

PCL-30 :Pipe and cable Locator Manual

1. Product Overview

1.1 Product Introduction

The PCL-30 is a high-performance general-purpose underground pipeline locator system comprising a signal transmitter and receiver. It is designed for path detection, depth measurement, and surveying of underground cables and metallic pipelines. When equipped with an optional transmitting probe (Sonde), it can also detect non-metallic pipelines.



PCL30 Receiver and Transmitter

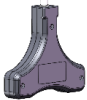


Optional accessories

Standard accessories

Item	Name	Pattern and Description	Quantity
1	Transmitter Direct Connect Output Cable		1
2	Ground Rod		2
3	Ground Extension Cable		1
4	Transmission Clamp		1
5	Positioning connector		1
6	Transmitter Accessory Output Cable	 Red 5-pin Plug	1
7	Gallium Nitride Fast Charger		1
8	Dual USB-C port charging cable		2

Optional accessories

Item	Name	Pattern and Description	Remarks
1	Receiver Accessory Output Cable	 Blue 5-pin Plug	
2	Depth Measurement Auxiliary Sensor		
3	Pipe locator stethoscope		

4	Transmission Probe		
5	Transmitter external power supply		
6	Fault-finding booster		
7	RTK position device		
8	A-frame locator		

- 1.Stethoscope: For cable identification in confined spaces.
- 2.Fault-finding booster and A-Frame: For locating certain cable faults and pipeline insulation breaches.
- 3.Positioning Module: Sub-meter or centimeter grade options available, for high-precision path recording and distance measurement.
- 4.Transmitter External Lithium Power Supply: Extends transmitter battery operating time.

1.2 Technical Specifications & Features

A. Transmitter Specifications:

- 1.**Output Methods:** Direct connection, clamp coupling, inductive coupling
- 2.**Output Frequencies:** 640Hz, 1280Hz, 8kHz, 33kHz, 82kHz, 197kHz
- 3.**Output Power:** Max 10W (10-level adjustable)
- 4.**Impedance Matching:** Fully automatic
- 5.**Protection:** Automatic overvoltage and overcurrent protection
- 6.**Display:** 320×240 dot matrix monochrome LCD

- 7.**Power Supply:** Built-in Li-ion battery (7.4V nominal, >6Ah)
- 8.**Auxiliary Power Input:** DC 7~15V, 2A
- 9.**Charger:** AC100-240V, 50/60Hz, Type-C PD Fast Charging
- 10.**Dimensions:** 280×220×90mm
- 11.**Weight:** 2.3kg
- 12.**Ingress Protection:** IP65 rated
- 13.**Operating Conditions:** -25°C to 60°C, <90% RH, <4500m altitude

B. Receiver Specifications:

- 1.**Detection Method:** Built-in Coil, Stethoscope, A-Frame
- 2.**Detection Modes:** Wide peak, narrow peak, valley, historical curve, spectrum analysis
- 3.**Active Frequencies:** 640Hz, 1280Hz, 8kHz, 33kHz, 82kHz, 197kHz
- 4.**Passive Detection:** AFB Full-Band Passive, Power Frequency (50/60Hz), Power Freq. Harmonics (2/5/9x), 5~15kHz, 15~25kHz, 25~40kHz
- 5.**Display:** Sunlight-readable color LCD
- 6.**Power Supply:** Built-in Li-ion battery (7.4V nominal, >3Ah capacity)
- 7.**Charger Input:** AC100-240V, 50/60Hz, Type-C PD Fast Charging
- 9.**Dimensions:** 680×120×277mm
- 10.**Weight:** 2.0kg
- 11.**Ingress Protection:** IP65 rated
- 12.**Operating Conditions:** -25°C to 60°C, <90% RH, <4500m altitude

1.3 Key Features

- 1.**Multi-Function Integration:** Path Tracing + Cable Identification + A-Frame Fault Pinpointing.
- 2.**Color Compass Display:** Visualize underground utilities clearly.
- 3.**Ultra-High Sensitivity:** 0.5Hz ultra-narrow bandwidth reception, highly resistant to interference.
- 4.**Current Direction (CD) Tracing:** Excludes interference from adjacent utilities.

- 5.**Enhanced Depth Measurement:** Real-time, accurate depth readings.
- 6.**Depth Assist Sensor (Optional):** Alerts to signal distortion affecting depth accuracy.
- 7.**Multiple Passive Detection Bands:** AFB Full-Band Passive, Power Frequency (50/60Hz), Radio Frequency bands.
- 8.**AFB Full-Band Passive:** Automatically analyzes signals across all bands; intelligent and convenient - no need to select bands.
- 9.**High-Performance Transmitter Clamp:** Couples signal onto energized cables.
- 10.**Unique Identification:** Uses a flexible clamp for convenient, highly reliable operation, with current measurement capability.
- 11.**Step Voltage Detection:** Locates insulation breaches on grounded pipes/cables.
- 12.**High-Power Digital Amplifier Transmitter:** Full automatic impedance matching and protection.
- 13.**Multiple Transmitter Output Modes:** Direct Connection, Inductive Clamping, Signal Induction.
- 14.**Fully Digital Transmit/Receive Processing:** Stable and reliable.
- 15.**Built-in High-Capacity Li-ion Battery Pack:** Automatic shutdown on low voltage or after prolonged inactivity.
- 16.**Transmitter Auxiliary Power Interface:** External power support for extended operation.
- 17.**IP65** High-Level Protection.
- 18.**Bluetooth Communication Module:** Exports recorded data to a host device.
- 19.**Type-C GaN Fast Charging.**

1.4 Application Scenarios

Industry Applications

The PCL-30 Pipe and Cable Locator is widely used across multiple industries, including:

Power Utilities – Locate underground power cables for maintenance and construction

Water & Sewer Systems – Detect and map water pipes and drainage networks

Gas Distribution – Identify buried gas pipelines for safety inspections and repairs

Construction & Civil Engineering – Survey underground utilities before excavation

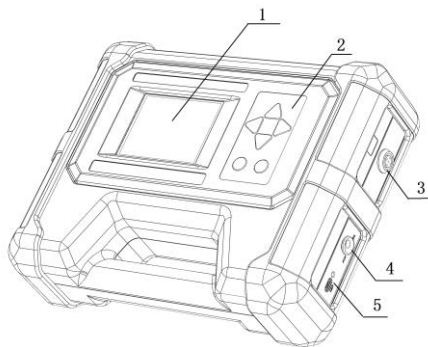
Key Use Cases

The PCL-20 provides reliable detection solutions for:

- ✓ Pre-Construction Surveys – Accurately map underground utilities to prevent accidental strikes
- ✓ Fault Detection & Maintenance – Quickly locate damaged or leaking pipelines
- ✓ Legacy Pipeline Mapping – Document aging infrastructure for renovation projects
- ✓ Routine Inspections – Verify pipeline conditions during periodic checks
- ✓ Post-Installation Verification – Confirm the position and depth of newly laid pipelines

2.Configuration

2.1 Transmitter button



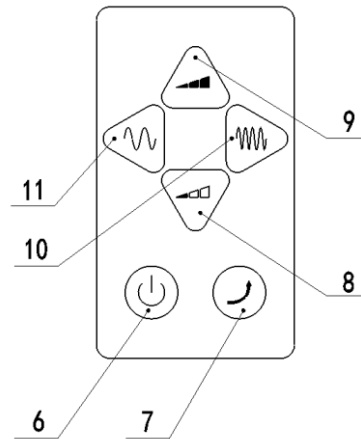
1.LCD Display

2. Keyboard

3.Output Socket

4. External Power Socket

5. Charging Socket



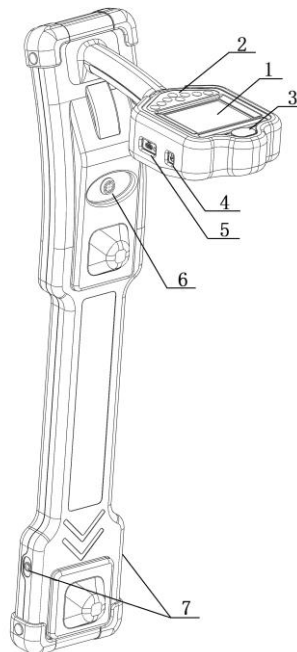
6.Power Key

7. Re-Match Key

8/9. Output Power Down/Up Keys

10/11. Frequency Down/Up Keys

2.2 Receiver button



1.LCD Display

3. GPS Antenna Socket (Optional)

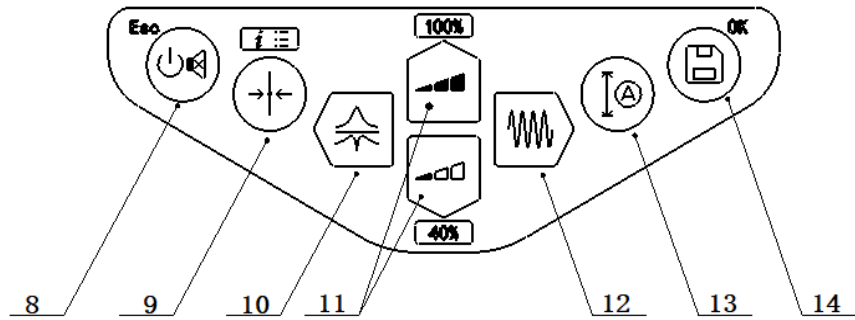
5. Charging Socket

7. Depth Assist Sensor Socket

2. Keypad

4. Headphone Socket (Optional)

6. Accessory Input Socket



8. Power/Mute Key

9. Calibrate Key

10. Mode Key

11. Gain +/- Keys

12. Frequency Key

13. Measure Key

14. Store Key

(Menu Cancel/Esc Key)

(Long Press: Menu Enter/Exit)

(Menu Left Key)

(Menu Up/Down Keys)

(Menu Right Key)

(Menu OK/Confirm Key)

2.3 Receiver Operation and Interface Instructions

1. Press and hold the power/mute key to turn on, press and hold the calibration key to enter the information and settings interface, the keyboard instructions and display example are shown in the figure below:

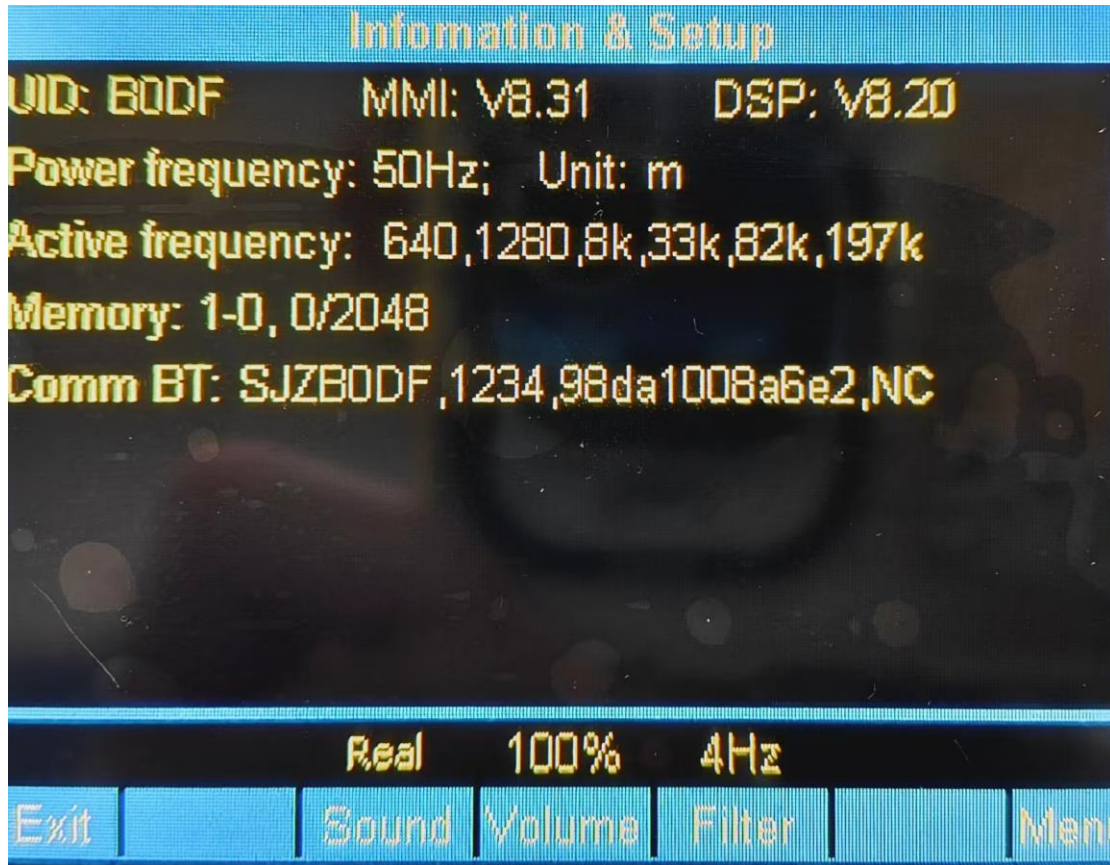


Information display

1. Press and hold the calibration key to enter Information display: information and settings, press the exit key to return to the operation interface.
2. The corresponding keyboard functions are prompted below the screen.
3. Sound options: simulated and real; volume adjustment range 10%-200%; bandwidth options: 0.5/1/2/4Hz.
4. The device's unique identifier UID is automatically generated and cannot be

modified.

