CD8000

CABLES/PIPES PATHFINDER

USER MANUAL

Catalogue

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Safety Notes

Thank you for purchasing our **pipeline meter**. In order to use this product better, please do:

-- Read this user manual carefully. The operator must fully understand the instructions in the manual and be proficient in operating this instrument before conducting actual tests.

-- Strictly follow the safety rules and precautions listed in this manual.

- This instrument is designed, manufactured and inspected in accordance with IEC61010 safety specifications.
- In all circumstances, safety should be given special attention when using this instrument.
- Pay attention to the label text and symbols on the body of this instrument.
- The instrument is designed with overvoltage protection, but avoid direct contact with or direct connection to live conductors.
- Before use, ensure that the instrument and its accessories are in good condition, and that the insulation of the instrument and test leads is not damaged, not exposed, and not broken. Stop using if metal is exposed due to breakage of the casing or test leads.
- **It is normal for the coupling clamp to produce a whistling sound when transmitting signals.**
- **When the coupling clamp is transmitting signals, it will generate a strong magnetic attraction force. At this time, the clamp mouth must not be opened. The clamp mouth can only be opened after the**

transmitter power is turned off.

- **When using the direct output mode, it is strictly forbidden to connect the red and black test leads to the power cable in operation.**
- **For personal safety, it is essential to test the identified cables with nails before sawing for maintenance.**
- During the measurement process, do not touch the exposed conductor or the circuit being measured.
- Make sure the plug of the wire is tightly inserted into the instrument interface.
- The test lead must be removed from the tested wire before being pulled out of the instrument. Do not touch the output jack to avoid electric shock.
- Do not measure in flammable places as sparks may cause an explosion.
- Do not place or store the instrument for long periods in high temperature and humidity, in places with condensation, or in direct sunlight.
- If the instrument gets damp, dry it before storage.
- When the low battery voltage symbol is displayed, charge it promptly.
- If the tester is left unused for a long time, charge the battery every 3 months.
- Use, disassembly, calibration and maintenance of this instrument must be carried out by authorized personnel.
- The maximum output voltage of the transmitter is 150Vpp. Do not touch the output clip or target line directly while working!
- If continuing to use this instrument poses a danger, stop using it

immediately and store it immediately for handling by an authorized authority.

- The "⚠" symbol in the instrument and manual is a safety warning sign, and users must operate safely in strict accordance with the contents of this manual.

1. Introduction

The CD8000 pipeline detector is a multi-functional cable path identification detector. It has multiple functions such as pipeline path detection, cable

identification, pipeline ground fault location, etc. The instrument consists **of A transmitter, a transmitting current clamp, a receiver, a receiving flexible current clamp (optional), connecting test leads, stethoscope (optional), tracer probe (optional), A-frame (optional accessory),** etc.

Pipeline path detection: Can be used in trenchless conditions for path detection of metal pipelines and underground cables, pipeline census and depth measurement. The instrument uses multiple filter techniques, has a certain anti-interference ability, can precisely locate and measure depth, and is suitable for the detection and inspection of various metal or non-metal underground pipelines, pipeline management and maintenance, municipal planning and construction, power supply and other departments' pipeline detection, and is one of the essential instruments for pipeline maintenance units. This function is achieved through the cooperation of a signal transmitter, receiver, signal transmitter clamp and connecting test leads. The instrument has the following features:

1. Multiple detection modes: Classic positioning mode, full-screen signal mode, signal curve mode, tracer probe mode.
2. Classic positioning mode: Compass, direction and signal amplitude display, intuitively showing the left and right direction of the pipeline.

3. Full-screen signal mode: 360° all-round pipeline path indication, continuous display of depth, current, and pipeline relative position. The interface is simple and intuitive, and no experience is required for operation.
4. Signal curve mode: It can display the historical signal strength curve. By observing the changes in the curve, the position of the cable can be found.
5. 4.3-inch color LCD screen supports touchscreen operation.
6. Current direction determination (for some frequencies) can be achieved by calibrating the current direction to eliminate adjacent line interference and prevent tracking errors.
7. Pipeline analog line color shows signal interference intensity in real time.
8. The built-in sweep test function allows users to select the appropriate signal frequency for pipeline measurement based on the sweep results to avoid co-frequency interference.
9. All-digital high-precision sampling processing: stable and reliable, ultra-high sensitivity, extremely narrow reception passband, strong anti-interference ability, capable of effectively suppressing power frequency and harmonic interference from adjacent operating cables and pipes.
10. Multiple detection frequencies: 18 active detection frequencies and 2 passive detection frequencies.
11. Transmitter multiple signal output methods: direct output, clamp coupling, induction method.

12. Transmitter digital power amplifier high power output, full automatic impedance matching, full automatic protection.

Cable identification: Designed for power cable engineers and cable workers to solve the technical problem of cable identification. It can identify live and de-energized cables. Users can accurately identify one of the target cables from multiple cables through the instrument to avoid serious accidents caused by mistakenly sawing live cables. When identifying cables, 10 cables can be pre-marked at the transmitting end and then identified at the remote receiving end, which greatly saves the time for engineers to travel back and forth and improves work efficiency. Mark √ for successful cable identification and × for non-target cables, which can quickly and automatically identify target cables. This function is achieved by the signal transmitter, receiver, signal transmitter clamp, connection test lead, and flexible clamp.

Signal transmitter: Signal transmission for pipeline path detection and cable identification. The device can add identification signals to the target cable through direct output, clamp coupling, induction, etc. There are 18 different pulse signals to choose from. The signal output power is up to 15W and can be adjusted in 15 steps. Thus, it can adapt to different application environments and make pipeline detection and cable identification more accurate and reliable. The instrument is equipped with a high power rate rechargeable lithium battery, automatic impedance matching, and full automatic protection. The main unit is equipped with a 5.6-inch color capacitive touch LCD screen, which shows real-time dynamic signal output status and battery usage.

Transmitter clamp: Suitable for caliper coupling method. The transmitter clamp couples the signal sent by the transmitter to the target cable. The clamp jaw size is Φ150mm. The transmitter clamp has directionality, and the transmitted signal flows in the direction indicated by the arrow on the transmitter clamp.

Receiver: For pipeline path detection, cable identification signal reception. With multiple shielded 3D antennas built in, it can effectively identify 18 different pulse-encoded current signals generated by the transmitter. It can also recognize 50Hz and 60Hz power frequency signals. It uses a 4.3-inch color LCD screen to display real-time dynamic 360° all-round pipeline path indication, depth, current and pipeline relative position.

A-shaped frame (optional) : A voltage signal sensor in the shape of an A, specifically designed for locating grounding faults in buried cables. The two probes or probes of the A-frame can accurately receive the step voltage signal transmitted from the transmitter. After data analysis on the receiver, the grounding fault point of the cable can be precisely located. The probes or trays are independently interchangeable. The probes are suitable for dirt ground, while the trays are suitable for concrete roads where direct insertion into the ground is not possible. The A-frame lead wire is designed with an aviation socket, which is connected to the receiver with an aviation plug connection wire. It can be disassembled at will and is compatible with the independently designed handle, allowing the A-frame to work independently for other functions.

Flexible current clamp (optional) : for cable identification. This current clamp is a Rockwell coil with excellent transient tracking capability, capable of

quickly identifying pulse-coded currents generated by the transmitter, suitable for thick cables or irregularly shaped conductors. The inner diameter of the clamp is 200mm, no need to disconnect the line under test, non-contact measurement, safe and fast.

Tracer probe (optional) : A tracer probe is a battery-powered signal transmitter, a signal transmission device widely used in path detection technology, mainly for precisely locating and tracking the actual direction of cables, non-metallic pipes, and other concealed lines. The probe is equipped with a 10mm metric thread, which can be used to attach the probe to the traction head of a pipe opener or a sewer push rod. When in use, the tracer probe generates an electromagnetic or acoustic signal of a specific frequency. When the tracer probe is placed at the starting point of the path of the pipe to be detected, it continuously emits the signal, which is guided along the pipe by the pipe spout. Meanwhile, engineers use receivers to scan along the path, and once they receive the corresponding signal, they can confirm the position and direction of the path.

Special note: When identifying power outage cables, it is strictly prohibited to connect them to live cables. The identification of live cables is only applicable to three-core armored cables. During identification, the transmitting clamp and the receiving clamp must not be mixed, and at the same time, the consistency of the input signal direction must be ensured.

2. Technical specifications

1. Receiver specifications

Functions	Pipeline detection (cable position tracking, direction indication, depth measurement, current measurement), cable identification, tracer probe location, ground fault location
Power source	7.4V DC 6400mAh rechargeable lithium battery
Input method	Built-in receiving coil; External connection flexible caliper; External A-frame
Receiving frequency	Active detection frequency: 128Hz, 512Hz, 577Hz, 640Hz, 1024Hz, 1280Hz, 2.56kHz, 3.20kHz, 4.09kHz, 8.19kHz, 9.80kHz, 10kHz, 33kHz, 66kHz, 82kHz, 83.1kHz, 133kHz, 201 kHz (The four frequencies of 640Hz, 1280Hz, 2.56kHz and 3.20kHz have directionality, and the receiver can identify the direction of the signal) Power frequency passive detection frequencies: 50Hz, 60Hz
Pipeline detection mode	Wide peak method, narrow peak method, sound valley method
Pipeline detection shows	Classic positioning mode, full-screen signal mode, Signal curve mode, Tracer probe mode
Pipeline	Direct connection method: Generally, it can reach a cable

detection Detection range	length of 0-20 kilometers, mainly determined by ground resistance, cable resistance and cable burial depth Coupling method: Generally, it can reach a cable length of 0-10 kilometers, mainly determined by the grounding resistance, cable resistance, and the depth of the cable being buried Induction method: Suitable for cables buried less than 2 meters deep
Depth accuracy	Planar position precision positioning accuracy: Center axis position of the target cable or pipeline: ±5% (burial depth 0-3m) -15% (burial depth 3 -20m)
Sound indication	FM tones that vary with signal strength
Interference distance	When using the coupling method and the induction method, the transmitter will generate interference within a short distance. The distance of interference is related to the transmission power and frequency. The higher the power and frequency, the stronger the interference. The minimum distance between the receiver and the transmitter often needs to be determined by experimentation: Pipeline detection: Coupling method 5 meters away, induction method 20 meters away can be confirmed as no interference Cable identification: No interference can be confirmed by coupling 5 meters away
Cable	Identification method: Flexible caliper intelligent

identification	identification; The number of calibrated cables: 1 to 10. Calibration value: The percentage of current from the received signal to the transmitted signal between 75% and 135% of the calibration value is one of the conditions for successful identification; Directionality: The transmitting clamp, receiving clamp and loading signal must be in the same direction, which is one of the conditions for successful identification
Cable identification Detection range	Direct connection method: Can identify signals with loop resistance ranging from 0Ω to 8kΩ (generally can reach cable length 0-20 km, mainly determined by ground resistance and cable resistance) Coupling method: Can identify signals with loop resistance ranging from 0Ω to 1kΩ; (Generally, it can reach a cable length of 0-10 kilometers, mainly determined by ground resistance and cable resistance)
Liquid crystal	4.3-inch color LCD with touchscreen support
Size	About 311mm*133mm*750mm
Mass	2.0 Kg
Charger	DC8.4V, 1A
Connection interface	1*USB interface (for firmware upgrade, can charge mobile phones) 1*DC charging port 1*Type-C charging port 1* Flexible caliper connection socket
Flexible	About 620mm in length and about 8mm in wire diameter

current clamp	
Flexible coil inner diameter	Phi 200 mm
Working temperature and humidity	-10 ° C to 40 ° C; Below 80%Rh
Storage temperature and humidity	-10 ° C to 50 ° C, ≤ 95% RH, no condensation
Pressure resistance	AC2000V/rms(before the front and back ends of the shell)
Fit for safety regulations	IEC 61010-1 CAT Ⅲ 600V, IEC61010-031, IEC61326, Contamination level 2

