Area on the screen. The Watermark is a marker which appears in the outer ring of the display,

traveling along the Race Track (Figure 54). The Watermark is a graphic representation of the highest Signal Strength reached (in Sonde mode) or the highest Proximity Signal level reached (in Line Tracing modes). It is "chased" by a solid Level Pointer  which shows the *current* Signal Strength. If the Signal Strength Level Pointer goes higher than the Watermark, the Watermark moves up accordingly to show the new highest level graphically. The Watermark, like the high-water ring in a bathtub, shows the highest level reached.

This provides an additional, visual way to track the maximum signal. If you are trying to trace a line by noticing its highest Signal Strength level, Watermark serves as a visual aid.

The Watermark and Race Track are a single option that is off by default but can be set on in the Display Elements selection menu.

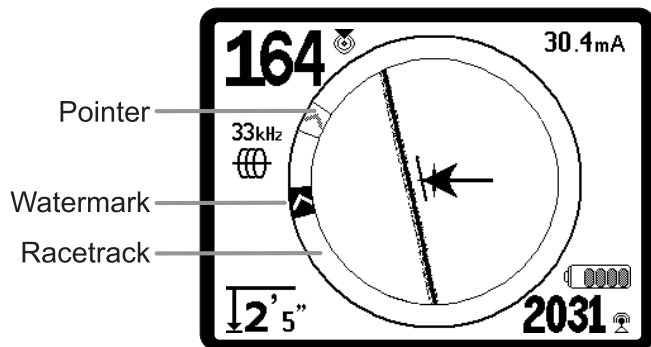


Figure 54: "Race-track" with Watermark and Level Pointer

No-Signal Icon (Suppression)

IF this feature is selected "on", when the SR-60 is not receiving any meaningful signal on the selected frequency, it will display a moving magnifying glass icon, indicating no signal is being detected (Figure 55). The sound will also mute when no signal is found. This reduces the confusion of trying to interpret the random noise that some locators display in the absence of a signal.

- Depth suppression – If the Measured Depth is greater than the threshold depth (by default, 99'/30m in Sonde mode and 30'/10m in Line Trace mode), the map is suppressed, and the magnifying glass appears.
- Noise suppression – If the signal is seen to be too noisy, the map may also be suppressed.

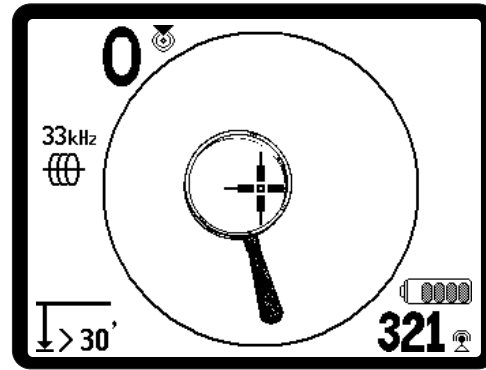


Figure 55: No-Signal Icon

Center Signal Strength Option

Selecting this option in the Menu Selection screen will force the number representing Signal Strength to be displayed in the center of the display area *anytime when a Proximity Signal is not available* (Figure 56). This may occur when signal is weak. When a Proximity Signal again becomes available, the Signal Strength number returns to the lower right corner of the screen as usual. (Line Trace Mode only).

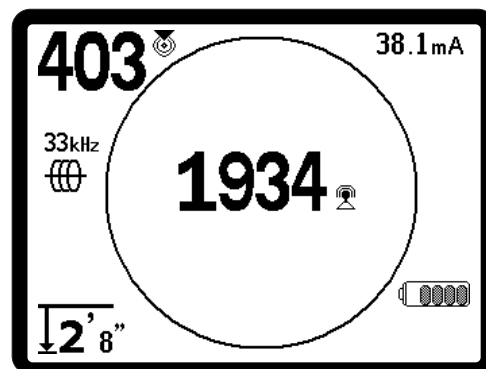
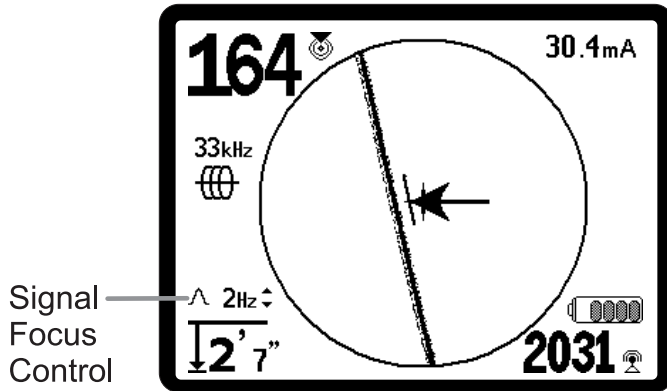


Figure 56: Display of Signal Strength at Screen Center

2Hz Signal Focus Control

The Signal Focus Control feature essentially acts something like a magnifying glass on the signal. It reduces the sample bandwidth of the signal that the receiver examines, and gives a display based on a more sensitive read of the incoming signals. The tradeoff in using the Signal Focus Control setting is that the display, while more precise, will update more slowly. The Signal Focus Control can be set at 4Hz (wide), 2Hz, 1Hz, .5 Hz, and .25 Hz (narrow). The narrower the selected bandwidth used, the greater detection distance and precision the receiver will show, but with a lower update rate of data on the display.


Figure 57: Signal Focus Control

Note this means that when using a *more narrow* Signal Focus Control setting, it is necessary to move the receiver along the line more slowly. This is a trade-off for the improved focus, and will avoid missing data updates at the slower rate.

When it is selected on, the Signal Focus Control is changed to narrower or wider settings using the Up (narrower) and Down (wider) Keys.

Signal Focus Control is useful when you need to focus in on a particular signal with detail.

Sound Muting → 99'

This option automatically mutes sound when Measured Depth is greater than 99 feet (30m). If it is unchecked, the sound will not mute automatically.