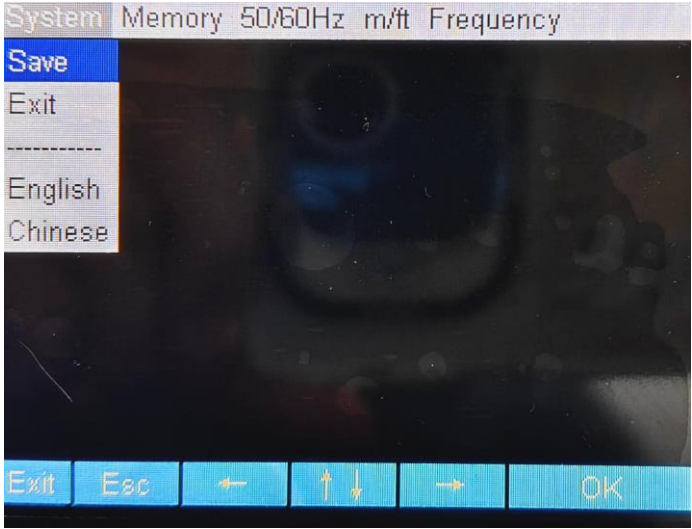
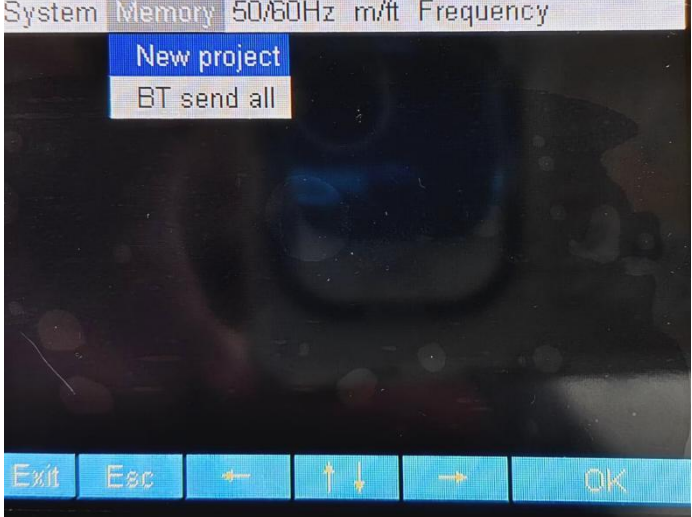
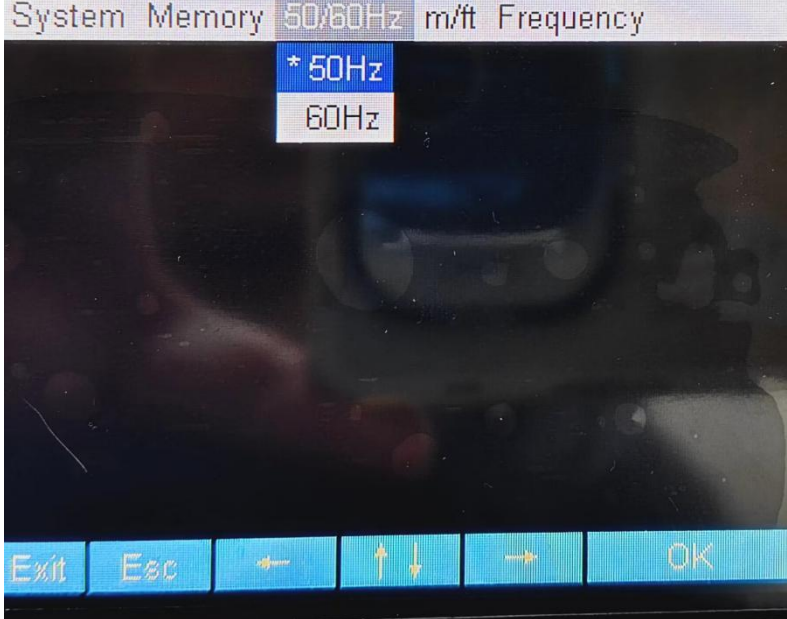
5. If storage/bluetooth and GNSS positioning functions are not selected, the corresponding information will not be displayed.
6. Power frequency, depth unit, and active detection frequency must be set by entering the menu.

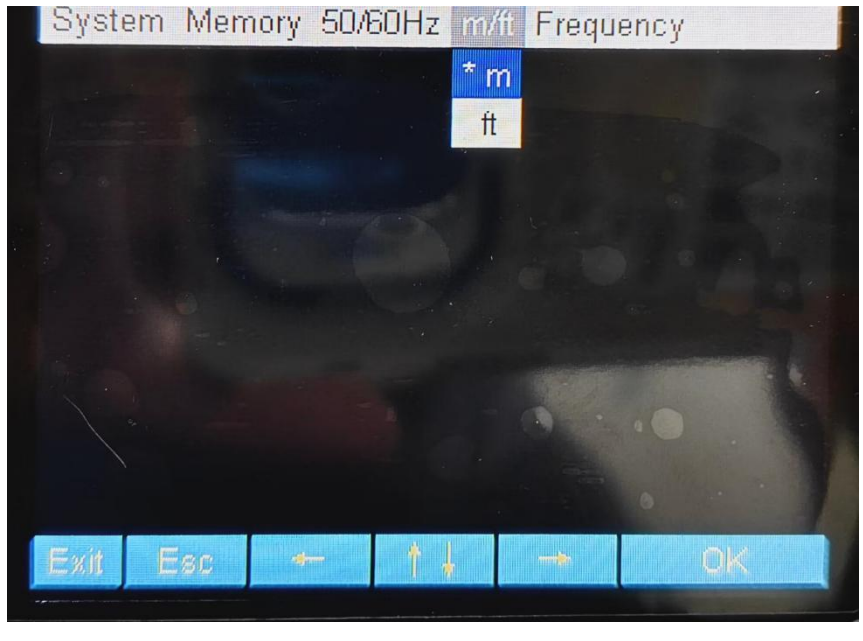
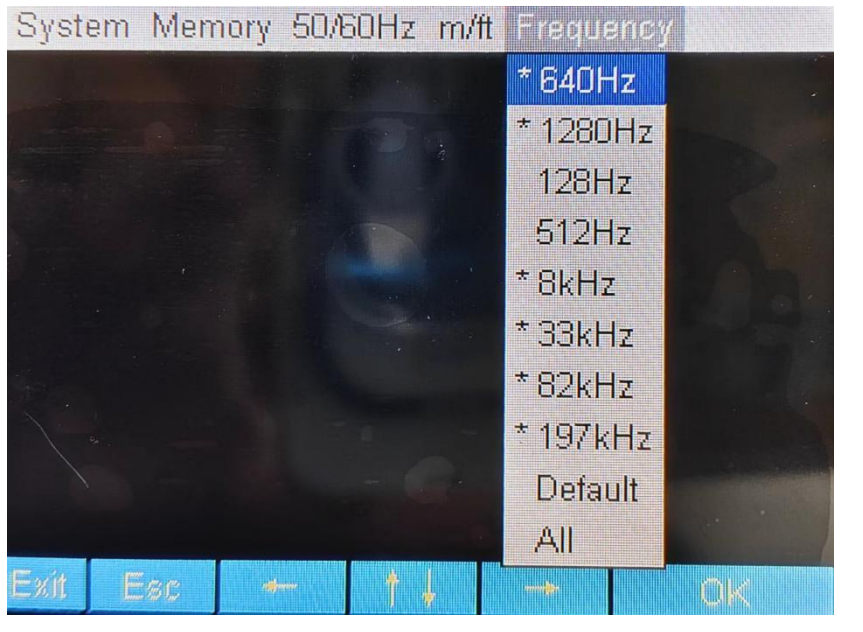


Menu

7. After entering the menu, B interface is displayed: menu.
8. Use ←↑↓→ key to select, confirm key to execute, cancel key to return to the upper menu, and exit key to return to A interface.
9. Detailed descriptions of menu items are on the next page.

Menu items:

1. System >Functions: Save Settings >Exit Menu Interface >Switch Between Chinese and English	 The screenshot shows the 'System' menu with options: Save, Exit, English, and Chinese. The background is a dark, blurry image of the device's camera view. At the bottom, there is a navigation bar with buttons: Exit, Esc, left arrow, up/down arrows, right arrow, and OK.
2.Storage Function: > Create New Project > Send All Stored Data via Bluetooth > Prompt	 The screenshot shows the 'Storage Function' menu with options: New project and BT send all. The background is a dark, blurry image of the device's camera view. At the bottom, there is a navigation bar with buttons: Exit, Esc, left arrow, up/down arrows, right arrow, and OK.
3. Power Frequency Selection: > Select 50 or 60Hz	 The screenshot shows the 'Power Frequency Selection' menu with options: * 50Hz and 60Hz. The background is a dark, blurry image of the device's camera view. At the bottom, there is a navigation bar with buttons: Exit, Esc, left arrow, up/down arrows, right arrow, and OK.

4. Depth Unit Selection: > Select Meters (m) or Feet (ft)	
5. Active Detection Frequency Enable: > Optional Active Frequency List > Restore Factory Default Frequencies > Enable All Frequencies	

Instructions:

1. Selection of power frequency, depth unit, and active detection frequency:
Menu items with an * in front are enabled, while those without an * are disabled.
Use the ↑↓ keys to select menu items, and the confirm key to toggle enable/disable.

2. Too many frequencies can complicate operation. It's recommended to enable only commonly used frequencies, enabling others as needed. 50Hz (or 60Hz) is used for power cables, 100Hz (or 120Hz) is used for pipelines with Impressed Current Cathodic Protection (ICCP).

3. If Bluetooth and storage functions are not selected, there will be no sub-menu displayed under the storage function main menu.
4. After completing the settings, you must enter the system main menu, choose save, and press the confirm key to execute the save.

2.General Methods for Emitting Signals

There are three methods by which a transmitter applies signals to pipelines: direct connection, clamp coupling, and radiation induction. This chapter provides a general introduction to these methods. For cable detection, special characteristics apply, which are specifically introduced in Chapter 3.

2.1 Direct Connection Method

The Direct Connection method involves connecting the Transmitter's output leads directly to the metallic utility to inject the signal. It is suitable for: Power cables, Communication cables, Metal water pipes, Metal gas pipes, Cathodic Protection (CP) test points or other access points, and any continuous metallic object with long-line characteristics.

Current from the Transmitter flows through the utility, enters the earth at its ground point(s), or leaks to earth via distributed capacitance between the utility and ground, and finally returns to the Transmitter. Current on the utility radiates an electromagnetic field, which the Receiver detects for utility location.

Compared to other methods, Direct Connection provides the highest injected current. Therefore, use this method whenever possible.

1. Direct Connection Output Cable Connection

Insert the 5-core red plug at one end of the direct connection output cable of the transmitter into the output socket of the transmitter.

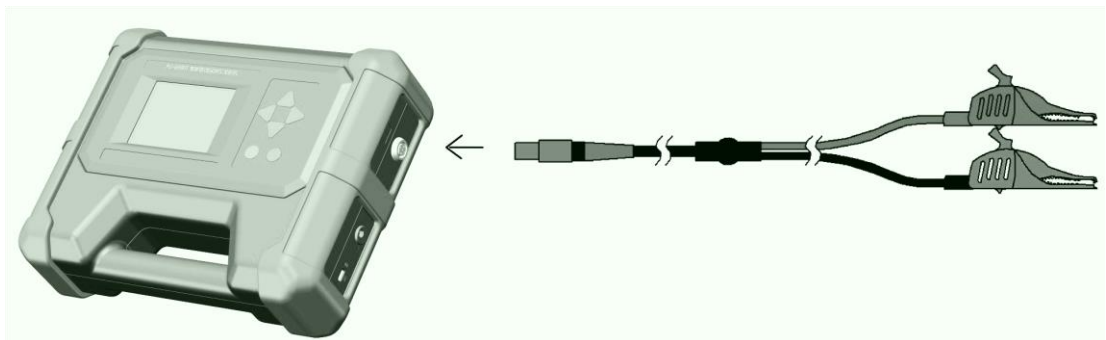


Figure 2-1-1 Direct connection accessory connection

2. Direct Connection Wiring

Connect the red alligator clip to the exposed metal part of the pipe (such as the cable core/valve, etc.), and connect the black alligator clip to the grounding rod driven into the earth (soil). If the grounding wire is not long enough, use an extension cable to connect.

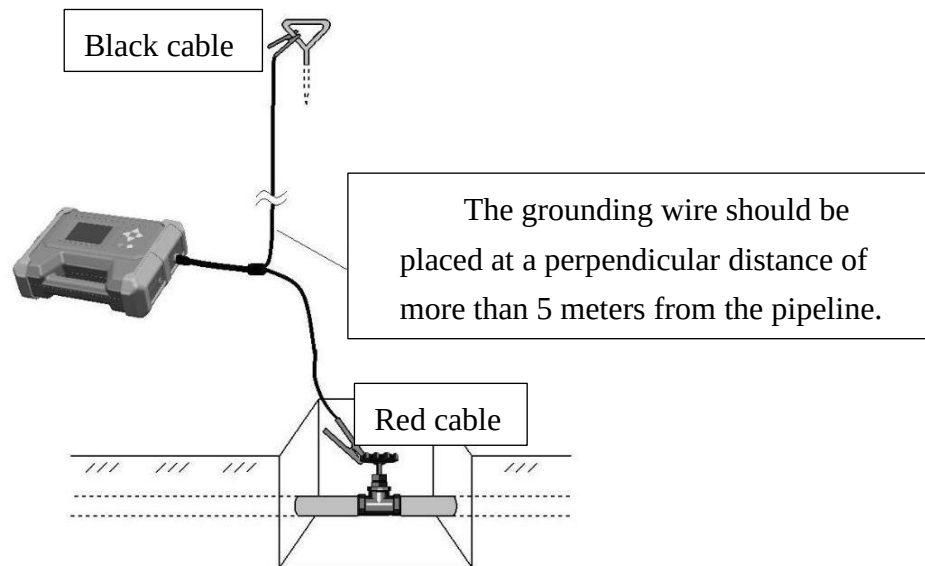


Figure 2-1-2 Direct connection wiring

Precautions:

Ground Stake Placement: For best results, place the ground stake more than 5m away from the target utility, and orient the black ground lead perpendicular to the utility direction if possible.

Do NOT connect the black ground clip to water pipes or other utilities, as this will couple signal onto them, interfering with the target utility detection.

There should be no other utilities between the ground stake and the target utility, otherwise signal may be induced onto them, causing interference. Check the area before driving the stake using passive detection.

Ensure Good Connection: If the utility connection point has insulating paint or severe corrosion, clean it first to ensure the red clip contacts bare metal directly.

Different utility segments or fittings may be insulated from each other. If insulated, you cannot use Direct Connection, or you must bridge the insulated sections electrically. **Check Method:** After confirming correct connections, turn on the Transmitter and observe the output current. If the current is too low for effective

detection, the utility may be isolated.

WARNING!

Transmitter max output voltage is 150Vpp. Do NOT touch the output clips or the target utility while operating!

3. Interface Introduction and Pipeline Voltage Detection

Long press the Power key to turn on the Transmitter. The Transmitter automatically detects connected accessories and operates in Direct Connect mode.