2. Transmitter specifications

Functions	Multiple frequency signal transmission methods for pipeline path detection, cable identification, and fault location
Power source	11.1V DC 12800mAh rechargeable lithium battery
Output mode	Direct output, induction, clamp coupling
Output frequency	128Hz, 512Hz, 577Hz, 640Hz, 1024Hz, 1280Hz, 2.56kHz, 3.20kHz, 4.09kHz, 8.19kHz, 9.80kHz, 10kHz, 33kHz, 66kHz, 82kHz, 83.1kHz, 133kHz, 201 kHz
Output power	15W Max, 15 levels adjustable, fully automatic real-time impedance matching
Direct	150Vpp MAX

connection to output voltage	
Circuit protection	Has overload and short circuit protection
Liquid crystal	5.6-inch capacitive touch LCD screen
Instrument dimensions	About 259mm*211mmX105mm
Mass	Transmitter 3.00Kg; Launch clamp 1.12kg
Charger	DC 12.6V, 1A
Launch clamp size	250mm x 140mm x 35mm in length, width and thickness
Inner diameter of the launch clamp	Phi 150 mm
Launch clamp wire length	3m
Connect the test wire directly	3m
Connecting interfaces	1*USB interface (for firmware upgrade, can charge mobile phones) 1*Type-C charging port 1*DC charging port 1* Signal transmitter pliers and DC test lead connect to the socket
Withstand	AC 3700V/rms(before top and bottom of the instrument

voltage	box)
Electromagnetic characteristics	IEC61326(EMC)
Fit for safety regulations	Iec 61010-1(CAT Ⅲ 300V, CAT Ⅳ 150V, Contamination level 2)

3. Optional functions

Obstacle detection and location	In conjunction with the A-frame, it enables precise location of cable grounding faults
Cable identification	Cable identification can be achieved in conjunction with flexible coils
Stethoscope	It can replace flexible coils for cable identification
Non-metallic tubing Path detection	Optional tracer probe for path detection of non-metallic pipes

3. Structure

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COMWAY
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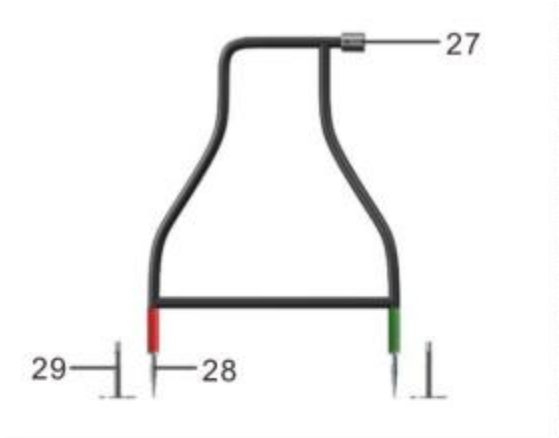
TEST



1. Capacitive touch LCD screen \ n

2. Receiver operation keys

3. Receiver

4. (DC charging port, Type-C interface, flexible current clamp or A-frame connection port)

5. Flexible current clamp (optional)

6. Flexible current clamp press lock

7. Flexible current clamp output port

8. Flexible current clamp output lead

9. Transmitter OEM

10. Capacitive touch LCD screen

11~15. Transmitter operation keys

16-19 External interface of the transmitter (SIM card slot, DC charging port, Type-C interface, USB interface)

20. Coupling caliper and straight wire to connect to the aviation socket

21. Launch clamp input port

22. Launch clamp output lead

23. Launch clamp trigger (control opening and closing)

27. A-frame connection port (optional)

28. A-frame probe (optional)

29. A-frame probe disk (optional)

4. Instrument operation

1. Receiver Basic Operations

Press the button to power on, and by default, enter the wire cruise mode interface of the pipeline detection function. If a flexible caliper or stethoscope is connected before startup, cable identification interface will enter. Connecting the A-frame connection cable leads to the fault location interface.

1.1 Cable Line detection interface

Short keys to switch between wide peak, narrow peak, and sound valley response modes

Under the cable line detection function, long press the key to switch between the **conductor cruise mode, classic positioning mode, signal curve mode** and tracer probe mode. The rich detection functions can meet the cable detection requirements in different occasions.

Figure 1 Interface diagram of the four modes

Short press to switch frequencies.

A short press of the key can adjust the signal gain, with a gain adjustment range of 0 to 96dB.

In wire cruise mode and classic positioning mode, select 640Hz, 1280Hz, 2.56kHz, 3.20kHz, and press the long key or tap the icon on the screen to calibrate the signal direction to prevent tracking errors

A short key or tap the icon on the screen leads to the function selection menu on that page. Change the parameters of the test by operating on the corresponding function by tapping or pressing the key.

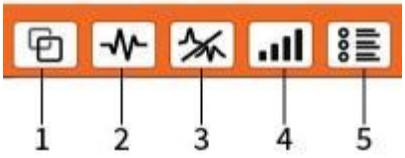


Figure 2 Function Menu bar

1. Select Detection mode 2. Select Test frequency 3. Change Test method

4 Adjust the internal gain 5 go to the Settings menu page

1.2 Cable identification interface

The flexible current clamp automatically enters **cable identification mode** after being inserted into the receiver:

When choosing to enter the cable identification interface for the first time, the following will occur:

a) There is no saved calibration data in the instrument, the instrument enters the cable identification interface normally;

b) If there is saved calibration data in the instrument, it will enter the **delete interface**. Prompt: "Whether to delete all calibration data". Select "Yes" or "No" by pressing the keys. Selecting "Yes" and pressing OK will delete all previously saved calibration data; Selecting "No" and pressing "OK" will not delete saved calibration data. After the selection operation is completed, the instrument automatically switches to the cable identification interface.

To identify the new cable, all previously saved calibration information must be deleted and the new cable must be recalibrated. Press the long key to enter the deletion interface. The interface for deleting existing calibration information is as follows:

Figure 3 Cable identification calibration information deletion section

Select "No" to delete and select "Yes" to delete

After entering the cable identification interface:

Short keys switch cable numbers L1 to L10, marking a total of 10 cables.

Press the switchable frequency. There is a corresponding display interface for selecting different frequencies.

After the wiring is done, the specific press is calibrated. Once the calibration is done, the frequency cannot be changed.

Figure 4 Cable identification interface diagram

A short key or tap the icon on the screen leads to the function selection menu on that page. Change the parameters of the test by operating on the corresponding function by tapping or pressing the key.

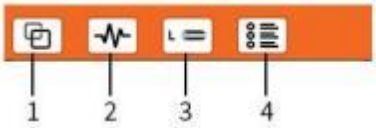


Figure 5 Cable identification function menu interface

1. Switch detection mode 2. Select Test frequency 3. Select Calibration cable

4 Go to the Settings menu page 5 go to the remote control page

1.3 Instrument Settings

Go to the Settings menu interface, where there are 9 option bars, namely **Sweep Test, Sound Settings, Backlight Settings, Auto Shutdown, Firmware Upgrade, About**, press the keys or swipe the screen to select the corresponding bar, press the keys or tap the screen to confirm, enter the corresponding function interface or change the corresponding Settings. Pressing a key or clicking will go back to the previous level

Figure 6 Receiver setup interface

Move the cursor to the **sweep test** bar, press the key to enter the sweep test, which shows the signal strength of different frequencies at the current

position, press the key to change the gain strength,

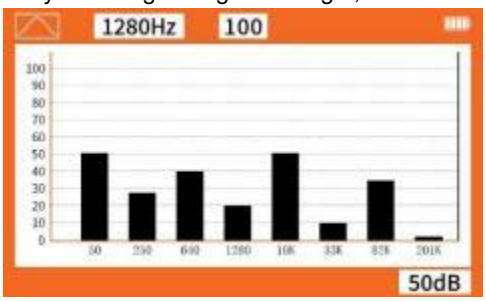


Figure 7 Sweep test interface

Move the cursor to the **sound Settings** bar and press the keys to turn on or off the instrument signal strength indicator tone.

Move the cursor to the **backlight Settings** bar, press the keys or slide the amplitude bar to adjust the LCD brightness.

Move the cursor to the **auto off** bar and press the keys to select the auto off time: 30 minutes, 60 minutes, 120 minutes. Select "Off" to disable the auto-shutdown function.

Move the cursor to the **firmware upgrade** bar, press the button to enter, and update the program according to the corresponding operation.

The **About** column only shows version information.

2. Transmitter basic operations

Press the button to power on, and by default, enter the path detection interface.

2.1 Signal transmission for path detection, cable identification, or fault

location

Key operations:

Keys: Switch current mode (Path detection, Cable identification, fault location).

Key: Switch output frequency.

Key: Increase or decrease output power.

TEST Key: Start/Stop test.

Key: Enter the system Settings interface.

Touchscreen operation:

Tap to switch to current mode (Path detection, cable identification, fault location,).

Tap to switch the output frequency.

Click to increase or decrease the power.

System Settings button: Click to enter the system Settings interface.

Start Output button: Click to start output frequency.

Stop Output button: Click to stop output frequency.

Connection option: Click Direct connection: Force switch to direct connection mode; Click Coupling: Force switch to coupling mode; Click induction: Force switch to induction mode. (The instrument automatically determines the matching output mode in the absence of selection)

Interface image:

Figure 8 Path detection signal transmission interface diagram

2.2 Instrument Setup

Key operations:

Keys: Move the option cursor.

Keys: Add or subtract selected parameters.

Key: Press the selected button.

Key: Invalid.

Key: Exit the system Settings interface and return to the Test interface.

Touchscreen operation:

Key: Click to exit system Settings.

Brightness setting: Click or drag the slider to adjust the brightness.

Sound setting: Tap the power button to turn on the sound

Date/Time: After clicking the selected number, click the keys to add or subtract the selected number.