Tracing Line Response

The Tracing Line distortion response checkbox sets the sensitivity of the Target Line's distortion display to low, medium, or high -- or disables it altogether. The higher the setting, the more sensitive the "distortion cloud" around the Tracing Line becomes.

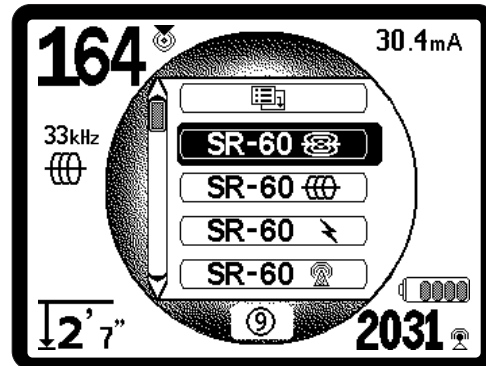
If the distortion response is disabled, the Tracing Line will become a single solid line, and the screen will show a second, dashed, line called the Distortion Line. (See page 35 for a description of using this alternative display.)

Frequency Selection Control

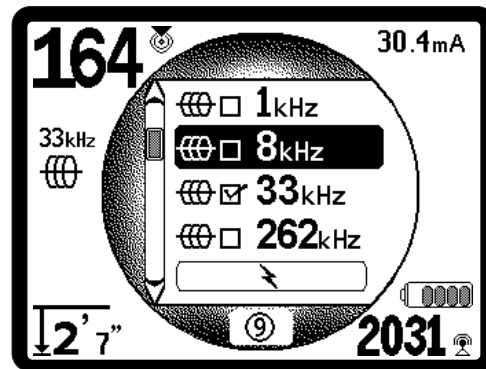
Additional available frequencies on the Master Frequency Menu can be added to the Main Menu list of available frequencies by going to the **Frequency Selection Control** sub-menu and selecting the desired mode. All frequencies available in the SR-60 for that mode will be displayed. *Checked* frequencies are already "Currently

Available" – that is, selected to appear in the Main Menu. From there, they can be set to "Checked-Active" status to make them available by use of the Frequency Key **f**. Checking a frequency to *add* it to the Main Menu will set the unit to operating in that frequency and place it in Checked-Active status.

To select additional frequencies, highlight and select the Frequency Selection Control sub-menu. Highlight the category of the desired frequency (Figure 58). Press the Select Key .


Figure 58: Selecting a Frequency Category

Then use the Up and Down Keys to scroll through the available frequencies. Highlight the desired frequency to add it to the currently available list (Figure 59).


Figure 59: Highlighting a Frequency to Activate

Checking a frequency (using the Select Key) will enable it to be included in the "Currently Available" list of frequencies on the Main Menu (Figure 60). Once on the Main Menu, it can be set to "Checked-Active" status, and then be put into use using the Frequency Key .

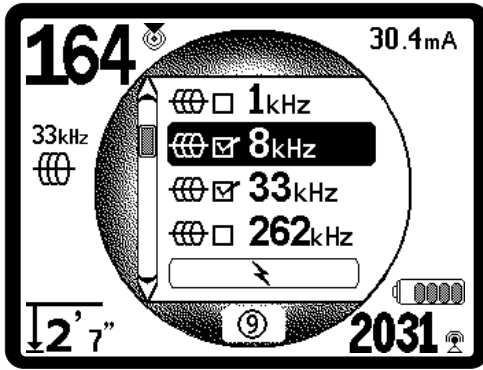


Figure 60: Setting a Frequency to “Currently Available” Status

To switch to a “Currently Available” frequency that is not yet “Checked-Active”, press the Menu Key and scroll down to the desired frequency; if it is not checked, press the Select Key to toggle the checkbox to “checked”. This sets the status of that frequency to “Checked-Active”. Press the Menu Key to return to the operating display, which will now be set to the frequency just activated. The SR-60 will show the chosen frequency and its icon on the left of the screen.

Selected frequencies in the Checked-Active set can be switched while the SR-60 is in use, by pressing the Frequency Key. The SR-60 will cycle down the list through the set of active frequencies from low to high, group by group, and repeat. Unchecking a frequency in the Main Menu will deactivate it, and it will then not appear when pressing the Frequency Key.

Note: If a frequency appears missing, look to make sure it is currently available in the Main Menu frequencies list. If it is, select it using the Select Key. If not, go to the Frequency Selection menu and the appropriate sub-category and select it there, checking the box to make it “Currently Available” and bring it into the Main Menu list. Make sure it is “checked” at *both menu levels* for it to appear in the current working set of frequencies.

Information Screen and Restoring Defaults



Information Screen

The information screen appears at the bottom of the menus choices list. Pressing the Select Key displays information about your locator, including software

version, serial number of the receiver, and its calibration date (Figure 61).

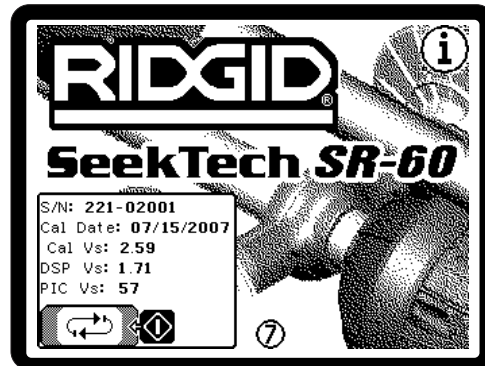


Figure 61: Information Screen

Restore Factory Defaults

Pressing Select a second time will display the Restore Factory Defaults option. (See Figure 62.)

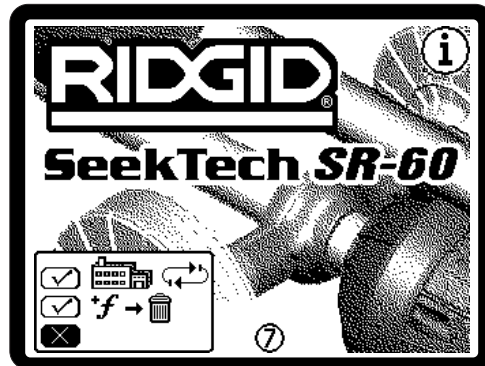


Figure 62: Restore Defaults Option

Use the Up and Down Keys to highlight either the “check” symbol to restore factory defaults, or the “X” symbol to NOT restore them.