In Direct Connect mode, it first measures the utility's inherent voltage. The screen displays:

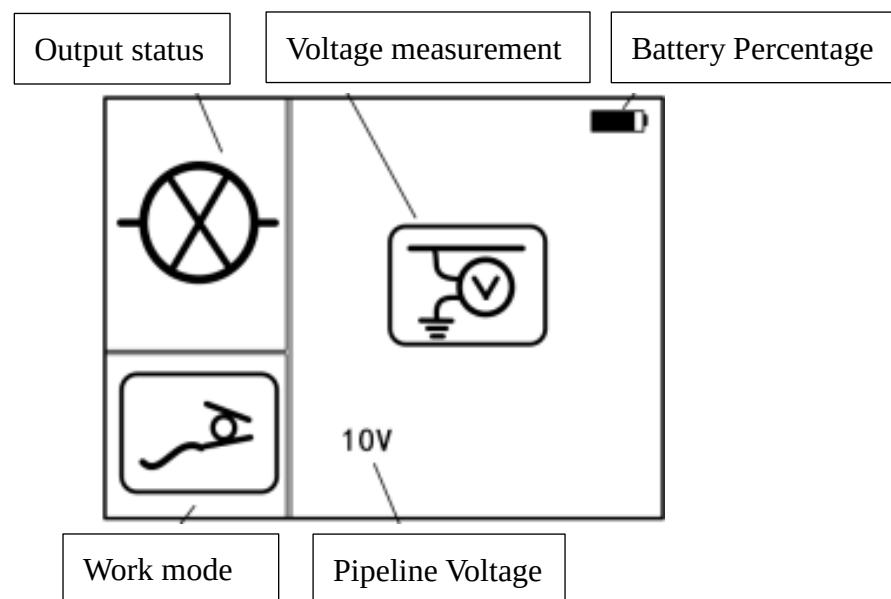


Figure 2-1-3 Pipeline voltage measurement interface

If the pipeline's own voltage exceeds the limit (50V), it will stay on the voltage detection interface and display a warning sign. No signal will be output to protect the instrument from damage, and the screen displays as follows:

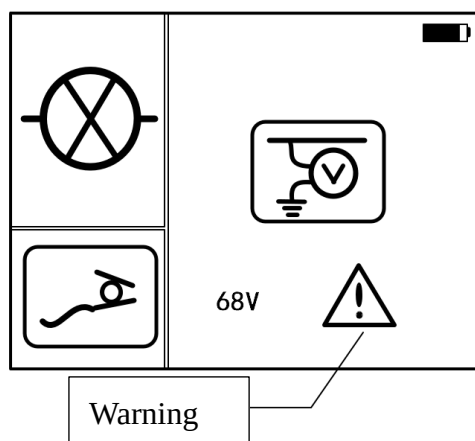


Figure 2-1-4 Pipeline voltage over-limit warning interface

If the voltage is normal, the signal will automatically output after a few seconds, and the screen displays as follows:

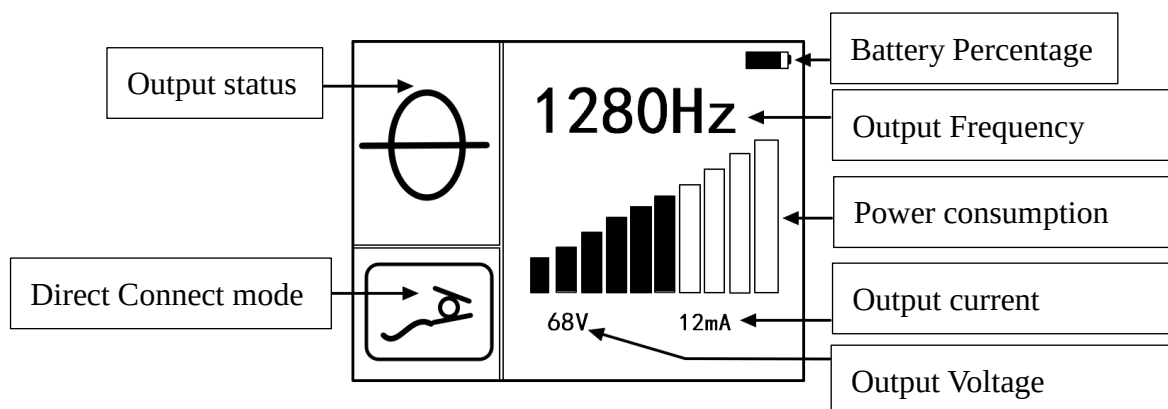


Figure 2-1-5 Direct connection output interface display

4. Frequency Selection

Press the Frequency Down or Frequency Up key to select the transmit frequency. Six frequencies are available: 640Hz, 1280Hz, 8kHz, 33kHz, 82kHz, 197kHz. Default at power-on is 1280Hz.

There is no strict rule for frequency choice. Select flexibly based on the following principles and actual reception results:

A.For utilities with good grounding (e.g., most cables/pipes), the default 1280Hz usually works well.

B.For long-distance utility tracing, choose lower frequencies (640Hz and 1280Hz). Low frequencies propagate farther and induce less onto other utilities. These are also CD frequencies, enabling the Receiver's Current Direction feature.

C.General utility tracing can use mid/high frequencies (e.g., 8kHz). Signal travels reasonably far and induces moderately onto other utilities.

D.For high-resistance utilities (e.g., floating cable conductors, coated pipes, cast iron pipes), use higher frequencies (33kHz, 82kHz, or 197kHz). High frequencies radiate better but travel shorter distances and induce more easily onto other utilities.

E.Prefer lower frequencies when they work adequately.

5. Output Power Adjustment

Press the Output Down or Output Up key to adjust the output level (signal strength), in 10 steps. Output voltage and current are displayed at the bottom right of the screen.

Adjust output level as needed:

A.Higher current aids stable tracing and accurate depth measurement.

B.At higher frequencies (8kHz and above) and very shallow depths (<1m), high output current may cause receiver saturation/distortion, leading to non-linear response and increased depth error. Reduce output level appropriately in this case.

C.Lowering output power helps extend battery life, but this should not be the primary consideration.

2.2 Clamp Coupling Method

The Inductive Clamping method is suitable when the utility is accessible but its metal cannot (or must not) be touched, and both ends of the utility are grounded (especially for power cables).

The circuit model for inductive clamping is equivalent to a transformer: The clamp's core acts as the transformer core, the clamp's internal winding is the primary, and the utility-earth loop acts as a single-turn secondary. The Transmitter drives primary current, inducing a secondary current in the utility-earth loop. The induced current magnitude is closely related to the loop resistance (mainly the ground resistance at both ends). Lower resistance yields higher current; higher resistance yields lower current. If resistance is too high, effective detection is impossible.

Advantages: Convenient to use, no electrical contact required with the utility, does not affect utility operation, reduces induction onto other utilities.

Disadvantages: Induced current is less than Direct Connection; requires both ends of the utility to be well grounded, which some utilities may not satisfy.

1. Connect Clamp

Insert one end of the Transmitter Accessory Output Cable (Red 5-pin plugs) into the Transmitter Clamp socket. Insert the other end into the Transmitter's Output Socket.

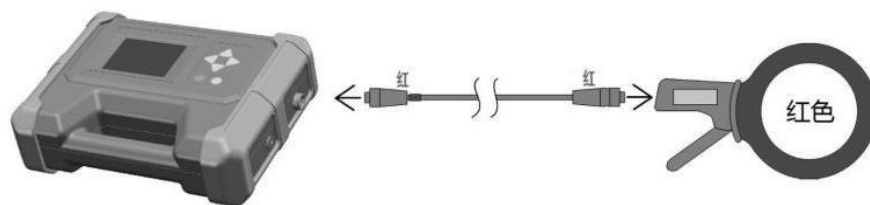


Figure 2-2-1 Accessory Connection for Clamp Method

2. Clamp onto Utility

Clamp around the exposed section of the utility, as shown below:

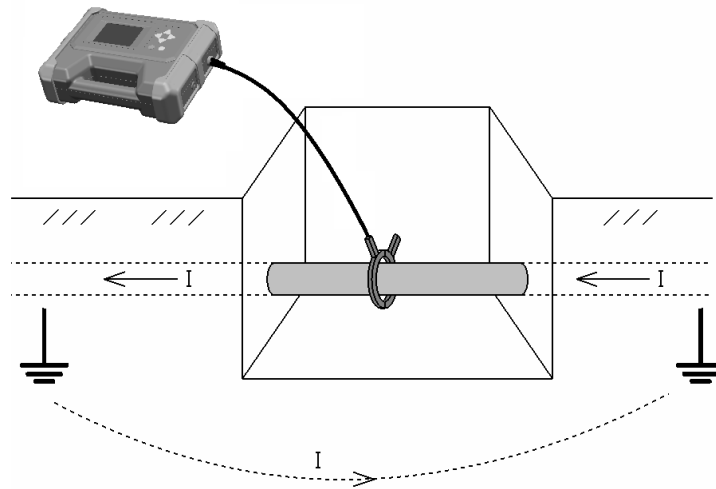


Figure 2-2-2 Clamp Coupling Method

Precautions:

- A.**Both ends of the utility must be grounded for signal to be induced. Grounding can be continuous (e.g., uninsulated pipe) or at both ends (e.g., HV power cable armor grounded at both ends).
- B.**Different utility segments or fittings may be insulated. If insulated, you must bridge the insulated sections electrically, otherwise inductive clamping won't work.
- C.**Whether current is effectively induced onto the utility can only be judged by the Receiver's detection results. If detection is poor, use another signal application method.
- D.**When clamping, ensure the clamp jaws are fully closed and free of debris or rust.

3. Interface Introduction

With the Transmitter powered on, it automatically detects the clamp and operates in Clamp mode. Screen display:

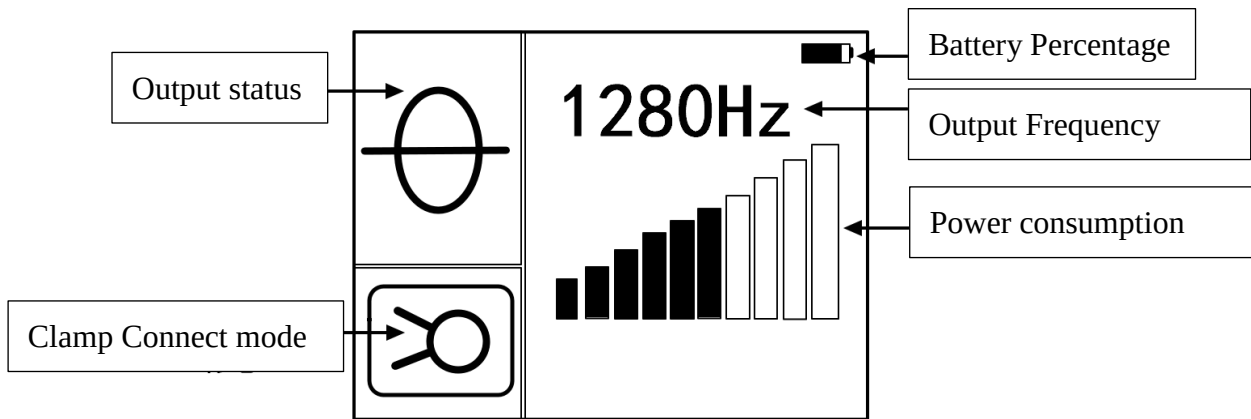


Figure 2-2-3 Caliper coupling output interface display

4. Frequency Selection

Press the Frequency Down or Frequency Up key to select the transmit frequency.

Five frequencies available: 640Hz, 1280Hz, 8kHz, 33kHz, 82kHz. Default at power-on is 1280 Hz.

Frequency selection principles are the same as for Direct Connection.

5. Output Power Adjustment

Press the Output Down or Output Up key to adjust output level, in 10 steps.

Current induced onto the utility via clamping is much lower than via Direct Connection. Use maximum output level whenever possible.

Inductive Clamping mode cannot display the voltage or current induced onto the utility.

2.3 Signal Induction Method

Use the Signal Induction method when there is no access point to the utility, or when surveying an area before excavation to check for underground utilities.

The Transmitter uses its built-in antenna coil to radiate a high-frequency

electromagnetic field (primary field). The metallic utility-earth loop couples this field, inducing a current (secondary current). This current radiates its own field (secondary field), which the Receiver detects for utility location.

Advantages: Easy to use, no leads, no electrical contact with the utility. Ideal for inaccessible utilities and area surveys. **Disadvantages:** Induced current is less than Direct Connection or Clamping. Suitable for shallow utilities; effectiveness decreases with depth. All utilities under the Transmitter within a certain range will have signal induced; cannot target a specific utility.

1. Placement of the Transmitter

For Signal Induction, the Transmitter needs no accessories attached. It automatically detects "Induction" mode.

For utility tracing: Place the Transmitter vertically on the ground above the estimated utility path, perpendicular to the estimated direction. Work with the Receiver, adjusting position/orientation based on the actual detected path, as shown.

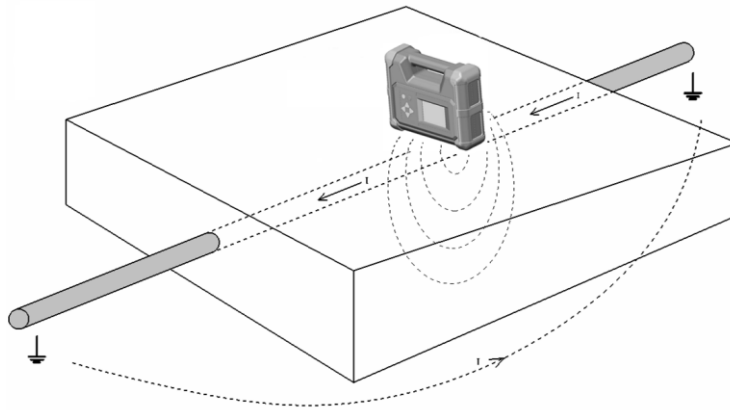


Figure 2-3-1 Signal Induction Method

For area survey: In the area to be surveyed, two operators are needed. The Transmitter and Receiver operate in sync, spaced apart, both perpendicular to the utility path (see P28: Induction Survey). Move parallel to each other.

Precautions:

A.Both ends of the utility must be grounded for signal to be induced. Grounding can be continuous (e.g., uncoated metal pipe) or at both ends (e.g., HV power cable armor grounded at both ends).

B.Utilities that are well-insulated and ungrounded at both ends cannot use induction (e.g., some LV cables with no armor, or ungrounded armor).

C.Do NOT place the Transmitter on metal manhole covers or on reinforced concrete slabs, as the signal will be blocked/shorted and not coupled to utilities below.

D.The Transmitter radiates signal into the surrounding space, causing interference for the Receiver. When using induction, the Receiver and Transmitter must be separated by a certain distance (Tx-Rx separation).

2. Interface Introduction

With the Transmitter powered on and no accessories attached, it automatically operates in Induction mode. Screen display:



Figure 2-3-2 Clamp Coupling Output Interface Display

3. Frequency Selection

Press the Frequency Down or Frequency Up key to select the transmit frequency.

Three induction frequencies available: 33kHz, 82kHz, 197kHz. Default is 33kHz.

Precautions:

A.Lower frequencies induce less effectively but propagate farther and cause

less interference.