Instrument automatic shutdown: After clicking the selected number, click the plus/minus keys for the automatic shutdown time. < >

Automatic shutdown time: There are five options: 15 minutes, 30 minutes,

60 minutes, 120 minutes, and never

Choose.

Firmware upgrade:

1. There is firmware documentation in the fixed path of the USB drive.

2. After the USB is plugged into the USB port, the button will light up. Upgrade Upgrade

3. After clicking the button, firmware upgrade will be carried out (at this time, the USB drive cannot be unplugged. Unplugging the USB drive during the upgrade process may cause the upgrade to fail, resulting in system crash, which requires return to the factory for repair) Upgrade

5. Output of the transmitter

There are three methods for transmitting signals from a transmitter to a pipeline: direct connection, clamp coupling, and induction. This chapter introduces the general operation of these methods. For cable detection, the operation and precautions of the three methods for connecting cables will be specifically introduced in Section 3 according to their particularities.

note meaning	**Electricity, dangerous! It must be operated by trained and authorized personnel, and the operator must strictly follow the safety rules, otherwise there is a risk of electric shock causing personal injury or equipment damage.**
	When conducting power outage line detection and cable identification (using direct connection output), make sure the target cable is powered off and the conductor cores at both ends are separated from the system.
	When conducting live pipeline detection and cable identification (using clamp-coupled output), no operation is required on the target cable, and the sheaths at both ends of the pipeline must ensure good grounding.
	It is strictly forbidden to forcibly open the transmitter clamp while the transmitter clamp is transmitting signals to avoid damaging the machine. The transmitter clamp should be

	opened and closed after the transmitter is turned off.

one Direct connection method

Turn on the transmitter. Select the appropriate frequency, mode, and power according to the application requirements. Connect the direct connection test lead and the instrument will automatically enter the direct connection output mode. When cutting off and reconnecting the red lead, check for a good connection by observing the output on the display or observing changes in the pitch of the transmitter clamp.

Factors affecting the quality of the wiring include:

a) Rust at pipeline connection points: Clean the wiring area with a wire brush.

b) Poor grounding: Insert ground nails into wet ground. Wet the surrounding ground with water. If there is still a problem, try connecting around the manhole cover. Avoid connecting to the fence guardrail, otherwise it may generate echo signal currents along the fence and interfere with the positioning signal.

If the received signal is not strong enough, start with a lower output signal first and gradually increase the output. If the output is set to a higher level, it may cause some of the signal to "flow out" to other functional structures, resulting in excessive power consumption and energy waste.

When attached to iron material, it may sometimes be difficult to find the proper protrusion and to hold the clamps. In this case, contact the wire with the optional magnet and then attach the red clip to the magnet. A good example is connecting to a street lighting circuit. The usual practice is to attach the sheath of

the lighting cable to the metal inspection cover of the street lamp. When connected to the inspection board, the cable will be powered through the board and the sheath. Typically, there are no protrusions on the cover plate that can be used for clamping, so use magnets on the cover plate to provide appropriate clamping points.

1.1 Interface Introduction

Rotate the mode dial knob to path detection mode or cable identification mode to enter the path detection or cable identification signal transmission interface.

After selecting the appropriate frequency, mode and power, short the button or tap the button to

output. When output normally , the symbol flashes as a prompt. During this time, do not touch the exposed part of the connection wire to prevent electric shock.

Figure 9 Direct connection output interface for path detection mode

Figure 10 Output interface of cable identification mode direct connection method

1.2 Direct connection lines

The direct connection method is to directly connect the transmitter's output line to the metal tube line and inject the signal directly. Direct connection is applicable to water pipes, gas pipes, communication cables, power cables, cathodic protection pipe test points or other access points, as well as continuous metal structures with long line characteristics, etc.

The current emitted by the transmitter flows through the pipeline, enters the ground at its grounding point, or enters the ground through the distributed capacitance between the pipeline and the ground, and finally returns to the transmitter. The current in the pipeline generates electromagnetic field radiation, and the receiver detects the pipeline by receiving the magnetic field.

Compared with other methods, direct connection can produce the maximum transmitting current, so direct connection should be used as much as possible if conditions permit.

1.2.1 The way of wiring when measuring metal pipes

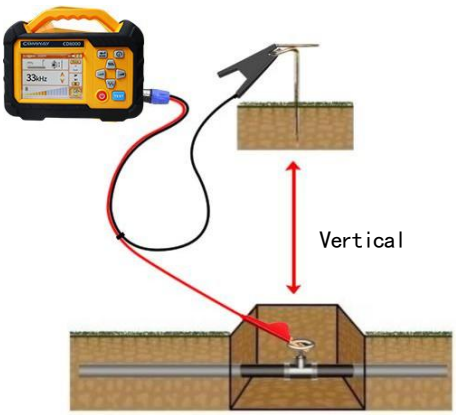


Figure 11 Wiring diagram of the direct connection method for metal pipes

As shown in the figure, insert the red and black test wire connection into the transmitter when a direct connection operation is required. Insert the ground pin into the ground, perpendicular to the line and at least 5 meters away. Connect the black test clip wire to the ground pin. Connect to the target pipe with a red test clip.

1.2.2 Measure the wiring method when the cable is out of service

Cable path detection and uniqueness identification play a significant role in the field of metal pipeline detection. Compared with the single continuous metal structure of metal pipes, cables are composed of several core wires and metal armor. The differences in their structure and purpose will cause differences in the way signals are applied during detection. Different connection methods will also generate different electromagnetic fields, and the detection effect will also be different. This chapter describes the signal transmission methods for cable detection separately.

1.2.2.1 Core wire - ground connection method (strong anti-interference ability, recommended)

The core-ground connection is the best wiring method for path detection and identification of offline cables (unenergized cables that have been taken out of service), which can give full play to the instrument's function and minimize interference, as shown in the following figure:

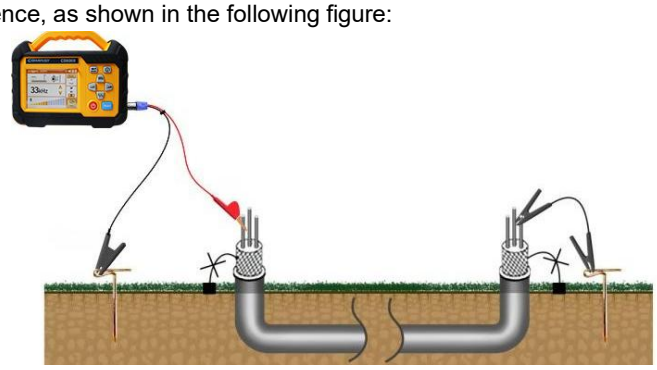


Figure 12 Wiring diagram of the core-ground connection

Figure 13 Schematic diagram of the signal flow direction of the core-ground method

Unplug the grounding wires at both ends of the metal sheath of the cable, and also unplug the grounding terminals of the neutral and ground wires of the low-voltage cable. Clamp a good core wire with the red clamp of the transmitter and attach the black clamp to the grounding pin driven into the ground. At the opposite end of the cable, ground the corresponding core wire to the ground pin driven into the ground.

Note: Try to use a grounding needle instead of a grounding grid directly! At least a grounding pin must be used at the opposite end of the cable, and the grounding pin should also be a certain distance away from the grounding grid, otherwise it will cause ground wire backflow on other cables, affecting the detection effect.

The current will flow from the transmitter through the core wire, into the ground at the opposite end of the cable, and return to the transmitter after flowing back to the near end. This connection allows the receiver to sense a very strong signal during ground detection, and the signal characteristics are relatively clear, which can make full use of the instrument's current direction determination function; The signal flows over a well-insulated core wire and does not flow to adjacent lines, especially not to intersecting metal lines, making it

most suitable for path finding in complex environments. In addition, the cable is grounded, and the signal voltage flowing through the cable is very low, making it difficult to generate capacitive coupling with adjacent lines, thereby reducing interference.

Due to the resistance and distributed capacitance between the core wire and the ground, the current gradually decreases as the distance increases. But if the ground is well grounded, it can be disregarded.

The method of connecting the core wire to the ground is more cumbersome to use, but the effective current on the target cable is the largest, and it is less likely to be disturbed by adjacent cables. If the cable is well insulated, the transmitted current will not flow to other intersecting metal conduits. Therefore, this method should be preferred in particularly complex environments.

1.2.2.2 Sheath - ground connection method (with potential problems, not recommended)

Wiring reference diagram:

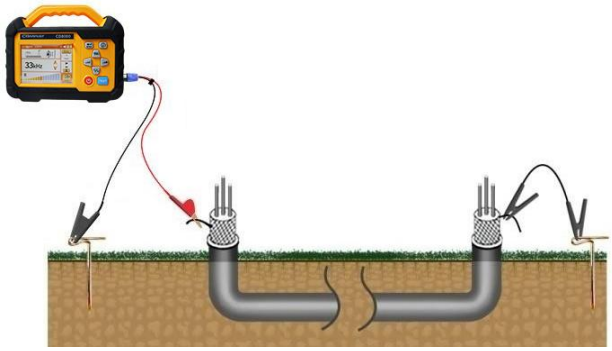


Figure 14 Sheath - ground connection wiring diagram

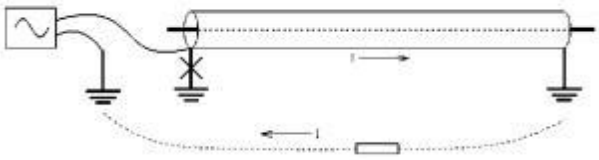


Figure 15 Schematic diagram of the signal flow direction of the cladding - ground connection method

As shown above, untie the grounding wire of the sheath at the near end of the cable. The grounding of the neutral and ground wires of the low-voltage cable should also be untied. Keep the sheath of the opposite end of the cable grounded. The signal is placed between the sheath and the grounding pin (**do not use** a **grounding grid)**. Keep the phase line of the cable suspended. The current will flow from the transmitter through the sheath, enter the ground at the opposite end of the cable, flow back to the near end and then return to the transmitter. This connection has no shielding and thus generates the strongest signal on the ground, and the signal characteristics are more distinct. Similarly, due to the presence of the protection-ground distributed capacitance, the signal gradually decays from near to far.

Potential problem: If the insulation outside the sheath (armor and copper shield) is damaged, some of the current will flow into the ground from the damaged point to form a shunt, causing the current behind the damaged point to suddenly decrease and affect reception.

1.2.2.3 Phase line - Sheath connection method (Wiring is simple, but it is difficult to eliminate interference from adjacent lines)

1. There is no need to remove the grounding copper braids at both ends of

the cable; the sheath is grounded.

2 Connect the red output end of the near-end transmitter to the red test lead and then to one end of the core wire, and connect the black output end of the transmitter to the black test lead and then to the sheath.