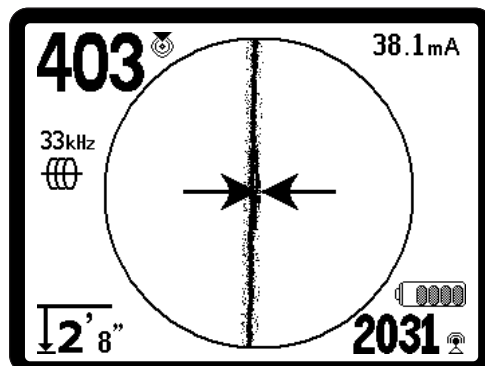


Figure 63: Defaults Restored (Line Trace Mode)

Pressing the Menu Key without changing either checkbox will exit the option and leave things as they were.

Menu Tree

The following figure shows options and controls built into the SR-60 menus.

Activated Frequencies		
Sonde	512	
Line Trace	126 Hz, 1 kHz, 8 kHz, 33 kHz, 93 kHz, 262 kHz	
Power	60 [^] 9 (450 Hz), <4 kHz	
Radio	L (4-15 kHz), H (15-35 kHz)	
OmniSeek	<4 kHz + 4-15 kHz + 15-35 kHz	
Depth Units	Feet, Meters	
Backlight	On/Off/Auto	
Auto Shutdown	1 HR, Off	
LCD Contrast	Increase/Decrease	
Display Elements	Sonde Mode	Trace Mode
*=Line Trace Display Only	➤ <u>Watermark</u>	
	➤ <u>Signal Focus Setting</u>	
	➤ <u>No-Signal Indicator</u>	
	➤ <u>Sound Signals</u>	
	➤ <u>Center Signal Strength*</u>	
	➤ <u>Signal Strength</u>	
	➤ <u>Signal Angle Indicator</u>	
	➤ <u>Distortion Line Response*</u>	
	➤ <u>(Hi, Med, Low)</u>	
	➤ <u>Tracing Line Distortion *</u>	
Frequency Selection	➤ SimulTrace™ : 512 Hz + 33 kHz	
	➤ Sonde : Custom Frequencies, 16, 512, 640, 850, 8k, 16k, 33k	
	➤ Line Trace : Custom Frequencies, 128 Hz, 1 kHz, 8 kHz, 33 kHz, 51 kHz, 93 kHz, 93 kHz-B, 200 kHz, 262 kHz	
	➤ Power : Custom Frequencies, 50 Hz, 60 Hz, 100 Hz, 120 Hz, 50 [^] 5 (250 Hz), 60 [^] 5 (300 Hz), 50 [^] 9(450 Hz), 60 [^] 9 (540 Hz), <4kHz	
	➤ RF : L (4-15 kHz), H (15-35 kHz)	
Information Menu	➤ OmniSeek : <4kHz + 4-15 kHz + 15-35 kHz	
	➤ Restore Defaults, Clear Custom Frequencies, Cancel	

Figure 64: SR-60 Menu Tree

Operating With the Distortion Line

If the Tracing Line's distortion response (blurring) is disabled, the detected field will be shown with two lines, one solid (the Tracing Line —) and one dashed (the Distortion Line - - - - -). (The dashed Distortion Line can be separately selected to be on or off in the Display Elements menu). The dashed Distortion Line is the signal as seen by the upper antenna node and the solid Tracing Line is the signal as seen by the lower node.

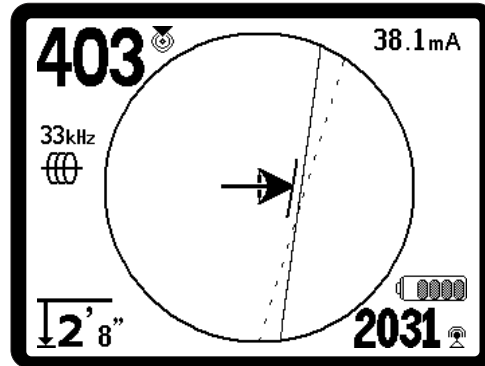


Figure 65: Screen Display with Distortion Line (Line Trace Mode)

The Tracing Line without the dynamic distortion response (blurring) still represents the location, and the direction, of the signal being traced. It still reflects changes in direction of the target utility. And it helps recognize signal distortion, when compared to the dashed Distortion Line — if something is interfering with the signal and distorting its shape, the Distortion Line could be significantly offset or skewed.

The Tracing Line represents the signal received by the lower antenna node. The Distortion Line represents the signal received by the upper antenna node. If these two do not align, or they do not reflect the same information as the Guidance Arrows about where the center of the field is, then the operator knows he is looking at some kind of distortion.

The two lines may also move randomly if a weak signal is being received, indicating that the locator circuit needs to be improved.

The balance of the Tracing Line and the Distortion line combine to give the operator much the same information as the Tracing Line with its distortion response enabled, but in a different graphical form. Advanced operators may find this more useful in discriminating the primary signal from the impact of distortion.

Informational Locating

The normal shape of a field around a long conductor such as a pipe or cable is circular (cylindrical in three dimensions). When over the center of a circular field, the operator can observe the following indicators:

- Maximum Signal Strength
- Maximum Proximity Signal (Line Trace Mode)
- Centered Tracing line with minimized distortion
- Guidance arrows centered, agreeing with Tracing line
- Minimum Measured Depth
- Sound pitch and volume will increase until they maximize over the target utility.