B.Higher frequencies induce better than lower frequencies but propagate shorter distances and induce more easily onto other utilities.

C.Use high frequencies for high-resistance utilities; low frequencies will induce little usable signal.

4 Power Adjustment

Press the Output Down or Output Up key to adjust output level, in 10 steps.

Precautions:

A.Using lower output levels helps reduce induction onto other utilities and shortens the required Tx-Rx separation.

B.Increase output level for deeper utilities.

C.The Transmitter cannot measure or display the current induced on the utility. Choose settings based on Receiver results through trial and error.

3.Signal Transmission Methods for Cable Detection

Cable path tracing and unique identification are crucial in metallic utility detection. Compared to the simple continuous metal structure of pipes, cables consist of multiple conductors and metallic armor/sheath. Structural and functional differences lead to variations in signal application methods during detection. Different connection methods produce different electromagnetic fields, affecting detection results. Therefore, this chapter separately describes signal transmission methods for cable detection.

3.1 Signal Transmission Methods for De-energized Cables

1. Basic Connection Method:

Conductor-to-Earth The Conductor-to-Earth connection is the optimal wiring method for path tracing and identification of de-energized (offline) cables. It maximizes instrument functionality and minimizes interference, as shown below:

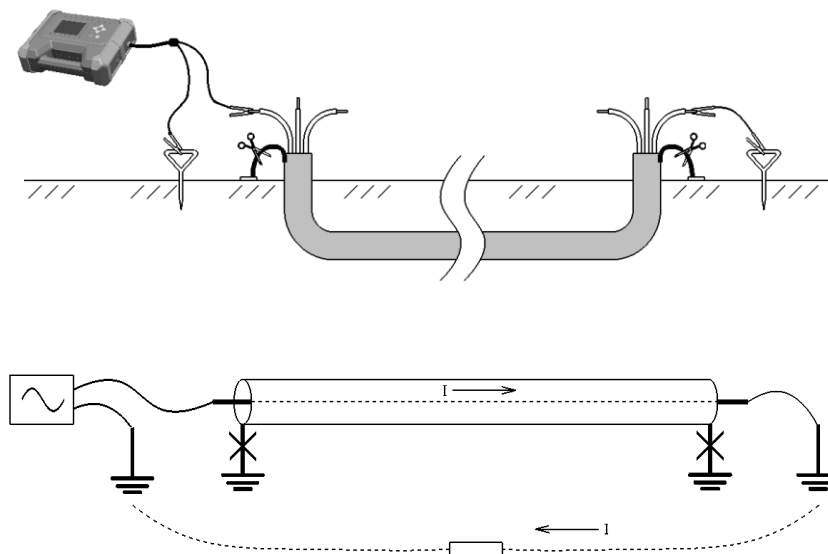


Fig 3-1-1 Conductor-to-Earth Wiring Method

Disconnect the cable's metallic sheath grounding wires at both ends. For LV cables, also disconnect Neutral and Earth Ground (EG) connections. Connect the Transmitter's red clip to one sound conductor. Connect the black clip to a ground stake driven into the earth. At the far end of the cable, connect the corresponding conductor to a ground stake driven into the earth.

Note: Use ground stakes whenever possible, NOT directly to an earth grid!
At least at the cable's far end, a ground stake is essential and should be placed away from the earth grid. Otherwise, signal return currents may flow through other cable grounds, affecting detection.

Current flows from the Transmitter, through the conductor, enters the earth at the far end, and returns to the Transmitter via the earth at the near end. This method provides strong, well-defined signals detectable at the surface and fully utilizes the instrument's Current Direction (CD) feature. Signal flows on the well-insulated conductor, minimizing flow onto adjacent utilities, especially crossing metal pipes, making it ideal for path tracing in complex environments. Additionally, the cable is grounded, keeping the signal voltage low, reducing capacitive coupling to adjacent utilities.

Signal attenuates over distance due to conductor-to-earth capacitance. However, with good grounding, capacitance current is small and often negligible.

The drawback is the need to disconnect grounds at both ends, which can be slightly cumbersome.

2. Sheath-to-Earth Method:

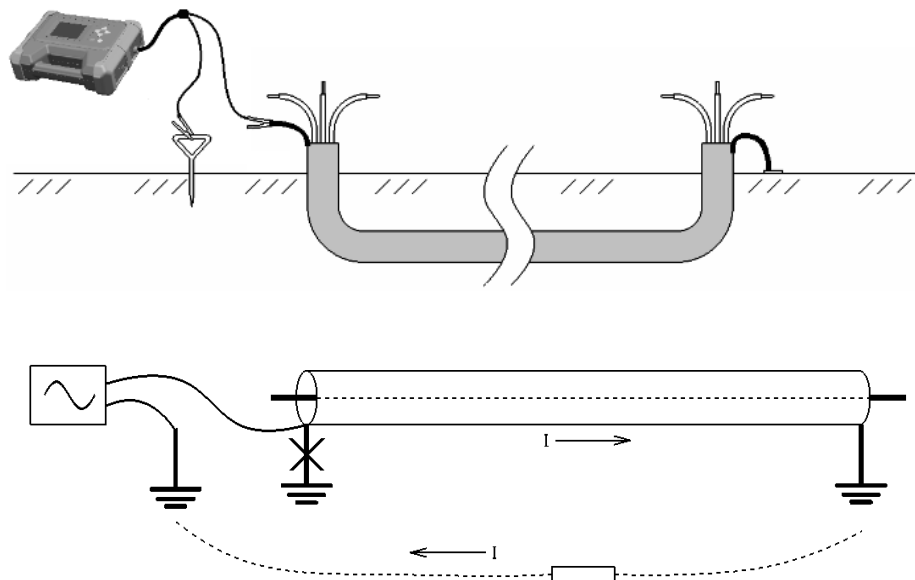


Figure 3-1-2 Sheath - Earth Connection Method

As shown above, disconnect the sheath ground at the near end. For LV cables, also disconnect Neutral and EG grounds. Keep the sheath grounded at the far end. Apply signal between the sheath and a ground stake (**do NOT use earth grid**). Keep cable conductors floating. Current flows from Transmitter through the sheath, enters earth at the far end, and returns to the Transmitter near end. This method lacks shielding, producing the strongest possible signal at the surface with clear characteristics. Signal also attenuates from near to far due to sheath-earth capacitance.

Potential Issue: If the outer jacket insulation is breached, some current will leak to earth at the breach point, causing a sudden drop in current beyond that point. The drop magnitude depends on the breach's ground resistance.

3. Conductor-to-Sheath Method:

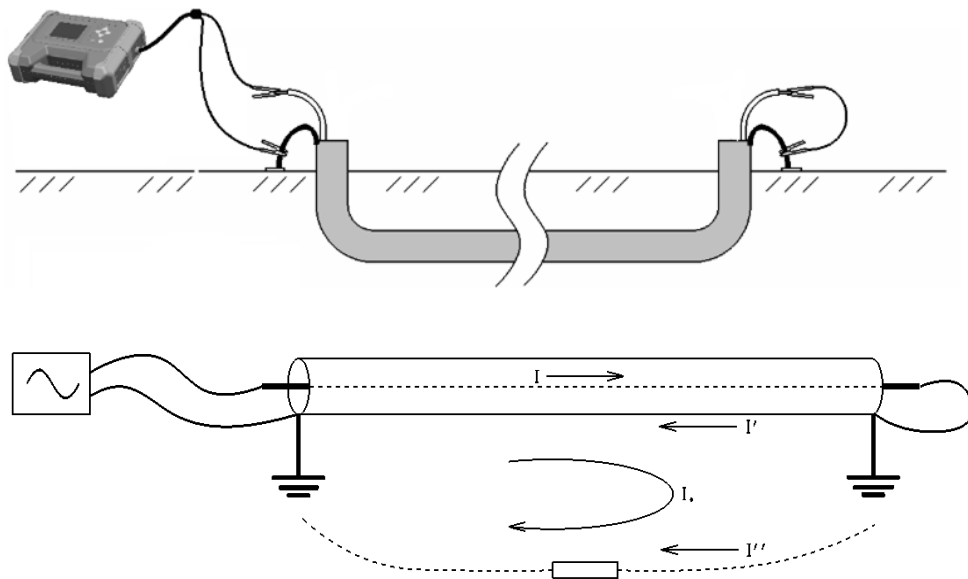


Figure 3-1-3 Conductor-to-Sheath Wiring Method

As shown above, apply signal between one cable conductor and the sheath. Short the conductor and sheath together at the far end. Keep the sheath grounded at both ends.

[Image Placeholder: Fig 3-1-4 Parallel Cable Effect] If it's a single cable, current flows from Transmitter through the conductor, returning via the sheath and earth paths. The sheath (armor & screen) has very low resistance. The earth path

has higher resistance due to end ground resistance and soil resistivity. Thus, most current returns via the sheath; a small portion returns via earth. Since conductor and sheath currents are opposite, the effective magnetic field current at a distance is their difference, equal to the earth return (resistive) current. Mutual inductance between conductor-sheath and sheath-earth loops also induces current in the sheath-earth loop. The net effective current is the vector sum of the earth resistive current and induced current (with phase difference). Depending on site conditions, effective current might be a few percent to over ten percent of injected current.

If other cables are installed in parallel (same path, same end points), return current is shunted by their sheaths. E.g., for three parallel cables, each sheath carries $\sim 1/3$. Effective current on target cable is forward, $\sim 2/3$ of injected value; adjacent cables carry reverse current, $\sim 1/3$. See right figure.

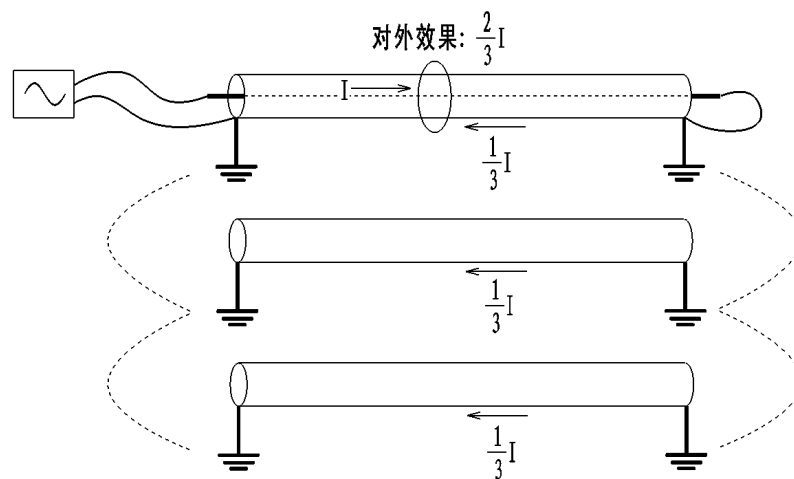


Figure 3-1-4 Parallel Cable Shunt Effect

Advantages: Simple wiring, no need to disconnect grounds. Disadvantages: When multiple cables share the same path, signals are similar, making distinction by amplitude difficult. For a single cable, effective current is much reduced, signal is weaker, and contains an inductive component. Target and adjacent utility induced signals may be in-phase, potentially preventing CD discrimination.

4. Phase-to-phase connection method:

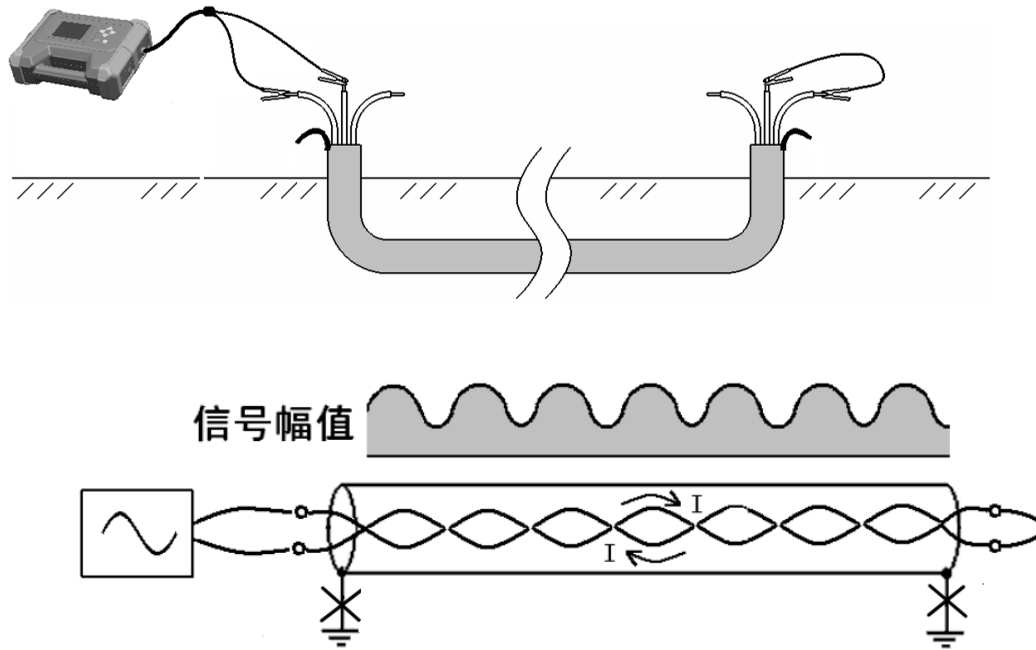


Figure 3-1-5 Phase-to-phase connection method

As shown above, apply signal between two cable conductors. Short the two conductors together at the far end. The two conductors are twisted within the cable, carrying equal but opposite currents. Though close, they are slightly apart. The distance from each conductor to the receiver coil differs minutely. Their generated magnetic fields oppose each other but, due to distance difference, don't cancel perfectly. A small residual field remains. Metallic sheath shielding further weakens this residual signal. Due to twisting, the signal exhibits periodic amplitude and direction changes along the cable path.

Within one twist length, the net radiated magnetic flux cancels out (360° rotation), so no current is induced in the sheath-earth loop.

The effective signal is very small. High frequencies are easier to detect than low frequencies. The CD feature cannot be used with this method.

5. Transmit Frequency Selection:

A.For general cable detection, unless using Phase-to-Phase, use the default 1280Hz. It's lower frequency, travels farther, induces less onto adjacent utilities. The Receiver also performs better at 1280Hz than 640Hz, offering stronger anti-interference and easier distinction.

B.For long cables (>3km), 1280Hz may attenuate significantly at long distances, becoming hard to receive, and phase may shift. Use 640Hz for long cable tracing.

C.640Hz and 1280Hz are CD frequencies enabling the Receiver's Current Direction feature.

D.When using Phase-to-Phase, prioritize higher frequencies (8kHz, 33kHz, 82kHz, or 197kHz).