3 Short-circuit the core wire and sheath at the far end of the opposite end.

Wiring reference diagram:

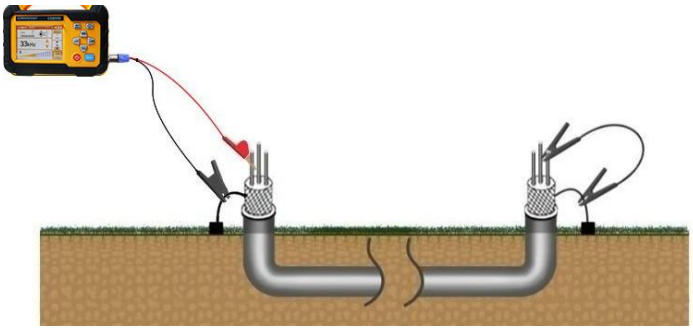


Figure 16 Phase line . Sheath connection method wiring diagram

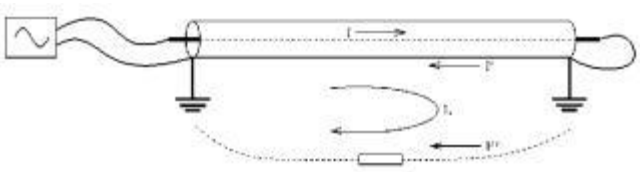


Figure 17 Schematic diagram of signal flow direction in phase line.sheath connection

As shown above, the transmitting signal is applied between one phase of the cable and the sheath. The opposite phase line and the sheath are short-circuited, and both ends of the sheath should remain grounded.

If a single cable is laid, the signal will flow from the transmitter through the core wire and then return through two loops, the sheath and the ground.

Because the sheath (armor and copper shield) is made up of continuous metal, the resistance is very low; Due to the ground resistance at both ends, plus soil resistance, the total resistance value of the ground loop is relatively large, so most of the current will return through the sheath, and a small portion of the current will return through the ground. Since the core wire current is opposite to the sheath current, the effective current that can generate the magnetic field signal at a certain distance outside is the difference, which is equal to the resistance current that returns through the earth. Additionally, due to the mutual inductance between the core-sheath loop and the protection-earth loop, an induced current can also be generated in the protection-earth loop through electromagnetic induction. The combined effect is that the effective current is equal to the vector sum of the resistive current and the induced current of the earth loop (with a phase difference between the two). Depending on the actual situation on the site, the effective current may account for a few percent to a dozen percent of the total injected current.

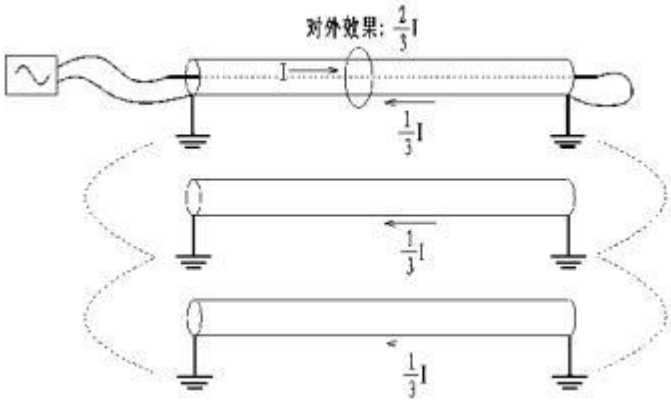


Figure 18 Shunt effect of parallel cables

As shown above, if there are other cables laid in the same path (with the same positions at both ends), the return current is mainly diverted by the sheaths

of several cables. For example, if three cables are laid in the same path, the return current of the sheaths of each of the three cables accounts for 1/3. The effective current is forward, accounting for 2/3 of the injected value, and the adjacent line current is reverse, accounting for 1/3.

1.2.2.4 Phase.to.phase method

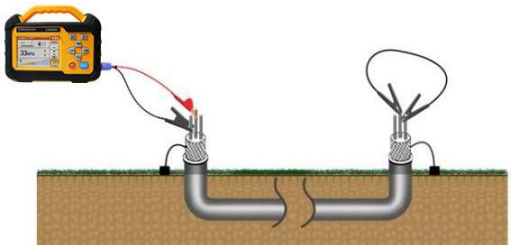


Figure 19 Phase indirect connection diagram

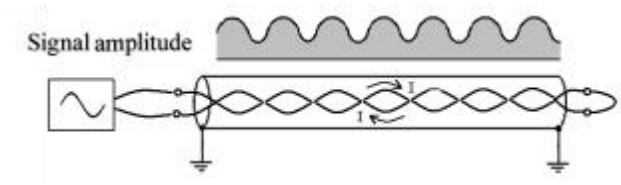


Figure 20 Schematic diagram of the signal flow direction of the phase indirect method

As shown above, the transmitted signal is applied between the two phases of the cable, and the opposite phase lines of the cable are short-circuited. The two phases are twisted inside the cable, with the same current values and opposite directions. Although the two phase lines are very close to each other, there is still a certain distance between them, so the distance between the two

phase lines and the receiver coil will cause a small difference. The magnetic fields produced by the two phase lines here are opposite in direction, but the intensity will not be exactly the same due to the distance difference. Most of them cancel each other out, but there is still a small residual part, which will be further weakened by the shielding effect of the metal sheath. The final remaining signal can be received. Because of twisting, the signal will have periodic amplitude and direction changes along the cable path.

During one twist cycle, the radiating flux will cancel each other out due to the continuous 360° change in direction, so no induced current will be generated in the protection-earth loop.

Since the effective signal is very small, it will be easier to detect using a high-frequency signal than a low-frequency one. The phase-to-phase method cannot use the current direction measurement function of the receiver to eliminate adjacent line interference.

1.3 Selection of the transmission frequency

Press the up and down buttons to switch frequencies. Different test methods have different selectable output frequencies.

There is no standard for which frequency to choose, and you can choose flexibly based on the following principles and the actual received detection effect:

- For general cable detection, unless phase-to-phase method is used, the default 3.20kHz frequency at startup is recommended for all other cases. It has a low frequency, a long propagation distance, and is less likely to sense other lines; Moreover, the receiver receives 3.20kHz signals better than 1024Hz and 1280Hz, has strong anti-interference ability and is easier to distinguish.

- For long-distance cables (longer than 2 to 3km), if a 3.20kHz signal is used, there will be greater attenuation at longer distances, the signal will not be easy to receive, and the phase will shift. Therefore, for detecting long-distance cables, 1024Hz and 1280Hz transmission signals are recommended, which have the characteristics of longer signal propagation distance and less likely to sense other lines.
- 1280Hz and 3.20kHz are composite frequency signals, and the receiver can give a correct or incorrect tracking prompt.
- When using the phase-to-phase method, high frequencies (8.19kHz to 82kHz) should be preferred.
- For generally well-grounded cables or conduits, the default 3.20kHz at startup is sufficient for most tests.
- For general line tracking, medium to high frequencies (8.19kHz) can be used, the signal travels a relatively long distance, and the induction of other lines is not very strong.
- For high-resistance lines (such as cable cores with floating ends, pipes with anti-corrosion coatings, cast iron pipes, etc.), higher frequencies (33kHz, 82kHz or) can be chosen. Although high frequency signals have strong radiation power, they travel a shorter distance and are more likely to sense other lines.

Notes:

- Location of the grounding pin: To ensure the detection effect, the grounding pin should be at least 5 meters away from the pipeline, and the black grounding wire should be as perpendicular as possible to the pipeline direction.

- Do not attach the black grounding clamp to water pipes or other pipelines, otherwise there will be transmitted signals on these pipelines as well, thereby interfering with the normal detection of the target pipeline.
- There should be no other lines between the grounding pin and the target line, otherwise these lines will also sense the emission signal and cause interference. A passive detection method can be used to check before the grounding pin is inserted.
- Ensure a good connection: If there is insulating varnish or severe rust at the pipe connection, it needs to be cleaned up first to ensure that the red test clip is directly connected to the metal part of the pipe.
- There may be insulation between different sections of the pipeline or between a fitting and the pipe. If insulated, the direct connection method cannot be used, or it is necessary to find an electrical connection between the two insulated sections. Check method: After confirming the wiring is correct, turn on the transmitter and observe the output current. If the current is too small to detect normally, it may be pipe insulation.

1.4 Output power adjustment

Tap the designated position on the screen or press the left or right buttons to increase or decrease the output power. There are 10 levels.

Output levels should be adjusted according to actual needs:

- A larger current can help with stable detection and accurate depth measurement.
- At higher frequencies (8.19kHz and above) and very shallow depths (within 1m), a higher output current may cause reception saturation distortion, resulting in nonlinearity of the receiver response and increased depth

measurement error. At this point, the output level should be appropriately reduced. When the receiver is saturated, the receiver will give a prompt

- Reducing the output power can effectively extend battery life, but it should not be overconsidered.

2. Clamp coupling method

- The clamp coupling method is suitable for situations where the pipeline is exposed but cannot (or is not allowed) access to its metal parts, and both ends of the pipeline are grounded (especially for power cables). The transmitting current clamp is directly clamped onto the cable for testing without any operation on the cable under test.
- The circuit model of the caliper coupling method for transmitting signals can be equivalent to a transformer: the magnetic core of the caliper can act as the magnetic core of the transformer, the internal winding of the caliper is the primary of the transformer, the pipeline - ground loop can be equivalent to the secondary (single turn) of the transformer, with the primary current provided by the transmitter and the secondary current generated by the coupling between the pipeline and the ground.
- The advantage of the clamp coupling method for transmitting signals lies in its convenient operation, no need for electrical connection with pipelines, no impact on the normal operation of pipelines, and the ability to reduce induction to other pipelines. The disadvantage is that the coupled current is less than that of the direct connection method, especially the requirement that both ends of the line must be well grounded, but some lines cannot

meet this requirement.

- The cable sheath must be well grounded at both ends, otherwise the coupling current will decrease as the grounding resistance increases. The magnitude of the coupling current is closely related to the loop resistance (mainly the grounding resistance at both ends). The smaller the resistance, the greater the current; conversely, the larger the resistance, the smaller the current. When it reaches a certain level, normal detection cannot be carried out.
- The clamp coupling method cannot be used if the two ends of the sheath are not grounded or the sheath is broken in the middle.
- When the launch clamp is inserted into the cable, the arrow on the clamp points towards the end of the cable.
- When probing the line, keep the receiving clamp 2 to 5 meters away from the transmitting clamp as much as possible. When identifying cables, keep the receiving clamp 2 meters away from the transmitting clamp as much as possible.