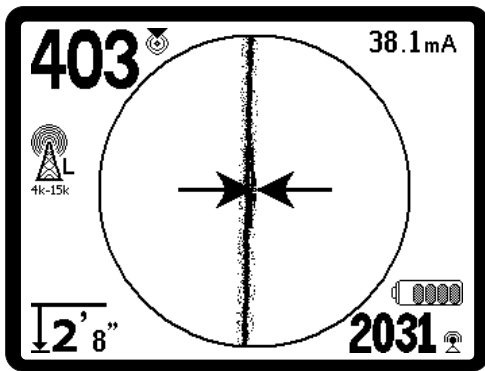


Figure 66: Over a Circular Field

The experienced operator learns to “see” the ground situation by knowing how the different pieces of information provided by the SR-60 relate to each other. While a simple straightforward locate of a circular field is fast and easy, tracing a line which is near other large conductors such as power lines, phone lines, gas mains, rebar, or even buried scrap metal can lead to questions which can only be correctly answered by taking all the available information into account.

By comparing the Guidance Arrows, the Tracing Line, Signal Strength, Signal Angle, Measured Depth, and Proximity Signal, an operator can see which way the field is being distorted. Comparing the field information with an educated view of the ground, noticing where transformers, meters, junction boxes, manholes, and other indicators are located can help in understanding what is causing field distortion. It is important to remember, especially in complex situations, that the only guarantee of the location of a

particular line or pipe is visual inspection, such as by potholing.

Compound or complex fields will produce different indications on the SR-60 that will show what is happening. Some examples might be:

- Disagreement between guidance arrows, Tracing Line and Distortion Indicator
- Inconsistent or unrealistic Measured Depth signal
- Fluctuating random indications (also caused by very weak signal)
- Inconsistent Proximity Signal compared to guidance arrows (Active or Passive Line Trace modes)
- Signal strength maximizing off to one side of the conductor.

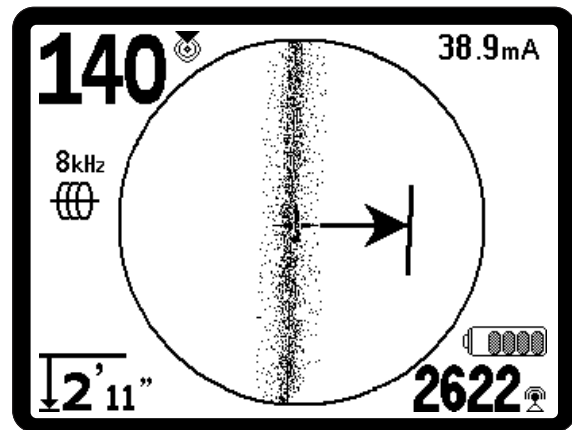


Figure 67: Over a Distorted Field

Generally, distortion is likely to be worse at higher frequencies, compared to lower frequencies. This is due to the tendency of higher frequency signals to “jump” to adjacent conductors. Large iron and steel objects such as vault and manhole covers, trench plates, structural supports, rebar and vehicles can significantly distort even the lowest frequencies. In general, passive locating is more subject to distortion than active locating, especially in regards to depth measurements. Power transformers, buried and overhead power lines are a common source of strong distortion. It may be impossible to get an accurate locate close to a large power transformer.

Notes on Accuracy

Measured Depth, Proximity, and Signal Strength measurements rely on a strong signal being received by the SR-60. Remember that the SR-60 is used above ground to sense electromagnetic fields emitted from

underground lines (electrical conductors like metal cables and pipes) or Sondes (actively transmitting beacons). When the fields are simple and undistorted, then the information from sensed fields is representative of the buried object.

If those fields are distorted and there are multiple interacting fields, it will cause the SR-60 to locate inaccurately. Locating is not an exact science. It does require the operator to use judgment and look for all the information available beyond what the instrument readings may be. The SR-60 will give the user more information, but it is *up to the operator to interpret that information correctly*. No locator manufacturer will claim that an operator should follow the information from their instrument exclusively. A wise operator treats the information gained as a partial solution to the problem of locating and combines it with knowledge of the environment, utilities practices, visual observation, and familiarity with the instrument to arrive at an informed conclusion.

Locating accuracy should *not* be assumed under the following conditions:

1. **When other cables or utilities are present.** “Bleed over” may produce distorted fields and illuminate cables or pipes unintentionally. Use lower frequencies when possible and if possible eliminate connections between the two cables (such as common bonding to ground).



Figure 68: Bleed-over

2. **When tees, turns, or splits are present in the line.** When following a clear signal that suddenly becomes ambiguous, try seeking in a circle of about 20' around the last known point to see whether the signal picks up again. This may reveal a branch, joint, or some other change in the line. Be alert to

“split opportunities” or sudden changes of direction in the utility being traced. Turns or tees can cause a sudden increase in the Distortion Indicator response.

3. **When Signal Strength is low.** A strong signal is necessary for accurate locating. A weak signal can be improved by changing the grounding of the circuit, frequency, or transmitter connection. Worn or damaged insulation, bare-concentric cables, and iron pipes exposed to ground will compromise Signal Strength through leakage to ground.
4. **Far-end grounding** will change Signal Strength significantly. Where far-end grounding cannot be established a higher frequency will provide a stronger signal. Improving ground conditions for the locating circuit is a primary remedy to a poor signal.
5. **When soil conditions vary.** Extremes in moisture, either very dry or water-saturated, may affect measurements. For example, ground that is saturated with salty water will shield the signal severely and be very difficult to locate in, especially at high frequencies. In contrast, adding water to very dry soil around a ground stake can make a major improvement in signal.
6. **In the presence of large metal objects.** Simply walking past a parked car during a trace, for example, can cause an unexpected increase or decrease in Signal Strength, which will revert to normal when past the distorting object. This effect is stronger at high frequencies, which “couple” more readily onto other objects.

The SR-60 cannot change the underlying conditions of a difficult locate, but changing frequency, grounding conditions, transmitter location, or isolating the target line from a common ground can change the results, by making a better ground connection, avoiding signal splits, or reducing distortion. Other locating receivers will give an indication that they may be over the line but they have less ability to determine the *quality* of the locate.