3.2 Signal transmission methods for energized cables

1. Inductive Clamping Method

This is an ideal method for tracing energized cables. It requires no direct cable modifications, keeps operators away from high voltage, is very safe, and provides signal along the entire cable length.

The cable's outer sheath must be well-grounded at both ends. Otherwise, coupled current decreases as ground resistance increases.

If ends are ungrounded, or the sheath is open-circuited midway, inductive clamping will not work.

(1) Clamp onto Cable Body

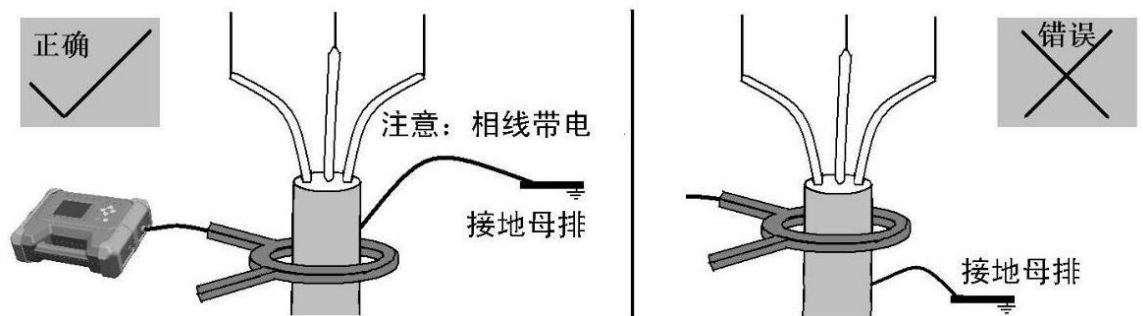


Figure 3-2-1 Operating Cable Clamp Coupling Method 1 (Clamp Cable Body)

As shown, suitable for 3-core belted energized cables. Connect Transmitter output clamp. Clamp around the cable body (do not clamp above the ground lug). The clamp acts as the transformer primary; the cable metallic sheath-earth loop is the single-turn secondary. Secondary current magnitude depends on loop resistance (mainly end ground resistances). Lower resistance yields higher current.

Current coupled via clamping is relatively low. Use maximum transmitter output power for best results.

(2) Clamp the cable sheath ground wire

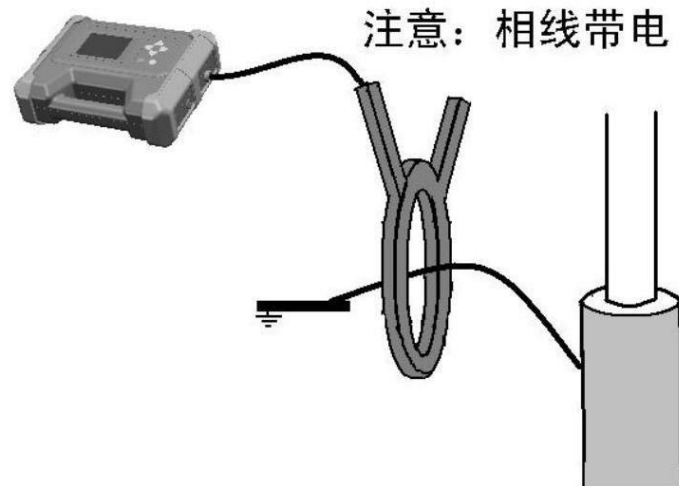


Figure 3-2-2 Operating Cable Clamp Coupling Method 2 (Clamp Cable Ground Wire)

As shown, suitable for EHV single-core energized cables. The strong phase current in single-core cables, without the phase cancellation effect of 3-core cables (resulting in small net zero-sequence current externally), easily saturates the clamp if clamped on the cable body. Clamp onto its sheath ground wire instead.

Long EHV single-core cables often have sheath cross-bonding points. Signal flows from one phase's sheath to another at these points – be aware during tracing.

For 3-core cables, clamping the ground wire is an option if clamping the body is difficult, but avoid it if possible. Signal characteristics (amplitude/phase) may change unpredictably in some cases.

2. Neutral / Earth Ground (EG) / Sheath Injection Method:

This method traces energized LV cables where the sheath is often ungrounded, discontinuous, or poorly grounded, preventing inductive clamping.

It requires no cable modifications. The injected high-frequency signal doesn't affect normal cable operation.

At the user end, connect the Transmitter's red clip to Neutral, EG, or Sheath. Connect the black clip to a ground stake, as shown:

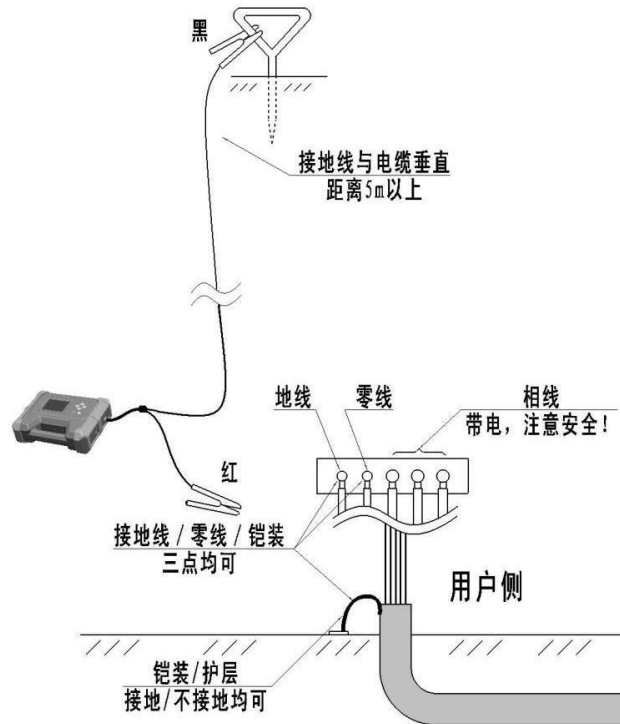


Fig 3-2-3 Energized Cable Neutral/EG/Sheath Injection

Precautions:

A.SAFETY WARNING: Cable is energized. Connections must be made by qualified electrical personnel!

B.Inject signal at the USER END. Injecting at the substation end couples signal onto all outgoing cables, making target identification impossible.

C.Ground Stake Placement: Place the stake >5m from the cable path. Orient the ground lead perpendicular to the cable if possible.

D.If Neutral is ungrounded at the user end, prioritize Neutral injection.

E.LV cable sheaths are often discontinuous. If sheath injection provides weak signal or signal drops out mid-path, try Neutral/EG injection.

F.Since all outgoing Neutral/EG/Sheath wires are paralleled at the substation, other cables will have some shunted current, also detectable but weaker. Distinguish carefully during testing.

G.For HV cables: If clamping yields no signal or weak signal, sheath ground resistance is likely too high. Try Direct Connection sheath injection.

H.For EHV single-core cables where clamping fails, use sheath injection.

4: Active Detection

Active (powered) detection requires applying a signal to the target pipeline according to the methods described in Chapters 2 and 3, selecting the appropriate technique.

4.1 Path Detection

1. Receiver operation interface:

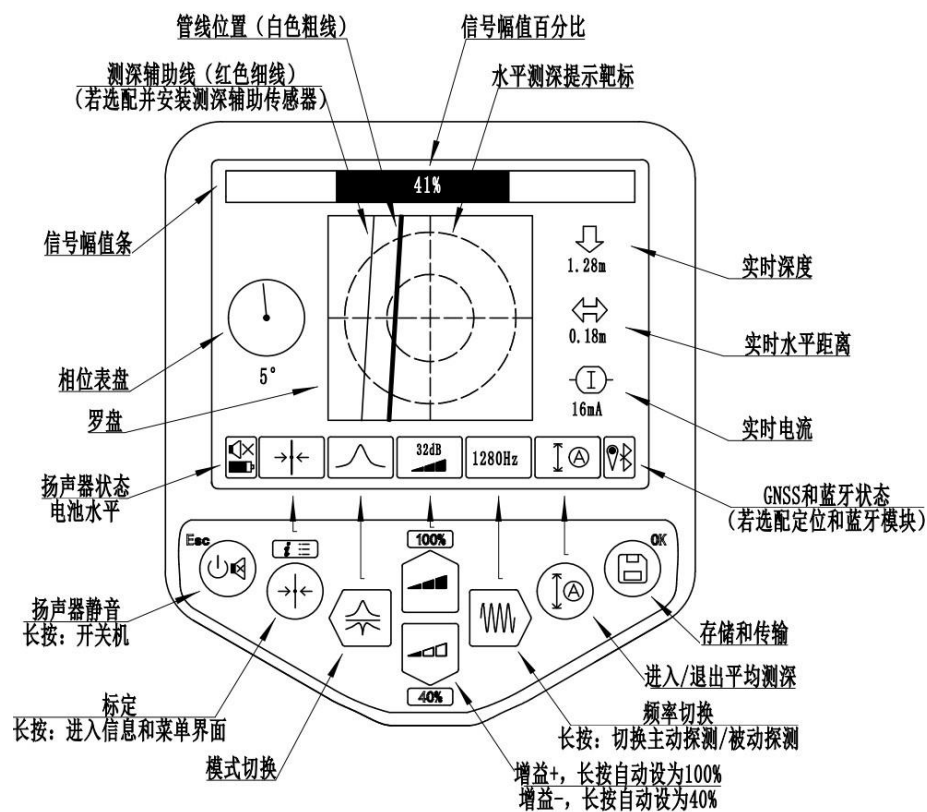


Figure 4-1-2 Example of the active detection receiver interface

2. Set the reception frequency:

Press the Frequency key to switch the receive frequency. Note: The transmit and receive frequencies must match.

Available frequencies:

Composite Frequencies: 640Hz, 1280Hz. Enable mis-tracking prevention

prompts.

Single Frequencies: 8kHz, 33kHz, 82kHz, 197kHz.

If a required frequency cannot be set, long-press the Calibration key to enter the Information and Settings interface. Navigate to the menu to enable the required frequency. Refer to Section 1.6: Receiver Information and Menu Settings for details.

Note: Long-pressing the Frequency key toggles between active and passive frequencies.

3. Select Mode:

Press the Mode key to select from five response modes: Wide Peak, Narrow Peak, Null, Peak/Null Scan, and History Curve.

Wide Peak Mode: Represents the signal response of the lower horizontal coil. The strongest signal is directly above the pipeline. Advantages: High sensitivity, large response range. Disadvantages: Slow response curve change, less effective for distinguishing parallel pipelines.



Wide Peak Mode

Narrow Peak Mode: Represents the differential signal response of the lower and upper horizontal coils. Similar to Wide Peak. Advantages: Steeper response curve, better for distinguishing parallel pipelines. Disadvantages: Reduced sensitivity.



Narrow Peak Mode

Null Mode: Represents the signal response of the vertical coil. The weakest signal is directly above the pipeline, with rapid signal change on either side. Advantages: Conducive to precise positioning of the target

pipeline. Disadvantages: Susceptible to interference, may provide false responses under strong interference.



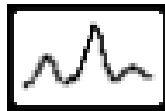
Null Mode

Peak/Null Scan Mode: Records the amplitude response signals of the lower horizontal coil and vertical coil. Determines if the peak and null positions coincide to verify pipeline positioning accuracy.



Peak/Null Scan Mode

History Curve Mode: Records the historical amplitude response curves of the lower horizontal coil and vertical coil. Can be used for passive detection judgment of multiple pipelines; for determining pipeline positioning accuracy by checking peak/null coincidence; or for locating phase-to-phase short-circuit faults in cables.



History Curve Mode

The response characteristics for different modes are shown below:

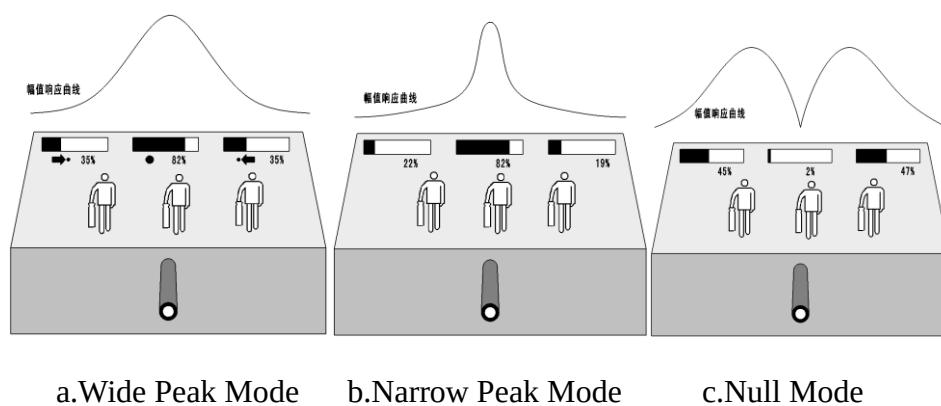


Figure 4-1-4: Signal Response in Different Modes

4. Gain Adjustment:

Short press the Gain +/- keys to adjust gain. The gain value in dB is displayed directly below the screen.

Long press the Gain+ key: Automatic gain adjustment sets the current signal amplitude to 100%.

Long press the Gain- key: Automatic gain adjustment sets the current signal amplitude to 40%.

5. Pipeline Tracking Based on Signal Amplitude and Sound (Traditional Method):

Start detection near the transmitter, ensuring you are outside its interference range:

A.For Clamp and Inductive coupling methods, the transmitter causes interference at close range. The interference distance depends on output power and frequency (higher power/frequency = stronger interference).

B.The minimum distance between receiver and transmitter often needs testing, but generally >5m for Clamp and >20m for Induction is interference-free.

Using Peak mode (Wide or Narrow), find the point with the strongest signal and start tracking the pipeline from there. Swing the receiver left and right; the signal amplitude will vary according to the pattern shown in Figure 4-1-4. Track the peak position (strongest signal in Peak mode) or the null position (weakest signal in Null mode) until the entire pipeline path is found.

Using Null mode can increase tracking speed, as the signal is weakest directly above and strengthens rapidly on either side. Since Null mode is susceptible to interference, periodically switch back to Peak mode to verify the correct pipeline position.

The receiver speaker's sound output reflects the current signal strength in real-time, aiding pipeline tracking. However, this feature primarily serves users

accustomed to traditional path tracers. Using the compass function enables faster, more intuitive tracking, so the speaker is muted by default at startup.

If needed, short press the Power/Mute key to toggle the speaker on or off.

6. Compass-Guided Fast Tracking (New Method)

When the receiver approaches the area above the pipeline, the compass in the center of the screen visually displays the pipeline's position relative to the receiver, enabling fast tracking.