2.1 Interface Introduction

Insert the coupling caliper, or click to Coupling. The transmitter works in caliper coupling mode. The screen shows as follows:

Figure 21 Pipeline detection mode caliper coupling output interface

Figure 22 Cable identification mode clamp coupling output interface

2.2 Clamp coupling wiring

After connecting the excitation clamp input line to the transmitter, the excitation clamp clamps the exposed part of the pipeline as shown in the following figure:

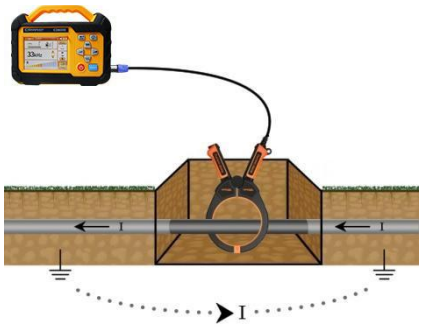


Figure 23 Clamp coupling wiring diagram

Clamp the cable body:

There should be no grounding busbar between the transmitting clamp and the receiving clamp.

Figure 24 Operating cable clamp coupling method 1 (clamp the cable body)

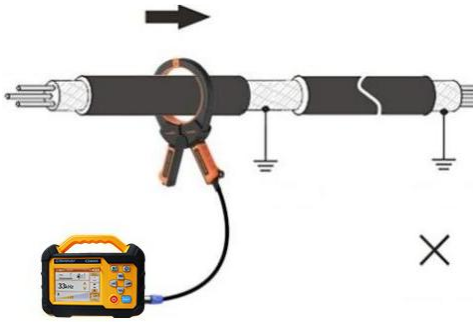


Figure 25 Demonstration of incorrect operation

As shown in the above figure, this method can be used for the detection of ordinary three-phase turnkey operation cables. The transmitter output is connected to the clamp, and the clamp is clamped onto the cable body (note that the part above the ground wire should not be clamped), then the clamp is equivalent to the primary of the transformer, the cable metal sheathed - ground loop is equivalent to the secondary (single turn) of the transformer, and the magnitude of the secondary coupling current is closely related to the loop resistance (mainly the ground resistance at both ends), the smaller the resistance, the greater the current.

However, the current obtained through the clamp coupling of the cable is relatively small, and a larger output level should be chosen to enhance the detection effect.

Hold the cable sheath ground wire:

Figure 26 Running cable clamp coupling Method 2 (Clamp cable ground wire)

As shown above, this method is applicable to the detection of ultra-high voltage single-core operating cables. Since the power frequency current flowing through the core wire of a single-core cable is very strong and there is no three-phase cancellation effect of a three-core wrapped cable (manifested externally as a relatively small zero-sequence current), if the clamp is clamped onto the cable body, it is very likely to cause magnetic saturation of the clamp and prevent the signal from being sent. At this time, the clamp should be clamped onto the grounding wire of its sheath.

Since the sheaths of long-distance ultra-high voltage single-core cables interconnect the ground wires at intervals, the signal will flow from the sheath of one phase to the sheath of the other phase at the interconnect point. Be careful to distinguish this when conducting detection and tracking.

For three-core jacked cables, if it is difficult to clamp the cable body due to field conditions, the method of clamping the cable's ground wire can be used, but it should be avoided as much as possible, as it may cause unexpected changes in signal characteristics (including amplitude and phase) in certain

special cases.

Notes:

- Both ends of the pipeline must be grounded in order to sense the signal. Grounding can be continuous grounding (such as in uninsulated pipes), or grounding at both ends (such as the metal armor of a high-voltage power cable grounded at both ends).
- It may also be insulated between different sections of a pipe, or between a fitting and a pipe. If insulated, it is necessary to find a way to electrically connect them, otherwise the clamp coupling method cannot be used.
- Whether current can be effectively induced in the pipeline can only be judged by the detection effect of the receiver. If it cannot be detected normally, other signal transmission methods should be used instead.
- When clamping the pipeline, make sure that the jaws of the caliper are completely closed and that the jaws are free of foreign objects and do not rust.

2.3 Frequency Selection

Tap the designated position on the screen or press the up and down buttons to switch frequencies.

The frequency selection method for the caliper coupling method is the same as that for the direct connection method.

2.4 Output power adjustment

Click the designated position on the screen or press the left and right buttons to increase or decrease the output power.

When using the clamp coupling to the line, the current is much smaller than the direct connection method, and the maximum output level should be used as

much as possible.

The clamp coupling method cannot show the voltage and current coupled to the pipeline.

3. Induction method

Induction is needed when there is no exposed point in the pipeline; The induction method is also mainly used when it is necessary to check for underground pipelines before ground excavation.

The transmitter uses the built-in radiation coil to emit a high-frequency electromagnetic field (primary field), the metal pipeline - earth loop couple out an induced current, the induced current emits an electromagnetic field (secondary field), and the receiver receives the secondary field for pipeline detection.

The advantage of the induction method is that it is convenient to operate, does not require wiring, and does not make any form of electrical connection to the pipeline. It is particularly suitable for pipeline detection without external exposure points and is also a major means of regional pipeline detection. The disadvantage is that the induced current of the pipeline is less than that of the direct connection method and the clamp method, especially when the depth of the pipeline is large, and it is suitable for pipelines with a depth of less than 2 meters; At the same time, it can sense signals for all pipelines within a certain range, but it will be difficult to identify specific pipelines.

3.1 Interface Introduction

The transmitter is working in induction mode, and the screen shows as follows:

Figure 27 The output interface of the induction method shows

3.2 Placement of the transmitter

When using the induction method, the transmitter does not need to be attached to any accessories.

For pipeline detection: Place the transmitter horizontally on the ground above the projected pipeline, and the opening and closing direction of the transmitter's cover plate is perpendicular to the projected pipeline direction. During the detection process, the receiver needs to be coordinated and adjusted according to the actual direction and position of the detected pipeline, as shown in the picture:

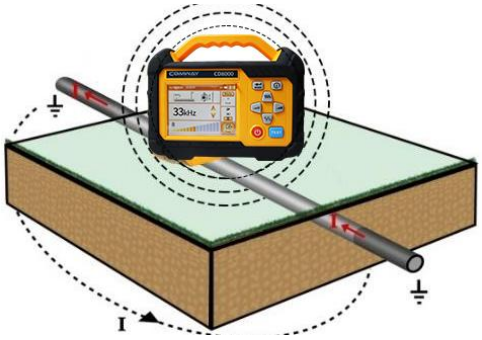


Figure 28 Induction method

For pipeline area exploration: Two people are required to operate on the area to be explored, and the transmitter and receiver move synchronously at a certain distance apart while keeping the directions of the transmitter and receiver consistent (see P48: Radiological exploration).

Notes:

- Both ends of the pipeline must be grounded in order to sense the signal. Grounding can be continuous (such as in uninsulated pipes), or it can be grounded at both ends (such as in the metal armor of a high-voltage power cable).
- Cables that are well insulated but not grounded at both ends will not be able to use the induction method, for example: some low-voltage cables have no metal armor, or the armor is not grounded, will also not be able to use the induction method or will have a poor effect.
- The transmitter should not be placed on a metal manhole cover, nor should it be used on a reinforced concrete road surface, otherwise the signal will be blocked by the manhole cover or the steel mesh and cannot be effectively applied to the pipeline below.
- In addition to radiating to the line, the transmitter inevitably radiates to the surrounding space, which can cause interference in reception. Therefore, when using the induction method, the receiver and the transmitter must be kept at a certain distance (transceiver distance).

3.3 Frequency Selection

Tap the designated position on the screen or press the up and down buttons to switch frequencies.

Notes:

- Low-frequency sensing is biased, but the signal travels a long distance and is less likely to cause interference.
- High frequencies have better sensing effects than low frequencies, but they travel shorter distances and are more likely to sense other lines.
- High frequencies should be used to detect high-resistance lines, and low frequencies will be difficult to detect applicable signals.

3.4 Power Conditioning

Tap the designated position on the screen or press the left or right button to increase or decrease the output power in 10 levels.

Notes:

- Using a lower output level can effectively reduce induction to other lines and shorten the transmission and reception distance.
- When probing deeper lines, the output level should be appropriately increased.
- Since the transmitter is unable to measure and display the magnitude of the current sensed in the pipeline, it can only be flexibly selected by repeated attempts based on the detection effect of the receiver.

4. Neutral wire/ground wire/sheath injection method

This method can be used for probing low-voltage cables in operation because many low-voltage cables' sheaths are not grounded, or the sheaths are discontinuous, or the grounding is not good enough to use the clamp coupling method.

This method does not require any changes to the cable, and it injects high-frequency signals, which will not cause adverse effects on the operating line.

At the user end, the red clip of the transmitter needs to be connected to the neutral wire, ground wire or sheath, and the black clip to the ground pin driven into the ground, as shown in the following figure:

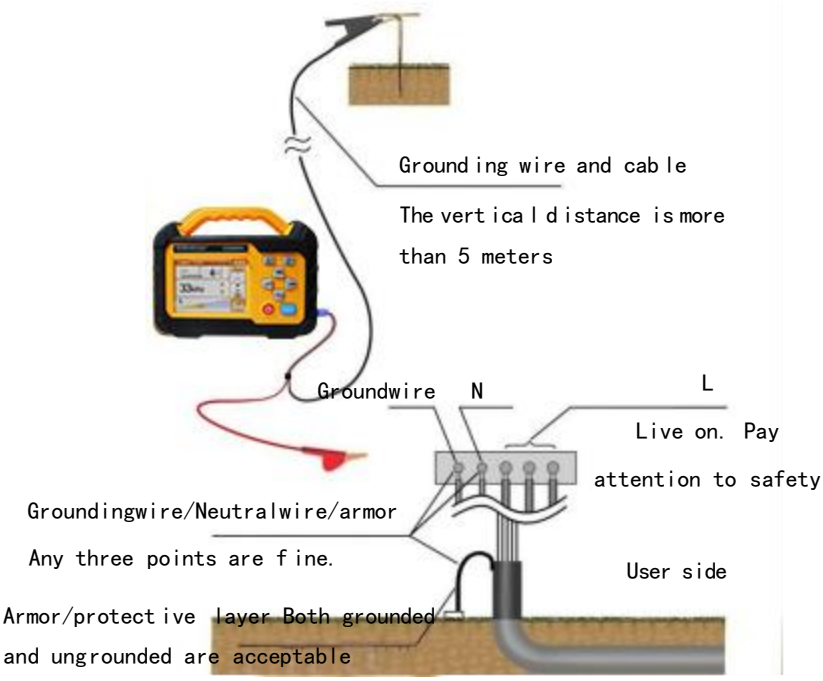


Figure 29 Running cable neutral/ground/sheath injection method

Notes:

- **Safety Warning: The cable is live. Wiring must be carried out by power workers with relevant qualifications or credentials!**
- Signals must be transmitted at the user end. If signals are transmitted at the transformer room end, signals will be injected across all outgoing lines, making it impossible to distinguish the target cable.
- Location of the grounding pin: To ensure the output effect, the grounding pin should be placed at least 5 meters away from the cable, and the grounding wire should be as perpendicular as possible to the cable direction.
- If the neutral wire is not grounded at the user end, use the neutral wire to inject the signal first.
- Since the sheaths of low-voltage cables are mostly discontinuous, if the sheath injection signal is too weak or the signal is interrupted at some point in the cable path during detection, the neutral wire/ground wire can be used for injection instead.
- Since the neutral/ground or sheath of all outgoing lines are connected in parallel in the transformer room, there will be a situation where some current is diverted from other outgoing lines. Although the signal can also be detected, the intensity is weak, and it should be distinguished in actual tests.
- When testing high-voltage operating cables, if no signal is received or the signal is weak using the clamp coupling method, it indicates that the grounding resistance of the sheath at both ends of the cable is too large. At

this time, injection can be made through the sheath.