The SR-60 provides *more information*. If all of the indicators are aligned and in agreement, mark-outs can be made with more confidence. If the field is distorted it shows immediately. This allows the operator to do something to isolate the target line, change the grounding, connection point, move the transmitter, or change the frequency to get better reception with less distortion. For extra certainty, take steps to inspect the situation, such as by requesting potholing.

In the final analysis, there is one “most important” component in the locating task – the operator. The SR-60 provides an unprecedented amount of information to

be able to make the correct decision rapidly and accurately.

A Better Way of Locating

The SR-60 gives the operator a picture of the situation as the receiver moves along the target area and makes it easier to understand where a target line's electromagnetic field is. With more complete information, an operator can understand how things stand underground and resolve complex situations, avoid inaccurate mark-ups, and find the right line or cable more rapidly.

What the SR-60 Does

The SR-60 is used above ground to sense and trace electromagnetic fields emitted from underground or hidden lines (electrical conductors like metal cables and pipes) or Sondes (actively transmitting beacons).

When the fields are undistorted, the information from the sensed fields gives an accurate picture of the buried object. When the situation is made complex by interference from more than one line, or other factors, the SR-60 provides a display of information that shows multiple measurements of the detected field. This data can make it easier to understand where the problem is, by providing clues as to whether a locate is good or bad, questionable or reliable. Instead of just laying paint in the wrong place, the operator can see clearly when a difficult locate needs re-evaluation.

The SR-60 provides more of the critical information the operator needs to understand the situation underground.

What It Does Not Do

The SR-60 locates by sensing electromagnetic fields surrounding conductive objects; it does not sense the underground objects directly. It provides more information about the shape, orientation, and direction of fields than other locators but it does not magically interpret that information or provide an x-ray image of underground objects.

A distorted, complex field in a noisy environment requires intelligent human thought to analyze correctly. The SR-60 cannot change the results of a difficult locate, even though it shows all the information about those results. Using what the SR-60 shows, a good operator can improve locating results by "making the circuit better", changing frequency, grounding or the transmitter's location on the target line.

Advantages of the Omnidirectional Antenna

Unlike the coils used in many simple locator devices, the Omnidirectional antenna detects fields on three separate axes, and can combine these signals into a "picture" of the apparent strength, orientation, and direction of the *complete* field. Omnidirectional antennas offer definite advantages:

The Mapping Display

The mapping display enabled by the Omnidirectional antennas provides a graphic view of a signal's characteristics and a bird's eye view of the signal from underground. It is used as a guide for tracing underground cables and pipes, and can be used to better pinpoint Sondes. It can also be used to provide more information for complex locates.



Figure 69: Mapping Display

The use of lines (representing the signals sensed by upper and lower antennas) and guidance arrows (pointing toward the center of the detected field) combine to give the locator a graphic picture of the receiver's location, and where the target utility or Sonde is. At the same time the operating screen provides all the information needed to understand what is happening with the field being located – its Signal Strength, continuous distance, Signal Angle, and proximity to the target. The information available at one moment on the SR-60 would take multiple sample readings with some conventional locators. A distorted or compound field will be easier to interpret when all the information is in a single display as it is with the SR-60.

Orientation to the Signal

Because of the multiple signals being processed by each Omnidirectional antenna, the target's signal always gets stronger as the receiver gets closer to the target. How the unit is held does not affect Signal Strength. The user can approach from any direction and does not need to know the orientation or direction of the pipe or wire.

Locating Sondes

Used with a Sonde, the SR-60 eliminates Nulls and "Ghost Peaks". A conventional locator signal often sees a signal increase followed by a null (better described as no signal registering on the antenna) and then a peak. This can confuse the operator who may interpret a smaller peak as the target.

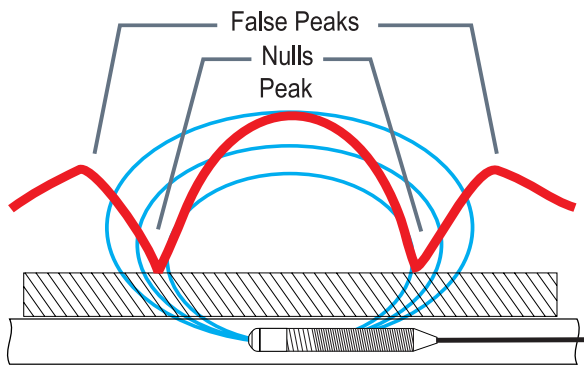


Figure 70: The signal from a Sonde as “seen” by a conventional locator

The main peak is in the center, and two false peaks are outside the two nulls.

The SR-60 uses measurements of the complete field to direct the user to the target. Finding a Sonde using Signal Strength is a very direct process.

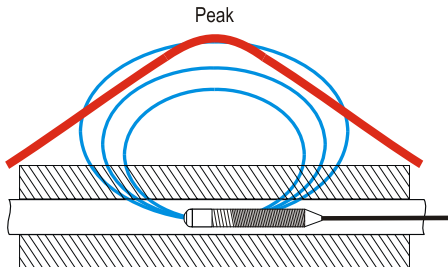


Figure 71: Sonde signal as “seen” by the SR-60

The only way to go is “up” toward the maximum signal.

More on Informational Locating

Because of the SR-60's advanced processing and display, the information provided by the SR-60 makes it clear when a locate is reliable, and when one is suspect. A good locator can understand the underground picture with much less effort by using the combined information provided by:

- Proximity Signal/Signal Strength
- Tracing Line
- Distortion Indicator
- Guidance Arrows and Directional Sound
- Continuous Measured Depth indications

These indicators show what the antennas are “sensing” as they move through the field. They signal when a field is being distorted out of shape by interference from other cables, pipes, or conductive objects nearby. When significant distortion is present, the indicators will not agree. Knowing distortion is present allows the operator the option of taking action to reduce it or at least account for it. (For example, both location and Measured Depth reading become suspect in distorted fields).

The other side of having more information is verification that a locate is *reliable*. If all of the indicators are in agreement and reasonable then the degree of confidence in a locate can be much higher.