Observe the position and angle of the line representing the pipeline in the compass. Adjust the receiver's position accordingly. When this line is vertical and centered in the compass, the receiver is directly above the pipeline.

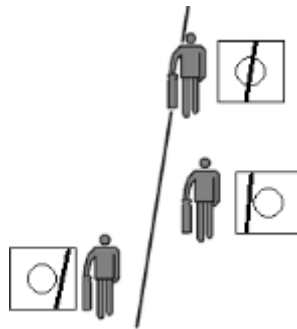


Figure 4-1-5: Compass Illustration

Note:

If adjacent pipelines also have strong signals and the receiver is near them, the compass may display the adjacent pipeline, not the target one. Pay attention to distinguish.

If adjacent pipeline interference is strong, the target pipeline is very deep, or the target current is weak, the compass indication may deviate. For precise positioning, refer to Section 4.1.9: Precise Positioning.

7. Mis-Tracking Prevention (Tracking Validity Prompt)

Adjacent pipeline signals are usually weaker than the target pipeline. However, the receiver's response also depends on depth. The target might be deep while an adjacent pipeline is shallow, making their signal amplitudes at the surface similar and hard to distinguish. Sometimes, adjacent pipeline current can be similar to the

target's, making identification even harder.

Measuring current phase enables tracking validity prompts and mis-tracking prevention.

When using the tracking validity prompt, the receiver measures the current phase in real-time and compares it to a reference phase. The process of recording the reference phase is called calibration. Calibration data is retained after power-off.

Note: To use the tracking validity prompt, you must operate at 640Hz or 1280Hz frequencies. The phase dial is not displayed at other frequencies.

At a location near the transmitter but outside its interference range (e.g., 5-10m), clearly identify the target pipeline's position. Stand directly above it, facing away from the transmitter and towards the pipeline's end. Short press the Calibration key . The area directly above the calibration key turns orange and displays a question mark "?", asking if you want to perform a phase-zero calibration. Pressing any other key cancels the operation. Press the Calibration key again; "OK!" is displayed, indicating calibration is complete. The current phase is now zero: the phase dial pointer points straight up, and the angle below the dial shows 0°. All subsequent phase measurements use this as the reference.

When probing or identifying another pipeline, you must recalibrate specifically for that target pipeline.

While tracking the pipeline, observe the phase dial. If the pointer is generally pointing upwards and the dial background is green, you are above the target pipeline. If it points generally downwards and the background turns orange, you may be tracking an adjacent pipeline, as shown in the figure on the right:

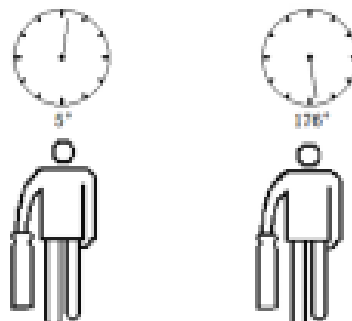


Figure 4-1-6: Target pipeline Adjacent pipelines

The signal amplitude of the adjacent pipeline might be smaller or larger, and it might also have a compass indication.

For very long pipelines, phase deviation gradually increases due to distributed capacitance. When it affects judgment (e.g., $>45^\circ$), you can recalibrate by standing directly above the target pipeline (where you are certain). The phase pointer will return to straight up.

The mis-tracking prevention process is illustrated below:

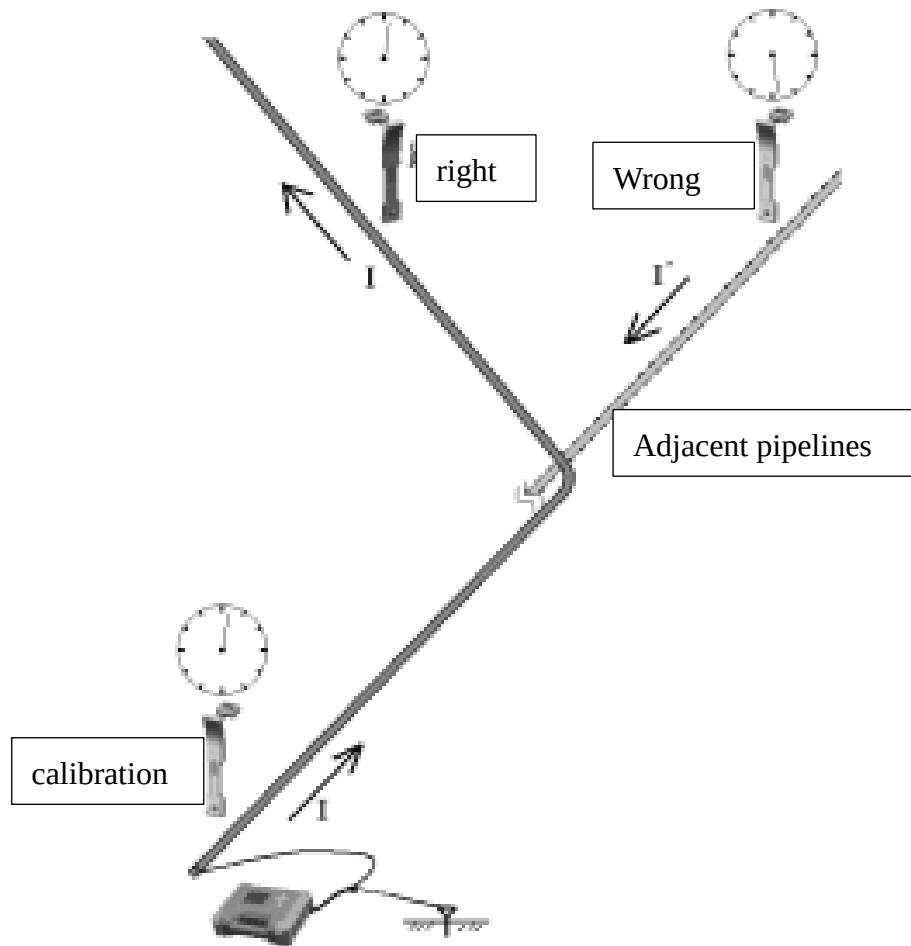


Figure 4-1-7: Mis-Tracking Prevention Process Illustration

8.Radiation Detection

Radiation method surveying requires the transmitter to be in Radiation Induction mode and two operators. Before surveying, determine the area to be searched and the possible directions pipelines might traverse through it. Set the transmitter to Radiation mode and ensure the transmitter and receiver frequencies match. One operator handles the transmitter, the other the receiver. Both units should be perpendicular to the pipeline direction. Operators move parallel to each other, perpendicular to the suspected pipeline direction, maintaining a distance of

about 20m between them. When the transmitter passes over a pipeline, the signal is induced onto it, and the receiver simultaneously detects the signal. Observe the receiver response; a peak response indicates a pipeline location. Mark these points on the ground, as shown below:

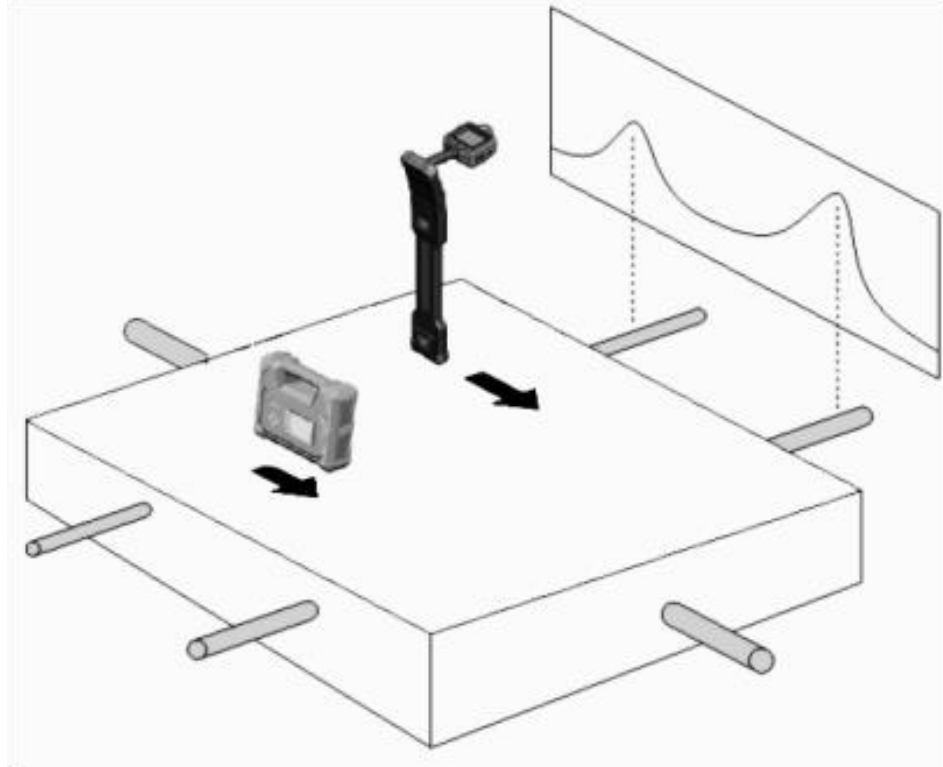


Figure 4-1-8: Radiation Method Area Surveying

After surveying in one direction, swap transmitter and receiver positions and survey in the opposite direction.

Survey in all possible directions.

After marking all pipeline locations, place the transmitter over each marked pipeline in turn and use the receiver to track each pipeline out of the surveyed area.

Radiation method surveying is the most reliable way for area pipeline surveying. However, due to inherent limitations of the radiation method (e.g., pipelines must be grounded; unusable on reinforced concrete), it cannot guarantee detection of all pipelines.

9.Basic Method for Precise Positioning

The compass may deviate under strong interference, very weak signals, or

influence from adjacent pipelines. If more precise positioning is needed, use the following correction method:

After finding the approximate location of the target pipeline, use Wide or Narrow Peak mode and adjust gain appropriately. a. Keep the receiver perpendicular to the estimated pipeline direction and find the point with the maximum response. b. Without moving the receiver, rotate it in place to find the angle where the response is maximum. c. Maintain this angle, move the receiver left/right, and find the point with the maximum response. Mark this point. Repeat the above steps to improve positioning accuracy. The process is shown below:

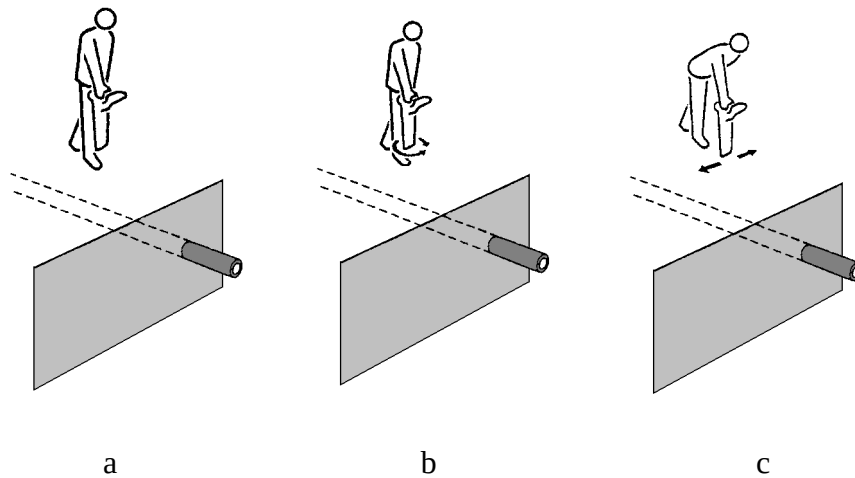


Figure 4-1-9: Precise Positioning

Positioning Correction Switch to Null mode. Using the angle determined in step b, find the point with the minimum response and mark it.

If the peak and null positions coincide, the positioning is accurate. If they differ, it indicates possible adjacent pipeline interference causing inaccurate positioning, requiring correction.

As shown in the figure on the right, if both peak and null points are offset to the same side of the pipeline, the actual position is on the opposite side of the peak point, at a distance equal to half the peak-null separation distance.

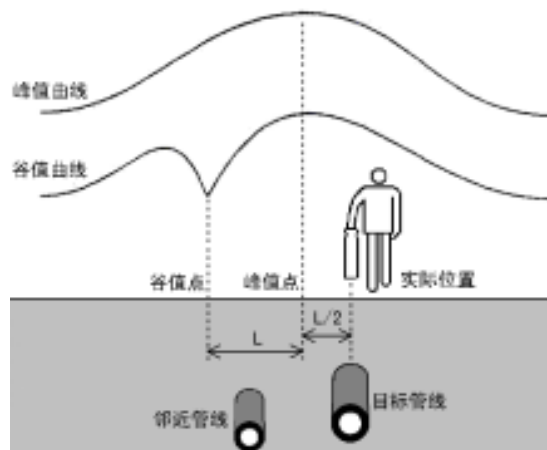


Figure 4-1-10: Positioning Correction

10. Precise Positioning Using Peak/Null Scan Mode

Peak/Null Scan mode allows rapid precise positioning by scanning the peak and null responses.

Short press the Mode key to switch to Peak/Null Scan mode. Above the pipeline, repeatedly traverse the receiver laterally across the pipeline. Observe the amplitude response curve. If the peak and null coincide, positioning is accurate. If they do not coincide, adjacent pipeline interference may be present, and positioning is inaccurate, requiring correction.

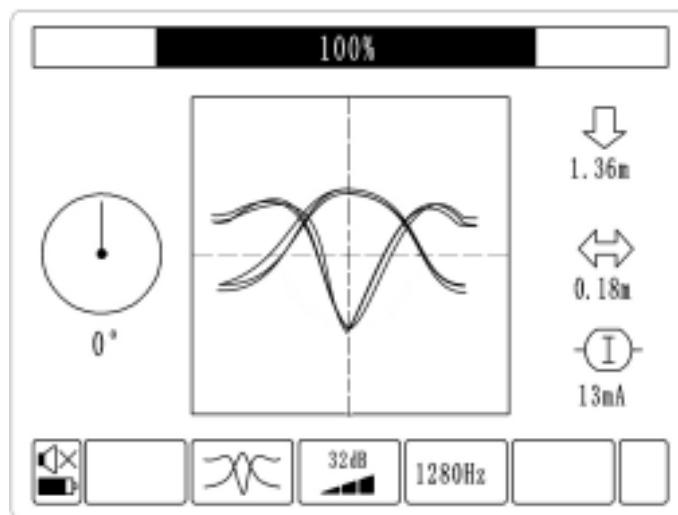


Figure 4-1-11: Precise Positioning Example

11. Precise Positioning Using History Curve Mode

The History Curve mode can also quickly determine if the signal peak and null positions coincide.