- When detecting single-core ultra-high voltage operating cables, if the clamp coupling method fails, the sheath injection method can be used.

6. Receiver detection

1. Pipeline detection

Choose the appropriate signal transmission method

According to the output instructions of the transmitter in Chapter 5, select the most appropriate method and use the transmitter to apply the signal to the target pipeline.

Use the built.in coil induction method of the receiver for pipeline detection

The receiver does not need to be connected to any external accessory sensors and will be automatically recognized as built-in coil induction.

Avoid interference

Start probing near the launcher and make sure it won't interfere with it:

- When using the clamp method or the induction method, the transmitter will generate interference at a close range. The distance of the interference is related to the transmission power and frequency. The greater the power and the higher the frequency, the stronger the interference.
- The minimum distance between the receiver and the transmitter often needs to be tested, but 5 meters away in the caliper method and 20 meters away in the induction method can be considered to have no interference effect.

1.1 Set the receiving frequency

The default frequency is 3.20kHz, and the frequency can be switched by pressing the keys. The transmitting and receiving frequencies must be the same.

1.2 Gain adjustment

Press the keys to change the gain size from 0 to 96dB, and the gain decibel value will be displayed in the lower right corner of the screen.

1.3 Select the measurement mode

Press the mode key to select three response modes: wide peak, narrow peak, and sound valley.

- Wide peak mode:

The signal is strongest just above the pipeline. The advantage is high response sensitivity and wide response range; The disadvantage is that the response curve changes slowly, which is not conducive to the distinction of parallel pipelines.

- Narrow peak mode:

Similar to the wide-peak method, the advantage is that the response curve is steeper, which is beneficial for distinguishing parallel pipelines; The disadvantage is that the sensitivity is reduced.

- Sonic Valley mode:

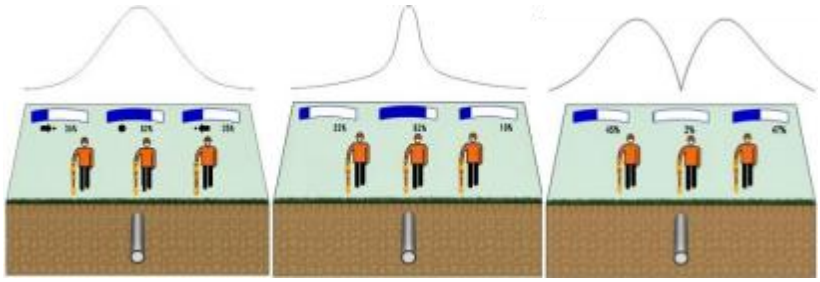
The signal is weakest directly above the pipeline, and the signal changes rapidly on both sides. The advantage is that it is conducive to the precise positioning of the target pipeline; The disadvantage is that it is vulnerable to interference and may have an incorrect response under strong interference.

By choosing different measurement modes, users can observe changes in the amplitude of the signal for pipeline detection.

Use the peak mode (wide peak or narrow peak) to find the point where the signal is strongest and start the pipeline detection from that point. Swing the receiver left and right, and the signal amplitude will decrease on both sides. Track the peak position (the point where the signal is strongest in peak mode) or the valley position (the point where the signal is weakest in sound valley mode) until you find the path of the entire pipeline.

When using the Sound Valley mode, the tracking speed can be improved. The signal is the weakest directly above the pipeline, while the signals on both sides increase rapidly. However, the valley mode is vulnerable to interference, so it should be switched to peak mode at intervals to verify the correct position of the pipeline.

The responses in different modes are shown in the following figure:



a. Wide peak b. Narrow peak c. Sound Valley

Figure 30 Signal responses in different modes

1.4 Introduction to the wire cruise mode interface

When the receiver approaches above the line, the blue simulated line in the

center of the screen shows the line position below the receiver intuitively, and the arrow in the center points to the cable; When the receiver is right above the line, the arrow becomes the origin, allowing for quick tracking of the line.

Observe the signal amplitude and use different measurement modes to determine where the cable is located below, as described in Section 1.3. The recommended signal amplitude is shown to be around 60.

Observe the direction of the pipeline position arrow. If the position arrow is to the right, it indicates that the cable is on the right and should be moved to the right; otherwise, it should be moved to the left. When the arrow becomes a dot and moves slightly left and right, the arrow will reverse and the receiver will be directly above the cable.

The current direction can be determined by observing the signal direction arrow, as described in Section 1.6. The current direction will only be shown at 640Hz, 1280Hz, 2.56kHz, and 3.20kHz.

Note: The origin does not always appear when the signal is weak or the interference is strong, as indicated by the direction change of the arrow.

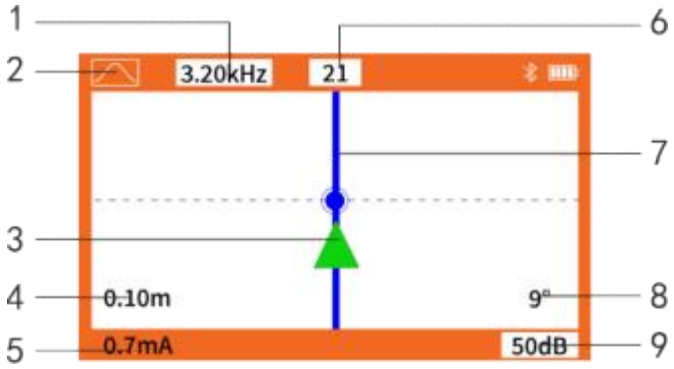


Figure 31 Wire cruise mode interface

1. Frequency 2. Mode 3. Signal direction arrow 4. Real-time depth 5. Real-time current

6. Signal amplitude 7. Analog pipeline 8. Phase 9. Gain

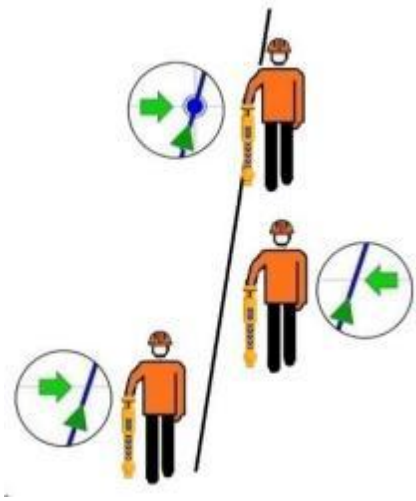


Figure 32 Demonstration of the wire cruise mode function

Notes:

- Whether facing the end of the pipeline or the transmitter, the arrows point to the pipeline correctly.
- When there is also a strong signal in the adjacent pipeline and the receiver is located near it, there will also be an analog pipeline indication, but it shows the adjacent pipeline rather than the target pipeline. Pay attention to the distinction.

- When interference from adjacent lines is significant, analog line indications may deviate, and if precise positioning is needed, refer to Subsection 3: Precise Positioning.

1.5 Introduction to the classic positioning interface

When the receiver approaches above the line, the compass in the center of the screen can visually show the direction of the line beneath the receiver, and the arrow in the center points to the direction of the signal in the cable;

Observe the signal amplitude and amplitude bar, and use different measurement modes to determine where the cable is located below, as described in Section 1.3. The recommended signal amplitude value shows around 60, and the amplitude bar shows in the middle position.

Observe the direction of the pipeline position arrow. If the arrow is to the right, it indicates that the cable is on the right and should be moved to the right; otherwise, it should be moved to the left. The display length of the pipeline position arrow will be related to the offset distance of the pipeline. The closer to the pipeline position, the longer the position arrow; conversely, the shorter the arrow length.

The current direction can be determined by observing the signal direction arrow, as described in Section 1.6. (Calibration is only available if the selected frequency signal has directional characteristics)

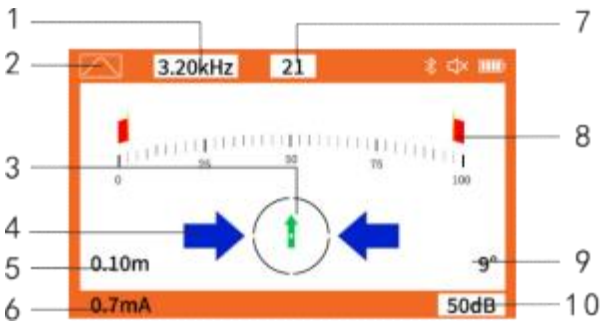


Figure 33 Classic positioning interface (1)

1. Frequency 2. Mode 3. Signal direction arrow 4. Pipeline position arrow 5. Real-time depth

6. Real-time current 7. Signal amplitude 8. Amplitude bar 9. Phase 10. Gain

The following picture shows the display interface when the frequency signal does not have directional characteristics.

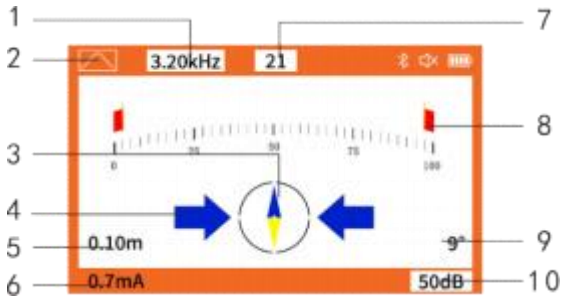


Figure 34 Classic positioning interface (2)

1. Frequency 2. Mode 3. Signal direction arrow 4. Pipeline position arrow 5. Real-time depth

6. Real-time current 7. Signal amplitude 8. Amplitude bar 9. Phase 10. Gain

1.6 Current direction determination

The current in the adjacent line is generally less than that in the target line, but the receiver's response is related to the depth of the line, possibly because the target line is deeper and the adjacent line is shallower, resulting in a small difference in the receiver's response amplitude above the two, making it impossible to distinguish. There are also other reasons that directly cause the current in the adjacent pipeline to be similar to that in the target pipeline, making identification more difficult.

This function can only be used in the wire cruise mode and the classic positioning mode.

To use the current direction determination function, it must work at 640Hz, 1280Hz, 2.56kHz, 3.20kHz frequencies, and the line signal direction arrow is not displayed at other frequencies.