SR-60 Maintenance

Transportation and Storage

Before transporting, make sure that the unit is off to preserve battery power.

When transporting, make sure that the unit is secure and does not bounce around or get bumped by loose equipment. The SR-60 should be stored in a cool dry place.

Note: If storing the SR-60 for an extended period, remove the batteries completely.

If shipping the SR-60, remove the batteries entirely from the unit.

Installing/Using Accessories

The SR-60 also comes with Sonde and Pole Markers that can be used to mark Pole or Sonde locations above ground. There are two (2) red markers to mark the Poles and one (1) yellow marker to mark the Sonde. The markers can also be used to temporarily mark points to come back to while scouting a target area or tracing a

Maintenance and Cleaning

1. Keep the SR-60 clean with a damp cloth and some mild detergent. Do not immerse in water.
2. When cleaning, do not use scraping tools or abrasives as they may permanently scratch the display. NEVER USE SOLVENTS to clean any part of the system. Harsh chemicals can cause cracking of the Case.

Locating Faulty Components

For troubleshooting suggestions, please refer to the trouble-shooting guide on page 42.

Service and Repair

Important

Instrument should be taken to a RIDGID Independent Authorized Service Center or returned to the factory. Remove batteries before shipping.

All repairs made by Ridge service facilities are warranted against defects in material and workmanship

CAUTION

Remove batteries entirely before shipping.

Icons and Symbols

KEYPAD ICONS

- Menu Navigation/Signal Focus
- Menu Selection
SondeMode: Force Depth/Re-center Audio
Line Trace Mode: Force Depth, Force current, Re-center Audio
Signal Strength Proximity Setting: Force Map On
- Menu Navigation/Signal Focus

- Power ON / OFF Key
- Menu Key
- Frequency Key
- Sound Key

DISPLAY ICONS

- Sonde Frequency
- Active Trace Frequency
- Radio Frequency
- Passive Line Trace Frequency
- Measured Distance/Depth
- Simultrace
- OmniSeek
- Tracing Line
- Line Direction Gradient
- Pole Icon
- Rotational Guidance Arrows
- Distortion Line
- Equator
- Pipe Direction

DISPLAY ICONS (Con't)

- Proximity Signal
- Signal Strength
- Audio Level
- Battery Level
- Backlight settings
- Low Battery Warning (flashing)
- Level Pointer (Signal Strength)
- Watermark (Signal Strength)
- No Signal
- Signal Focus
- Signal Angle Indicator
- Milliamp, Current

MENU ICONS

- Tools Menu
- Measured Depth/Distance Settings
- Screen Contrast Adjust
- Auto Power Off Setting
- Display Elements
- Frequency Selection Control
- Information Screen
- Factory Settings Reset
- Frequency Settings Reset
- Menu Timeout Counter
- Go Up One Level (press menu key)

>30' >10m Depth Greater Than 30 Feet/10 Meter Threshold


Figure 72: Icons and Symbols

Glossary -- Definitions	
Active Line Tracing	A mode of locating using a Line Transmitter to inject a chosen frequency onto a hidden conductor; the frequency is then detected by the SR-60 to trace the conductor
Active View Area	The area within the circle in the center of the operating screen, where the Tracing Line or Sonde Pole and Equator symbols appear.
Bleed over	Coupling of the signal from the target line onto adjacent conductors by any means (resistive, capacitive, or inductive). Bleed-over makes the signal appear to be coming from a different conductor than the one being traced by setting up a field of the same frequency in a nearby conductor.
Checked-Active Frequencies	A frequency is said to be "Checked-Active" when it has been checked on the main menu; this enables it to be accessed by the use of the Frequency Key during operation of the SR-60. The "In Use" frequency is always one of the Checked-Active set.
Clear Signal	A clear signal is a field caused by current through a conductor which is strong enough to be detected unambiguously by a receiver such as the SR-60. Clear signals depend on good conductivity, good grounding, and adequate current through the target conductor.
Clipping	The condition of receiving a signal too strong to be processed all at once by the signal processor; in the SR-60 this condition will cause a warning signal to flash. The signal peaks are too high and are "clipped" off.
Common Bonding	The use of a connector to ground more than one line through the same ground connection. Phone lines, for example, are often bonded to ground via the electrical service ground line. Common bonding can be a cause of ambiguous signals in locating.
Compound Field	An electromagnetic field caused by the combination of two or more fields in proximity to each other. A compound field has multiple lobes and a complex energy pattern which can require analysis to interpret correctly when locating.
Coupling	The transfer of energy (without direct electrical contact) between two or more cables or components of a circuit. This can occur through induction, through common bonding, or other means.
Crosshairs	A symbol in the center of the Active View Area representing the location of the SR-60, relative to the detected field.
Current Strength	The calculated level of current based on field strength detected by the Omnidirectional antennas of the SR-60; expressed approximately in milliamps (mA). An accurate depth measure is required for accuracy.
Currently Available Frequencies	Frequencies which have been checked in the Master Frequency Menu are said to be "Currently Available"; they appear on the Main Menu when the Menu Key is pressed, and can be set to "Checked-Active" status.
Default	Default values are those settings which the SR-60 uses if the operator does not choose alternative settings; they can be restored from the Information Menu.
Depth	See "Measured Depth"