Short press the Mode key to switch to History Curve mode. Move the receiver smoothly and laterally from one side of the pipeline to the other (unlike Peak/Null Scan mode, do not repeatedly traverse). The screen displays the response curves of the peak and null amplitudes over time. In the example below, the peak and null clearly do not coincide, requiring correction.

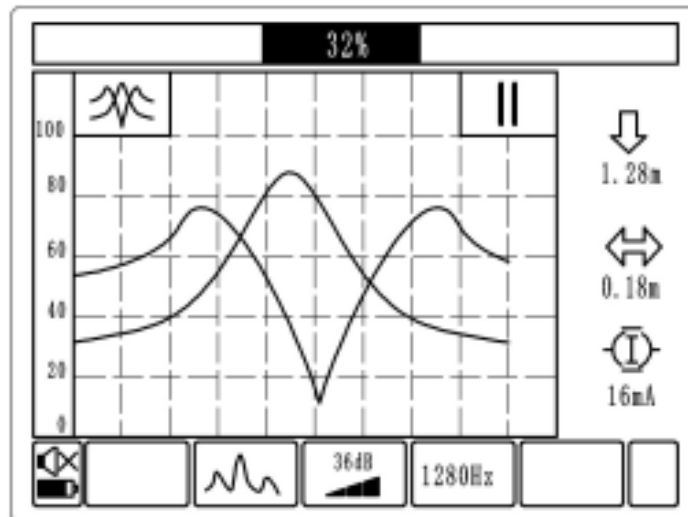


Figure 4-1-12: History Curve Example

Operation Notes:

- 1.The signal amplitude displayed is the Wide Peak mode response.
- 2.The left side shows the signal percentage scale.
- 3.The upper left indicates the colors for Peak and Null signals.
- 4.If the curve amplitude is too large, reduce the gain; if too small, increase the gain.
- 5.Short press the Store key to pause curve recording (pause icon appears top right). Short press again to resume. Long press the Store key to clear the curve and restart.

4.2 Depth Measurement

1. Real-Time Measurement

When the receiver is judged to be roughly above the pipeline, real-time depth and current measurements are displayed on the right side of the screen, as shown:

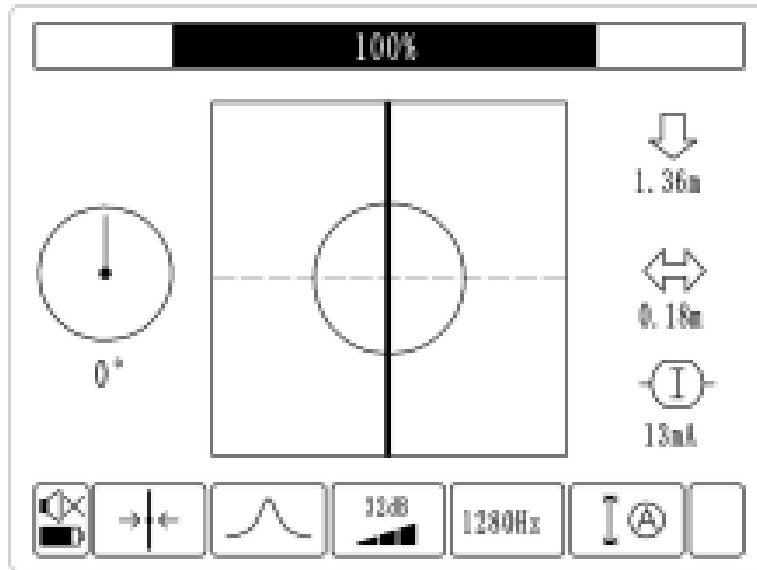


Figure 4-2-1: Real-Time Depth and Current Measurement

When the pipeline shown in the compass is vertical and centered, the receiver is directly above the pipeline, and depth measurement is most accurate. The greater the horizontal deviation (pipeline left or right in the compass), the larger the indicated depth and the smaller the indicated current. Depth and current readings disappear if horizontal offset or tilt angle exceeds instrument settings.

The direction of the phase pointer is not a prerequisite for real-time depth measurement. However, at 640Hz and 1280Hz frequencies, the pointer pointing upwards indicates correct tracking (you are above the target pipeline, not an adjacent one), which is an important reference. The phase pointer does not appear at other frequencies.

If the signal amplitude display shows "Distortion!" (e.g., "135% Distortion!"), it means the transmit signal is too strong, causing receiver saturation distortion. Depth error increases with distortion severity. Reduce the transmitter output level using the key until the distortion warning disappears.

2. Averaged Measurement

If depth readings are unstable for any reason, press the Measure key  to perform continuous averaging for more stable and accurate results.

After pressing the Measure key, the key area turns orange and shows the

number of averages (e.g., "48Avg" means 48 averages so far). Averaging stops automatically after a maximum of 180 averages (approx. 1 minute) or can be stopped anytime by pressing the Measure key again. The value below the real-time depth/current, enclosed in angle brackets < >, is the averaged measurement result, as shown on the right:

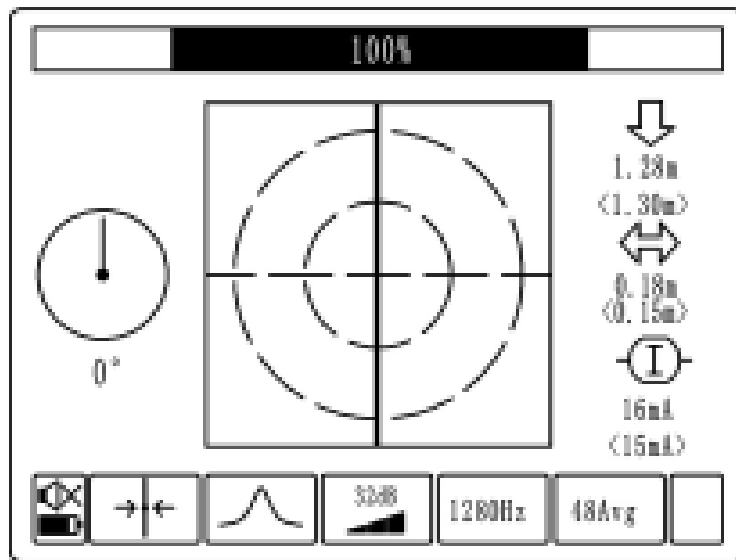


Figure 4-2-2: One-Touch Depth and Current Measurement

3. Measuring Signal Distortion with Depth Assist Sensor (If Equipped) to

Improve Confidence



Using the Depth Assist Sensor to measure signal distortion is the most convenient method to improve depth measurement confidence.

If the Depth Assist Sensor is installed (optional) and the pipeline in the compass is roughly vertical, depth assist lines are automatically displayed, as shown on the right: The thick line in the compass represents the pipeline; the thin red line next to it is the Depth Assist line.

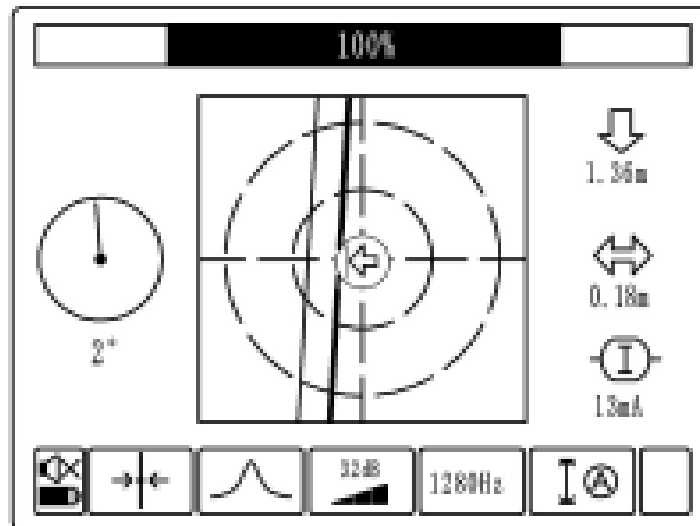


Figure 4-2-3: Signal Distortion Example

Normally, the two lines coincide when the pipeline is centered.

If they do not coincide when the pipeline is centered, it indicates signal distortion due to various factors, and depth measurement is inaccurate (usually reads too large, current too small).

When the pipeline is centered in the compass and the two lines coincide, the signal is undistorted and depth is accurate!

The higher the coincidence of the two lines, the more credible the depth result.

4. Improving Confidence Through Peak/Null Coincidence

Refer to the "Precise Positioning" section (4.1.9). If peak and null positions are judged to coincide, depth measurement at that point is credible. Otherwise, it is inaccurate (usually reads too large, current too small).

Use Peak/Null Scan mode or History Curve mode to quickly check if peak and null positions coincide.

In the example below, Figure a shows peak/null coincidence – depth credible; Figure b shows no coincidence – depth inaccurate. \



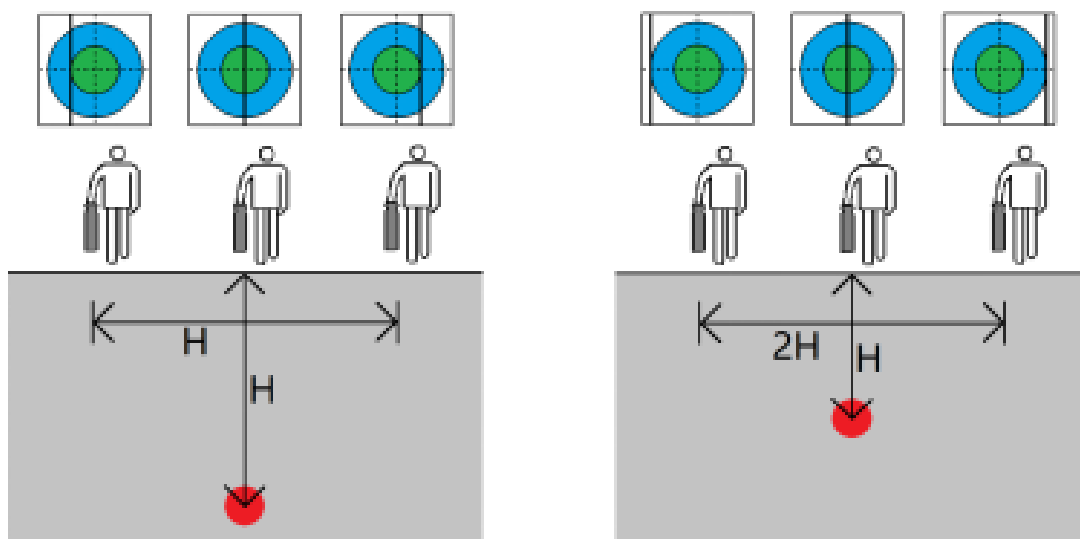
a. Peak/Null Coincident, Depth Credible b. Peak/Null Not Coincident, Depth Not Credible

Figure 4-2-4: Peak/Null Coincidence Example

5. Compass Target Method for Depth

A. Depth: Use the compass to find the pipeline. Move left until the pipeline line in the compass is tangent to the left side of the smaller green target ring. Mark the ground. Move right until the pipeline line is tangent to the right side of the green ring. Mark the ground. The distance between the two marks equals the pipeline depth, as shown in Figure A below. B. Twice Depth: Use the compass to find the pipeline. Move left until the pipeline line in the compass is tangent to the left side of the larger blue target ring. Mark the ground. Move right until the pipeline line is tangent to the right side of the blue ring. Mark the ground. The distance between the two marks equals twice the pipeline depth, as shown in Figure B below.

Depth and twice depth can be measured separately for cross-verification.



A. Green Ring Tangent = Depth

B. Blue Ring Tangent = Twice Depth

Figure 4-2-5: Compass Target Method for Depth

6. Wide Peak 80% Method for Depth

Using Wide Peak mode, find the point of strongest signal over the pipeline. Long-press the Gain+ key to auto-adjust amplitude to 100%. Then move the receiver horizontally left and right to find the two points where the signal amplitude drops to 80%. The distance between these two points equals the pipeline depth. The horizontal depth indicator bar below the amplitude bar helps judge when the amplitude change reaches the preset value, as shown on the right:

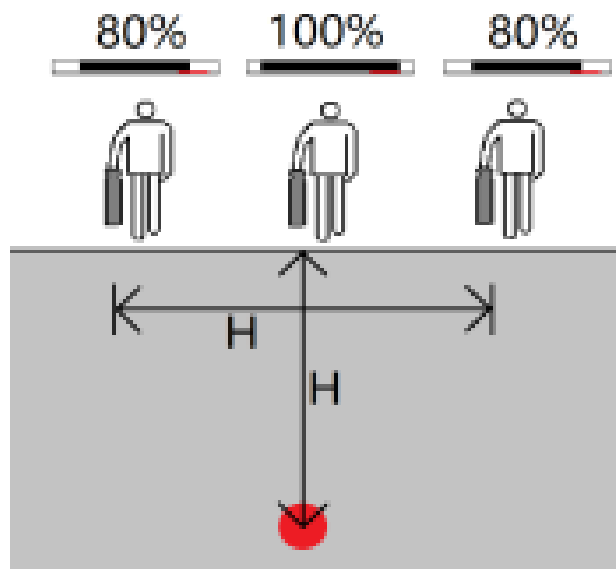


Figure 4-2-6: Wide Peak 80% Method for Depth

7. Narrow Peak 70% Method for Depth

Using Narrow Peak mode, find the point of strongest signal over the pipeline. Long-press the Gain+ key to auto-adjust amplitude to 100%. Then move the receiver horizontally left and right to find the two points where the signal amplitude drops to 70%. The distance between these two points equals the pipeline depth. The horizontal depth indicator bar below the amplitude bar helps judge when the amplitude change reaches the preset value, as shown on the right:

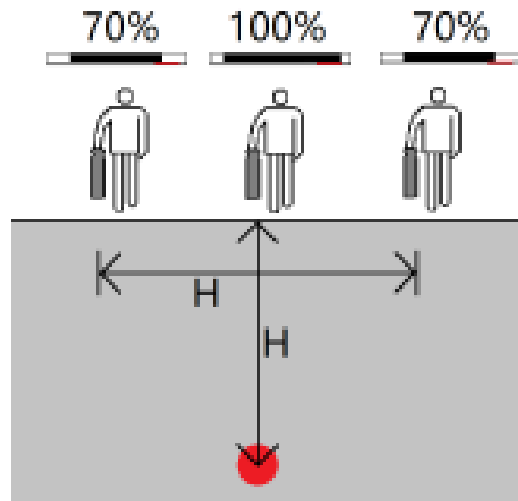


Figure 4-2-7: Narrow Peak 70% Method for Depth

Advantage: The Narrow Peak 70% method has better resistance to interference (especially far-field) compared to the Wide Peak 80% method.