When using this function, the receiver measures the current phase in real time and compares it with the reference phase. The process of recording the reference phase is called calibration, and the calibration data will not be lost when the device is turned off.

At a distance that is close to the transmitter but not disturbed by it (such as 5 to 10m), clearly identify the position of the target pipeline, directly above it, away from the transmitter, facing the end of the pipeline, press the long key, and the flashing prompt in the upper right corner of the screen will ask if you want to perform phase reset calibration. If you press other keys, the calibration operation will be cancelled. If you press the key again, confirm the calibration, the current phase will be reset: The direction of the pipeline signal changes to a green arrow and points directly above, the phase value shows 0°, and the

current phase measurement after calibration is based on this.

When probing or identifying another line, recalibration must be performed for the target line that needs to be detected.

While tracking the pipeline, observe the direction arrow of the pipeline signal. If the green arrow points upwards, it indicates that it is above the pipeline to be tested. If the arrow points down and turns red, it indicates that the adjacent pipeline is being tracked, as shown below:

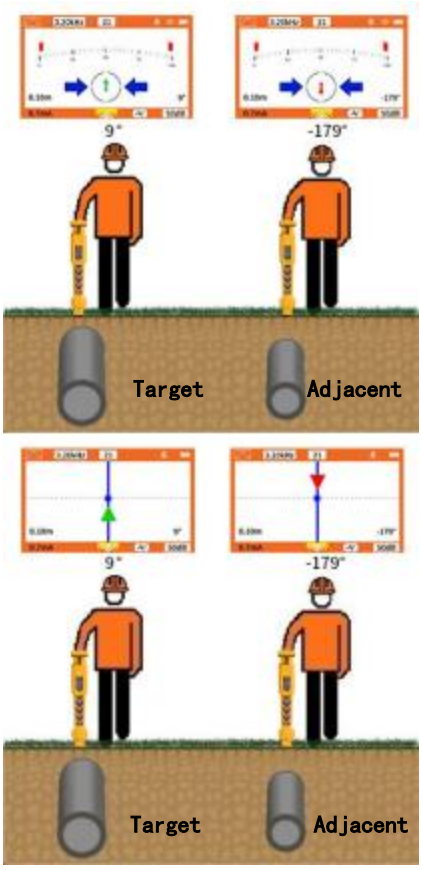


Figure 35 Current direction determination

The signal amplitudes of adjacent lines may be small or large, and there will also be arrows indicating them.

If it is a very long pipeline, due to the influence of distributed capacitance, the phase value deviation will gradually increase. When it reaches a certain level of influence on judgment (for example, greater than 45°), recalibration can be done directly above the confirmed target pipeline, and the phase value will be

displayed again as 0°. The signal direction arrow points directly above and is green.

The process of determining the current direction is shown in the following figure:

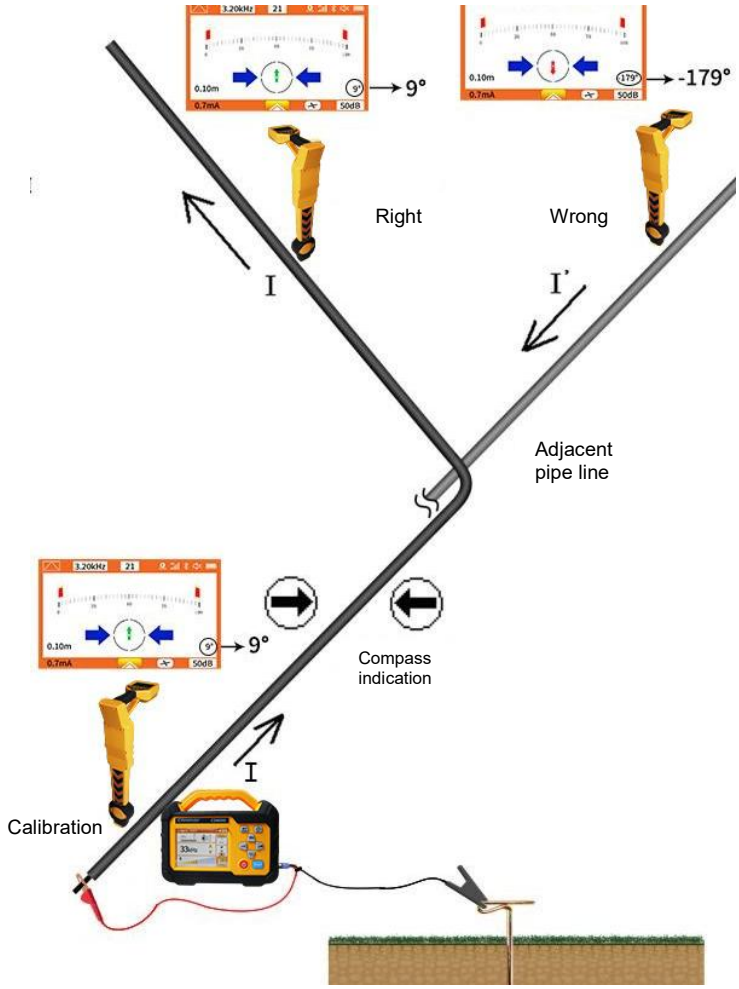


Figure 36 Signal direction tracking detection process

1.7 Introduction to the signal strength interface

This interface shows historical curves of signal amplitudes for recording and distinguishing signal changes over time.

Figure 37 Signal strength interface

1.8 Use sound output to assist tracking

The sound output from the receiver speaker can reflect the current signal strength in real time, which is helpful for tracking the pipeline.

Press the key to enter the Settings interface, press the key to move the cursor to select the **sound Settings bar**, press the key to turn on or off the signal strength prompt tone

2. Area detection

To avoid damaging pipelines, it is important to find out whether there are unknown pipelines before ground excavation. Here, it is necessary to use the area probing method to identify unknown pipelines. There are two types of probing methods: the passive method and the induction method.

2.1 Passive exploration

Passive probing is a passive detection method that does not require the use of a transmitter. Adjust the receiver's frequency to power frequency/radio frequency and the mode to wide peak (or narrow peak), conduct a grid-like search, switch to the signal strength interface, observe the historical curve, and there will be a peak response above the pipeline. Mark it on the ground as shown in the following figure.

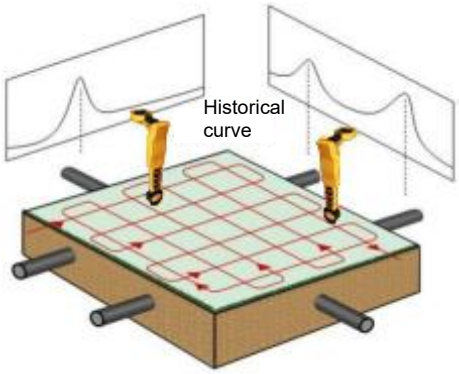


Figure 38 Passive method area exploration

Power frequency method: The power frequency method receives power frequency and fifth harmonic signals emitted by the pipeline and is particularly suitable for probing operating cables. Some (but not all) other lines can also be detected due to the presence of power frequency induced current, so the lines detected by the power frequency method cannot be identified as power cables. The power receiving frequency is 50Hz.

Notes:

- When receiving power frequency, real-time depth measurement is not possible.

- In passive detection, the adjustment of gain is very important. Some strong signal lines have a strong response at low gain, but weak signal lines require a very high gain to detect. Therefore, after checking the strong signal lines, the gain needs to be increased for another search. Strong signal lines will experience saturation distortion at high gain, but their interference can be ruled out by observing the already marked ones.
- Power frequency detection does not ensure that all pipelines are detected.

2.2 Radiological exploration

Induction probing requires the transmitter to use induction to transmit signals in coordination, and also requires two operators. Before probing, determine the area to be searched and the possible direction in which the pipeline passes through that area, put the transmitter in induction mode, and set the frequencies of the transmitter and receiver to be consistent. One person operates the transmitter and the other operates the receiver, with both the transmitter and receiver perpendicular to the pipeline. Two people are spaced about 20 meters apart, along at the same time

It moves parallel to the pipeline. When the transmitter passes through the pipeline, the signal will be sensed on the pipeline and the receiver will receive the signal. Observe the receiver response. If there will be a peak response above the line, mark it on the ground as shown below:

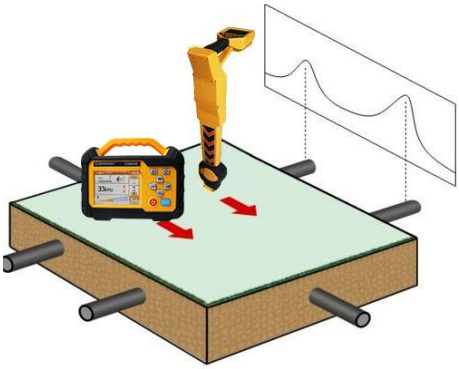


Figure 39 Induction area exploration

After probing in one direction, swap the positions of the transmitter and receiver and probe in the opposite direction again.

Probing is required in every possible direction.

After marking the positions of all the lines, place the transmitter above each line in sequence and use the receiver to track each line until it leaves the area to be explored.

Induction detection is the most reliable method for regional pipeline detection, but it cannot guarantee the detection of all pipelines due to its own limitations (such as requiring pipelines to be grounded, concrete roads with steel mesh cannot be used, etc.).

2.3 Comprehensive Inspection

Since different methods have their advantages and limitations, in order to prevent missed inspections, one, multiple, or even all methods should be used repeatedly depending on the site conditions to minimize the possibility of construction damaging the pipelines.

3. Precise positioning

When affected by interference or adjacent pipelines, deviations may occur at times. If more precise positioning of pipelines is required, the following methods can be used manually:

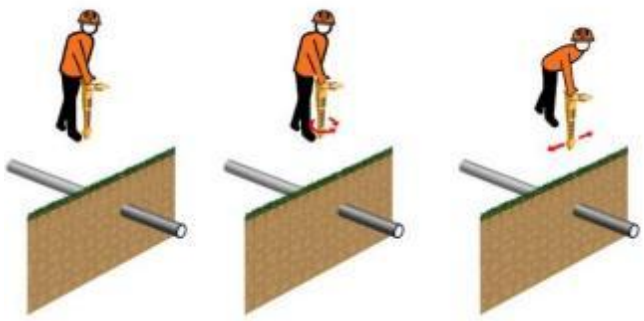
After finding the approximate position of the target pipeline, use the wide peak or narrow peak method and adjust the appropriate gain:

a. It is necessary to keep the receiver perpendicular to the expected pipeline direction and find the point where the response is maximized.

b. Do not move the receiver randomly. Place it in place and rotate it to find the Angle with the maximum response.

c. The Angle needs to be maintained. Move the receiver left and right to find the point where the response is the greatest and mark it.

Repeat these steps to improve the positioning accuracy. The operation process is shown as follows:



a b c

Figure 40 Precise positioning

When switching to the Otome method, find the corresponding smallest point according to the Angle determined in step b and mark it.