Glossary -- Definitions

<i>Distortion</i>	The impact of near-by fields, other conductors, magnetic flux, or other interference on a circular electro-magnetic field. Distortion is detected by comparing the information from the SR-60's Tracing Line, Proximity Signal, Signal Strength, Measured Depth Display, and Signal Angle readings. The Tracing Line will grow less focused in response to more distortion in the detected field.
<i>Distortion Line</i>	A dashed line which is displayed when the Tracing Line's distortion response property is disabled. It can be used to analyze distortion in the detected field.
<i>Distortion Response</i>	A property of the Tracing Line which shows the degree of distortion detected by displaying a varying cloud of particles around the Tracing Line; the blurriness of the line is proportional to the detected distortion. This property is enabled by default and can be disabled in the display.
<i>Frequency</i>	The number of times per second that an electro-magnetic field forms and collapses (or shifts from positive to negative in the case of alternating current). Expressed in hertz (Hz) (cycles per second), or in kilohertz (kHz) (thousands of cycles per second).
<i>Guidance Arrows</i>	The two arrowheads which represent detection from the gradient-coil antennas in the "side-wheels" of the SR-60 antenna system. The Guidance Arrows provide an indication of where the center of the field currently being traced lies.
<i>'In Use' Frequency</i>	The frequency the SR-60 is currently set to detect. The default 'in use' frequency is 33 kHz. The "in use" frequency is selected using the Frequency Key from the set of frequencies that are "Checked-Active".
<i>Informational Locating</i>	An advance in the science and art of locating underground utilities and Sondes through the combination of multiple pieces of information in an integrated display. Depends on Omnidirectional antenna arrays for real-time information.
<i>Level Pointer</i>	On the SR-60, a solid pointer which moves around a circular track indicating the current Signal Strength being detected. See "Watermark".
<i>Master Frequency Menu</i>	The set of all frequencies that can be used on the SR-60. It is accessed through the Frequency Selection sub-menu.
<i>Measured Depth/Distance</i>	The calculated depth or distance to the Sonde or to the apparent center of the conductor being traced. This is a virtual measurement and may be inaccurate if distortion is present. Physical depth must be verified by potholing before excavating.
<i>Mode</i>	A distinct operating state or method in which a system can be used. The SR-60 has three modes: Active Line tracing, Passive Line Tracing, and Sonde Locating.
<i>Omnidirectional antenna</i>	A proprietary antenna technology which combines detection of electro-magnetic fields on three axes simultaneously. The SR-60 uses two Omnidirectional antennas.
<i>∞ OmniSeek</i>	An advanced mode enabling the simultaneous search for signals on several frequency bands simultaneously: <4kHz, 4-15 kHz and 15-35kHz

Glossary -- Definitions

<i>Operating Screen</i>	The display screen of the instrument as seen when locating. It includes an Active View area, where the Tracing Line appears in Line Trace modes, and where Pole and Equator icons appear in Sonde mode. It also includes Measured Depth, Signal Strength, Signal Angle, current and Proximity Signal values, depending on the mode and choice of options in use.
<i>Passive Line Tracing</i>	A mode of tracing a line which does not use a transmitter to place current on the line. It is used when tracing lines which are energized from external sources such as 50/60 Hz electrical cables or conductors reflecting transient RF energy, etc.
<i>Pole</i>	Where the field lines from the Sonde exit the ground vertically. One of the two ends of a dipole field, such as the magnetic field of the Earth, or the field around a Sonde. The SR-60 displays a Pole icon when it detects the Poles of a Sonde.
<i>Proximity Signal</i>	A computed signal which reflects how close the operator is getting to the target utility in Line Trace modes. It is calculated based on the signal received by the two Omnidirectional antenna nodes of the SR-60.
<i>Race Track</i>	An optional circular track around the outside of the Active View Area in which the Level Marker moves to show current Signal Strength graphically. It also contains the Watermark which shows the highest level of Signal Strength reached.
<i>Signal Angle</i>	The field angle measured relative to the horizontal plane.
<i>Signal Strength</i>	The relative strength of the total field signal detected by the lower Omnidirectional antenna in three dimensions.
 <i>SimulTrace™</i>	An advanced locating mode which makes it possible to simultaneously trace a pushcable emitting a 33kHz signal and also detect a 512k Sonde when it comes in range of the locator.
<i>Sonde</i>	A self contained transmitter, often battery-powered, which is used to signal a point within an underground pipe, tunnel, or conduit.
<i>Tracing Circuit</i>	The complete flow of energy from a transmitter, through a conductor, to ground, and from ground to the transmitter. When the tracing circuit is compromised for some reason, a weak signal and poor detection will result.
<i>Watermark</i>	An optional display icon which shows the highest level of Signal Strength detected. It travels in the Race Track and moves up when the Level Pointer reaches a new high point, providing a graphic indication of the highest signal detected. See Level Pointer.

Trouble Shooting Guide

PROBLEM	PROBABLE FAULT LOCATION
SR-60 locks up during use.	Power the unit off, and then back on. Remove the batteries if the unit will not switch off. If batteries are low, replace them.
SR-60 will not pick up the signal.	Check that the correct mode and frequency is set. Examine circuit for possible improvements. Relocate transmitter, change grounding, frequency, etc.; or modify Signal Focus Control settings (page 32).
While tracing, lines are "jumping" all over the screen in the mapping display.	This indicates that the SR-60 is not picking up the signal or there is interference.
	Make sure that the transmitter is well connected and grounded. Point the SR-60 at either lead to be sure that there is a complete circuit.
	Try a higher frequency, or connecting to a different point in the line, or switching to inductive mode.
	Try to determine the source of any noise and eliminate it. (Bonded grounding, etc.)
	Check SR-60 batteries are fresh and fully charged
While locating a Sonde, lines are "jumping" all over the screen.	Check the batteries in the Sonde to see that they are working.
	Sonde may be too far away; try starting with it closer in if possible, or do an area search.
	Verify signal by placing lower antenna close to Sonde. Note – Sondes have difficulty emitting signals through cast iron and ductile iron lines.
Distance between Sonde and either Pole is not equal.	Sonde may be tilted or there may be a cast-iron-to-plastic transition.
Unit acts erratic, won't power down.	Batteries may be low. Replace with fresh batteries and power on.
Display appears completely dark or completely light when it is switched on.	Power the unit off and then back on.
	Adjust the LCD screen contrast.
There is no sound.	Adjust the sound level in the sound menu. Verify Proximity Signal is greater than zero.
SR-60 will not power on.	Check orientation of batteries.
	Check that the batteries are charged.
	Check to see that the battery contacts are OK.
	Unit may have blown a fuse. (Factory service is required.)