Disadvantage: The Wide Peak 80% method has no theoretical error. The 70% method has increasing theoretical error with depth: minimal theoretical error below 2m; theoretical relative error ~5% at 4.75m; ~10% at 8m (measured value larger than actual).

Note: The above theoretical errors refer to ideal conditions. Actual measurements will have additional errors due to various factors.

Recommendation: Use the Narrow Peak 70% method for shallow depths due to better interference rejection and acceptable accuracy. Be aware of increasing error at greater depths; cross-verify with other methods.

8. Null 45°

Method for Depth Using Null mode, find point A, the point of weakest signal over the pipeline. Tilt the receiver 45° to one side and move laterally away from the pipeline until you find another point of weakest signal, point B. Tilt the receiver 45° to the other side and move laterally away from the pipeline to find a third point of weakest signal, point C.

Generally, $\text{Depth} = AB = AC$. Adjacent pipelines may cause the null point to shift away from directly above the pipeline. Therefore, $\text{Depth} = BC / 2$ is often more accurate.

When tilting the receiver, observe the guide lines on the receiver. When one

guide line is horizontal to the ground and the other is vertical, the receiver is correctly tilted at 45° .

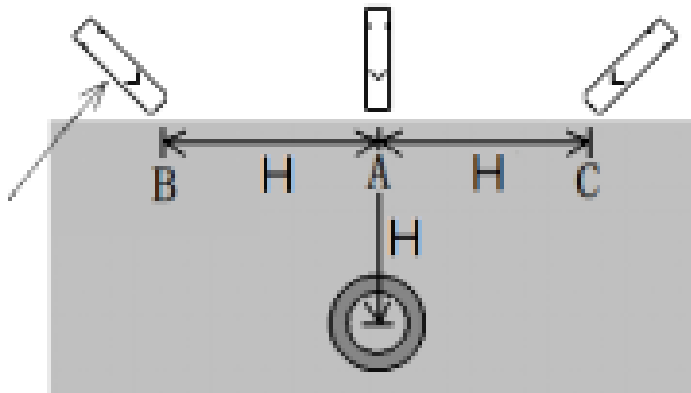


Figure 4-2-8: Null 45° Method for Depth

9. Tips and Precautions

A.Speaker output slightly affects real-time depth measurement. Once accustomed to compass-guided detection, mute the speaker.

B.Method to verify depth credibility: Measure once with the receiver close to the ground. Lift it 0.5m (or 2ft) and measure again. If the difference is approximately 0.5m (2ft), the result is credible.

C.If using Radiation method for signal transmission, measurement error will be larger than with Direct Connect or Clamp methods. If Radiation must be used, maximize the distance between receiver and transmitter (>20m).

D.Avoid measuring near pipeline bends or tees (cable T-joints). Ensure the receiver is >5m away from bends/tees.

E.The measured depth is the distance between the bottom of the receiver and the center of the pipeline. The depth to the top of the pipeline is less than the depth reading, especially significant for large-diameter pipelines.

F.Current measurement helps identify the target pipeline. Sometimes, adjacent pipelines have smaller current but are shallower, making their signal stronger than the target's, leading to mis-tracking. Measure the current on parallel pipelines; the pipeline with the highest current (not the strongest signal) is the target.

G.Analyzing current change with distance helps assess pipeline condition. The current injected by the transmitter onto the target pipeline gradually decreases with distance

(leaking back to the transmitter). The decay rate depends on pipeline type and soil. If the decay rate is stable without sudden drops, the pipeline is normal. A sudden current drop indicates either a tee (current diversion) or an insulation fault to ground at that point.

H.Current measurement relies on correct depth measurement. If depth data is unreliable, current data is also unreliable.

Important Note!

Some strict pipeline surveying standards do not accept automatic depth results from any device. While automatic depth is very convenient and sufficiently accurate under strong signal, low interference, and simple pipeline conditions, according to such standards, the results should only be considered as a reference. To obtain credible depth results, cross-verify using multiple methods!

5: Passive Detection

Passive (non-energized) detection does not require a transmitter to apply signals to pipelines. Instead, it uses only the receiver to detect pipelines by capturing signals naturally radiated by the pipelines themselves.

5.1 Path Detection

1. Frequency Band Selection:

Long-press the Frequency key to switch to passive detection frequency (the key turns orange). Short-press the Frequency key to toggle the following receive bands:

A.AFB (All-Frequency Band) Passive Detection

B.Power Frequency Band: Fundamental wave (50Hz or 60Hz) and its 2nd/5th/9th harmonics. The 2nd harmonic is used to detect pipelines with cathodic protection systems (CPS).

C.Radio Frequency Band: Divided into low (5–15kHz), medium (15–25kHz), and high (25–40kHz) sub-bands.

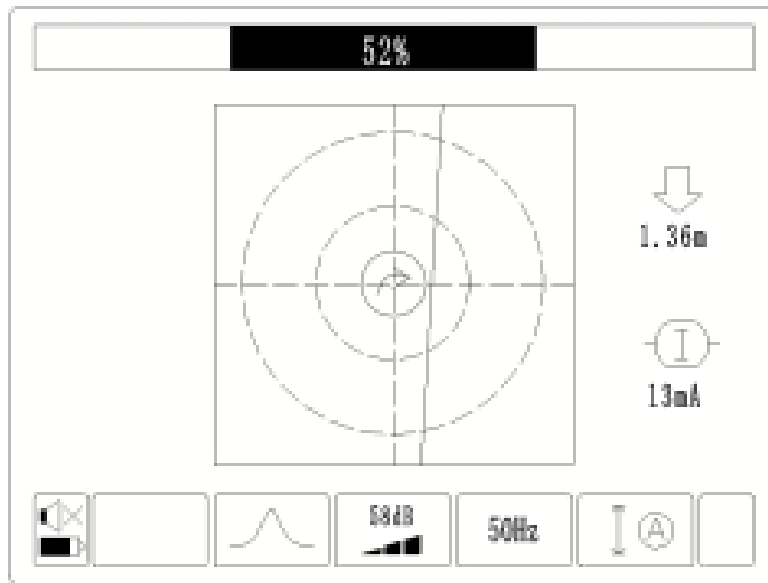


Figure 5-1-1 Passive Detection

The passive detection interface is shown in Figure 5-1-1: The right side displays real-time pipeline depth and current data. The amplitude bar shows signal strength (for select bands only).

Special Notes:

AFB Mode simultaneously scans all power and radio frequency bands, intelligently distinguishes primary/secondary signals, and displays them as thick lines (primary, with real-time depth) and thin lines (secondary).

Caution: Simultaneous thick and thin lines generally do not indicate two separate pipelines.

AFB offers convenience but lower sensitivity compared to single-band detection.

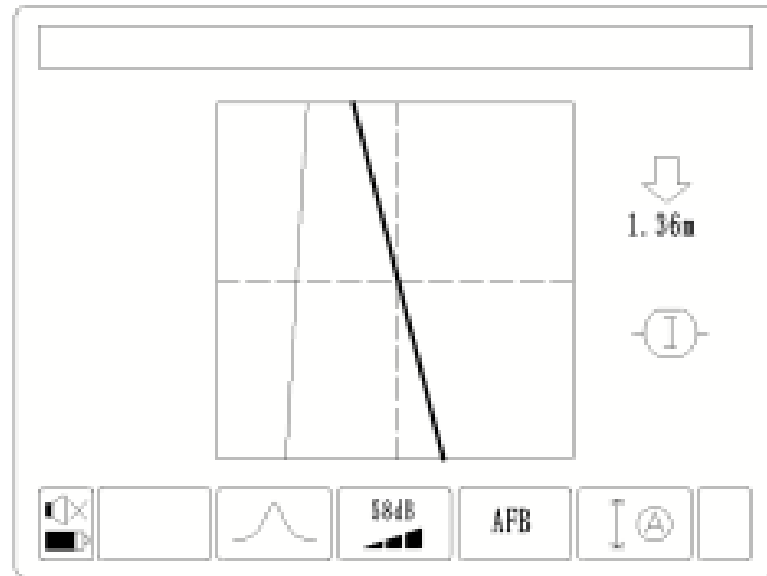


Figure 5-1-2 AFB Mode

2. Operating Modes

In passive mode, short-press the Mode key to toggle between:

Wide Peak / Narrow Peak / History Curve

Note: Mode switching has no effect in AFB mode (no amplitude display).

Operational Recommendations:

Use Narrow Peak Mode: Passive signals are uncontrolled with low signal-to-noise ratio. Far-field interference is common. Narrow Peak mode suppresses far-field interference when relying on amplitude for detection.

Use History Curve Mode: For meticulous detection without omissions, perform a grid search across all bands (non-AFB) after initial scanning. Peaks/valleys in the history curve indicate pipeline locations .

Gain Adjustment: Start with 40% gain (long-press Gain-). Reduce gain when encountering strong signals. After locating strong-signal pipelines, increase gain to detect weaker ones. Mark findings promptly.

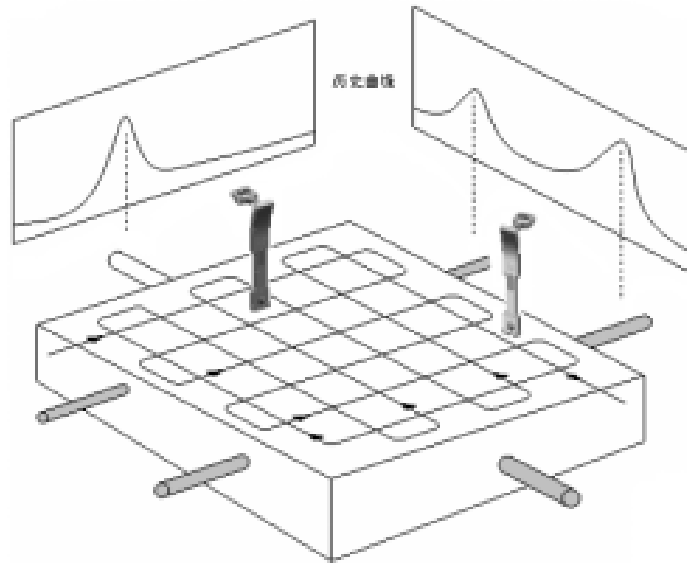


Figure 5-1-3: History Curve Example

5.2 Depth Measurement

1. Real-Time Measurement

Depth is displayed on the right side of the screen only when the receiver is directly above the pipeline (vertically aligned and centered in the compass).

Averaged Measurement: If depth is unstable, press the Measure key for continuous averaging. The bracketed value below real-time depth is the averaged depth.

2. Compass Target Method:

Locate the pipeline using the compass.

Move left until the pipeline aligns with the left edge of the green target ring; mark the point. Move right until aligned with the right edge; mark the point.

Distance between marks = Pipeline depth

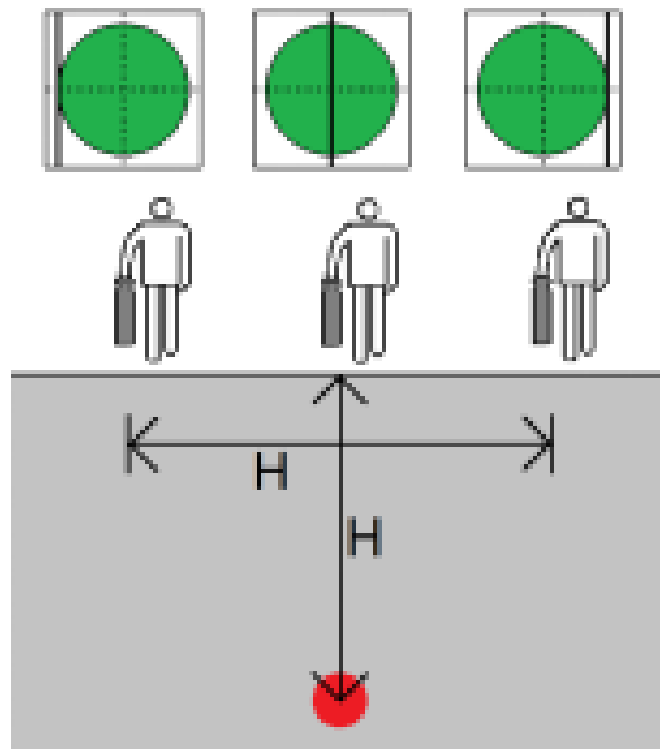


Figure 5-2-1: Compass Target Depth Measurement

Unlike active detection, passive mode has a smaller detection angle. Only one green target ring is shown, supporting auxiliary depth measurement (not dual-depth).

3. Wide Peak 80% & Narrow Peak 70% Methods:

For power/radio frequency bands, use horizontal depth measurement via:

Wide Peak 80% method

Narrow Peak 70% method Operational steps match active detection. Due to unstable passive signals and strong interference (especially far-field), Narrow Peak 70% is preferred.

Critical Notes:

- 1.No passive depth method provides highly reliable results.
- 2.Use active methods (e.g., clamp coupling) for depth measurement whenever possible.
- 3.Cross-validate with multiple methods.

Chapter Nine Maintenance and Warranty

1. Charging

The instrument has a built-in lithium battery pack. Depending on the output level, the continuous working time varies, but generally, it can meet the needs of an 8-hour workday.

During use, the battery level icon is displayed at the bottom left of the screen. The green portion of the icon indicates the battery charge level. Fully green represents full charge, while fully empty and flashing indicates low voltage, meaning the battery is completely drained and will automatically shut down after a few seconds.

When charging is needed, connect the charger plug to the transmitter/receiver's charging socket, and plug the charger's AC plug into an AC220V/110V mains socket.

Depending on usage and maintenance conditions, the battery pack can generally undergo 300-500 charge-discharge cycles. As the number of charge-discharge cycles increases, the battery capacity will gradually decrease, and the instrument's operating time will also be shortened accordingly. When it becomes unacceptably short, please contact the manufacturer/distributor to replace the battery pack.

2. Warranty

The main unit of the instrument and its accessories are warranted for one year, and the battery is guaranteed for replacement within one year. Beyond this period, only the cost of replacing parts will be charged for repairs. If damage occurs due to improper use (including within the warranty period), or if product quality issues arise after the warranty period, our company will handle the repair, charging only for the cost of the replaced parts.

If the device automatically shuts down, fails to turn on, or shuts down immediately after turning on, it may be due to insufficient battery power. Please try

charging it before use.

If other problems occur, do not attempt to repair it yourself to avoid worsening the issue. Instead, contact the manufacturer/distributor for prompt repair and service.

FCC Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Caution: Any changes or modifications to this device not explicitly approved by manufacturer could void your authority to operate this equipment.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

RF Exposure Information

The device has been evaluated to meet general RF exposure requirement. The device can be used in portable exposure condition without restriction.