Specifications

- Weight w/ batteries5.4 lbs. (2.5 kg)
- Weight w/o batteries4.7 lbs. (2.1 kg)

Dimensions

- Length 14" (35.56 cm)
- Width 7" (17.78 cm)
- Height 31" (78.74 cm)

Power Source

- 4 C-size batteries, 1.5V Alkaline (ANSI/NEDA 14A, IEC LR14) or 1.2V NiMH or NiCad rechargeable batteries
- Power Rating: 6V, 550mA
- Signal Strength
Non-linear in function. 2000 is 10x higher than 1000, 3000 is 10x higher than 2000, etc.

Operating Environment

- Temperature -4°F to 122°F (-20°C to 50°C)
- Humidity 5% to 95% RH
- Storage Temperature -4°F to 140°F (-20°C to 60°C)

Default Settings

- Depth units = Feet & inches,
- Volume = 2 (two settings above mute)
- Backlight = Auto
- Frequency = 33 kHz (Line Trace Mode)

Standard Equipment

Item	Cat. #
SR-60 Locator	22163
Markers and Mast Holder	12543
Stereo Sound-Pointer Speakers	30143
Operator's Manual	
4 C-cell batteries (Alkaline)	
Training Video (DVD)	

Optional Equipment

Additional Sonde Markers	12543
ST-33Q Transmitter	26168
ST-510 Transmitter	21903
Inductive Clamp (4.75")	20973
Remote Sonde	16728
Float Sonde	19783

The SeekTech SR-60 is protected under U.S. Patents 7009399, 7136765, and other Patents Pending.

Frequencies Table

The following table shows the frequencies available in the SR-60. The default frequencies shown are in Checked-Active status as shipped. Optional frequencies may be added as described on page 33.

Default Frequencies:

Active Line Trace 128Hz, 1 kHz, 8kHz, 33kHz, 200 kHz, 262 kHz; 93kHz (EU only)

Power Line Trace 60Hz (9th), <4kHz

Radio Frequencies: **Low** (4-15kHz),
High (>15kHz)

OmniSeek <4 kHz+4-15 kHz + 15-35 kHz

Optional Frequencies:

Sonde 16 Hz, 512Hz, 640 Hz, 850 Hz, 8 kHz, 16 kHz, 33 kHz
SimulTrace..... 512 Hz + 33 kHz
Passive Line Trace..... 50 Hz, 50 Hz (5th), 50 Hz (9th) 60 Hz, 60Hz (5th), 60Hz (9th), 100 Hz, 120 Hz

Exact Frequency Values (SR-60)								
Sonde	16 Hz	16.0	Passive Line Trace	50 Hz	50	Active Line Trace	128 Hz	128
	512 Hz	512.0		50 Hz ^{5th}	250		1 kHz	1024
	640 Hz	640.0		50 Hz ^{9th}	540		8 kHz	8192
	850 Hz	850.0		60 Hz	60		33 kHz	32768
	8 kHz	8192		60 Hz ^{5th}	300		93 kHz	93,696.0
	16 kHz	16384		60 Hz ^{9th}	540		93 kHz-B	93,622.9
	33 kHz	32768				European		

Manufacturers Frequency Table

Displayed Option	Company	Available Frequencies	Model	Exact frequency (Hz)	Notes
Dyna	3M Dynatel TM	577Hz 8kHz 33kHz 200kHz	2273	577 8192 32768 200012	200 KHz not present in European model of the ST-510.
Fish	FISHER	820Hz 8.2kHz 82kHz	TW-8800	821 8217 82488	
Gen	Gen-Eye TM	512Hz 8kHz 65kHz	LCTX 512/8/65	512 8192 65536	
Gold	GOLDAK	117.5kHz	3300	11750	Not recommended for use with the ST-510 transmitter. Not present in European model of the ST-510.
Heath	Heath Consultants Incorporated	8.1kHz 81kHz 480kHz	ALLPRO	8128 81326 480323	480 KHz not present in European model of the ST-510.
McLau	McLAUGHLIN®	9.5kHz 38kHz	VERIFIER	9499 37997	Made by Takachiho Sanyo Co., Ltd.
Metro	METROTECH ®	982Hz 9.8kHz 82kHz 83kHz	9890 810 for 83kHz	982 9820 82488 83080	
MicroE	Microengineering	76.8kHz	Xmtr-101	76802	
Mytan	MyTana	76.8kHz	PT20	76802	
Phorn	PipeHorn	480kHz		479956	Not present in European model of the ST-510.
RD	Radio Detection (Same as Gen-Eye TM above)	512Hz 8kHz 33kHz 65kHz 82kHz 200kHz	(Same as LCTX 512/8/65 above)	512 8193 32768 65538 81865 200000	200 KHz not present in European model of the ST-510.

Displayed Option	Company	Available Frequencies	Model	Exact frequency (Hz)	Notes
RIDGID (Old)	Ridge Tool Co.	512Hz 8kHz 33kHz 51kHz 200kHz		512 8192 32768 51712 200000	200k changed to 93khz in European model of the ST-510.
RIDGID (New)	Ridge Tool Co.	128 Hz 1 kHz 8 kHz 33 kHz 93 kHz 262 kHz		128 1024 8192 32768 93623 262144	262k, changed to 93khz in European model of the ST-510.
RIDGID-B (New)	Ridge Tool Co.	128 Hz 1 kHz 8 kHz 33 kHz 93 kHz		128 1024 8192 32768 93696	Older 93 kHz value
Ryco	RYCOM	815Hz 82kHz	8876	815 82318	
SeekTech-B		128 Hz 1kHz 8kHz 33kHz 93kHz* 262kHz		128 1024 8192 32768 93696 262144	Older 93 kHz value
Schon	Schonstedt Instrument Company	575Hz	TraceMaster	575	
Ssurf	SubSurface	8kHz 27kHz	PL-2000	8055 26721	Made by FUJI TECOM.
SubS	SUBSITE ® ELECTRONICS Ditch Witch ®	1kHz 8kHz 29kHz 80kHz	950	1170 8009 29430 80429	
Telex		577Hz		577	