If the peak and trough positions are the same, the positioning is accurate. If they are different, it indicates that there may be adjacent pipelines affected by which the positioning is inaccurate and needs to be corrected.

As shown in the figure below, the peak and trough points are biased towards the same side of the pipeline, and the actual location is on the other side of the peak point, at a distance of half the peak and trough distance from the peak point.

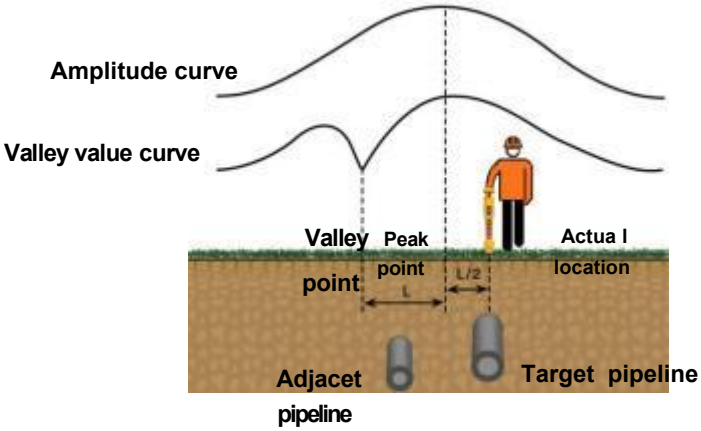


Figure 41 Positioning correction

4. Depth measurement

4.1 Automatic measurement of depth and current

When the receiver determines that it is basically directly above the pipeline and performs real-time depth and current measurements, the display is as

follows:

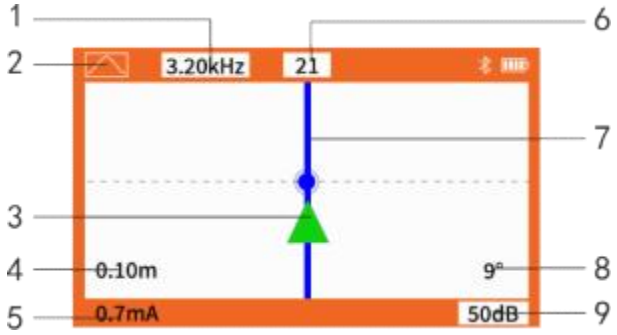


Figure 42 Real.time depth and current measurements

1. Frequency \ n2. Mode \ n3. Signal direction arrow \ n4. Real-time depth \ n5. Real-time current

6. Signal amplitude 7. Analog pipeline 8. Phase 9. Gain

1. A dot is shown in the center of the screen, and the dot is pressing against the line, indicating that the receiver is basically directly above the line.
2. The line in the interface is basically in the up and down direction (as shown in the picture, the blue line is vertical to the interface, and the signal in the line points forward), indicating that the detection direction is basically in line with the direction of the line.
3. Phase is not a prerequisite for real-time depth measurement, but at frequencies of 640Hz, 1280Hz, 2.56kHz, and 3.20kHz, a phase within ±30° indicates correct tracking, indicating that the current position is above the target line (rather than the adjacent line), and is an important reference.
4. Depth is measured in m (m).

Notes:

- The speaker's output can affect real-time depth measurement, and in general, the speaker should be muted as much as possible.
- A way to verify whether depth values are reliable: bring the receiver close to the ground and measure once, raise it 0.5m and measure again. If the difference between the two depth data is around 0.5m, the result is reliable.
- Real-time depth and current measurements cannot be carried out when using passive detection.
- If the signal is transmitted using the induction method, the measurement error will be greater than that of the direct connection method or the caliper method. If induction must be used, the distance between the receiver and the transmitter should be more than 20 meters.
- Try not to measure near pipeline turns or tees (cable T-junctions), and ensure that the receiver is at least 5 meters away from the turn or tee.
- The measured depth is the distance between the bottom of the receiver and the center of the pipeline, while the depth at the top of the pipeline is less than the depth reading, and the difference is more obvious when the diameter of the pipeline is larger.
- Interference from parallel lines can increase the depth measurement error, and in severe cases, the data will not be reliable. A precise positioning method can be used to determine whether automatic measurement can be used: if the peak point coincides with the trough point, the depth measurement data is reliable; If they do not overlap, there is adjacent line

interference, and the greater the peak-valley distance, the greater the depth measurement error.

- The current value helps to identify the target pipeline. In some cases, the current in parallel lines is small but the depth is shallow, causing the adjacent line signal to be larger than the target line signal, which can lead to incorrect tracking results. It is necessary to measure the currents of the parallel lines separately. The line with the largest current (rather than the strongest signal) is the target line.
- According to the rule that current values vary with distance, it can help to analyze pipeline conditions. The transmitter applies a signal to the target pipeline, but the current intensity gradually decreases as the distance increases (gradually leaks back to the transmitter), and the degree of attenuation depends on the type of pipeline and soil. If the rate of current attenuation remains steady and there is no sudden drop, it indicates that the pipeline is normal. If there is a sudden drop in current, one situation is that the pipeline has a three-way (cable T connection) here, and the current is diverted; Another situation is that there is an insulation break at this point and it is grounded.
- Current measurement is carried out on the basis of its correct depth measurement. If the depth data is not reliable, then the current value is also not reliable.
- Special note: In most of the stricter pipeline exploration specifications, the results of its automatic depth measurement are not adopted regardless of

the equipment used. Although real-time depth measurement is very convenient and its accuracy can basically meet the requirements in some cases where the transmission signal is strong, the interference is small, and the pipeline is not too complex, its results can only be used as a reference. For more reliable depth measurement, the sound valley 45° method or the wide peak 80% method should be used for manual depth measurement.

4.2 Manual depth measurement using the 45° valley method

When using the valley method, locate point A on the line where the signal is weakest; Then tilt the receiver 45° and move it to one side of the pipeline until you find another point B with the weakest signal; Tilt the receiver another 45° in the opposite direction and move it to the other side of the pipeline to find another point C with the weakest signal.

In general, Depth is equal to AB and also to AC. Adjacent lines may cause signal valleys to occur not directly above the lines, so it would be more accurate to assume Depth is half of BC.

Note that when tilting the receiver, pay attention to the marking lines on the receiver. When one marking line is horizontal to the ground and the other is vertical to the ground, the receiver is correctly tilted at 45°.

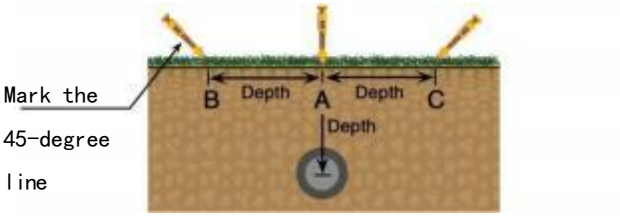


Figure 43 Sound valley 45° sounding method

4.3 Wide peak 80% method manual depth measurement

When using the wide peak method (narrow peak method and valley method cannot be used), locate the point on the line where the signal is strongest, press the gain knob, and the automatic gain adjustment amplitude is 60%; Then move the receiver left and right horizontally to find two points where the signal amplitude weakens to 48%, and the distance between the two points will be equal to the depth of the pipeline, as shown below:

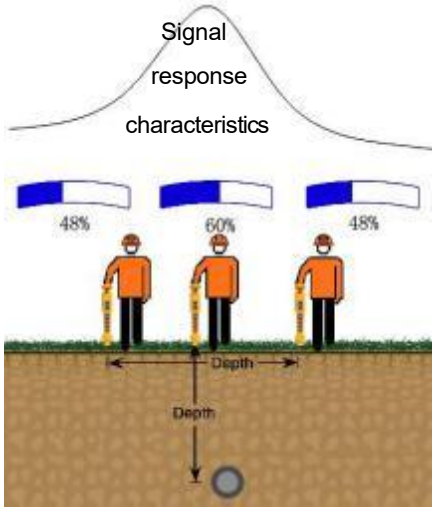


Figure 44 Wide peak 80% method depth measurement

5. Cable identification (optional)

In power construction, the identification of the uniqueness of cables is a very demanding task because it involves facility and personal safety. Flexible calipers are needed.

5.1 Selection of Signal Transmission Methods

- The transmitter has multiple frequencies to choose from, among which the 3.20kHz frequency can meet most of the test requirements.
- Direct connection can be used for non-operational cables, with the core wire - ground connection preferred; If wiring is not convenient, the phase line - sheath connection may be used, but the sheath - ground connection is not recommended.
- For operating cables, the clamp coupling method is preferred. If it cannot be used, the neutral wire/ground wire/sheath injection method should be used with caution.
- Do not use the induction method to transmit signals.

5.2 Interface Introduction

When powered on, the receiver automatically recognizes connected accessories and enters cable identification mode, with the following interface:

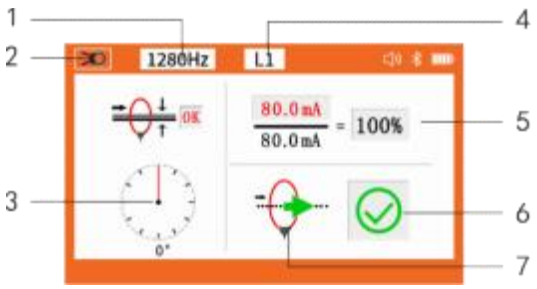


Figure 45 Cable identification interface

1. Frequency 2. Mode 3. Phase dial 4. Signal amplitude 5. Ratio of measured value to calibrated value

6. Identification result 7. Current direction

The receiver works at 3.20kHz by default when powered on, and set the frequency to be consistent with the transmitter; There is no need to adjust the gain in cable recognition mode. The current value is displayed directly and compared with the calibrated current to calculate and show the percentage. The phase dial shows the current phase; Identification results show identification right or wrong ICONS o 。

5.3 Calibration

The receiver can pre-calibrate 10 cables, or calibrate 10 signals on the same cable.

For the same cable, multiple data calibrations can be carried out at different frequencies. After the staff arrive at the remote end, they inform the operators at the nearby end by phone to change the transmitter's transmission frequency and transmission power to match the pre-calibrated data, and then identify it through the receiver, so that the

operators do not have to run back and forth for calibration and improve efficiency.

The identification of live cables requires the receiver to first measure the magnitude and direction of the current at a known position of the target cable as a reference point for comparison, and then compare the measurement results at the unknown point with the reference point to determine whether the identification is correct or incorrect. The process of measuring and recording the detection current and its direction is called calibration.

Calibrate at a location close to the transmitter and where you can ensure that you won't be disturbed by it. For the clamp-coupled transmission signal, the flexible current clamp should be clamped onto the target cable as far as 2m away from the transmission clamp.

Calibrate when both the arrow on the transmitter caliper direction and the arrow on the flexible current caliper point to the end of the cable, so that the received signal is maximized. After each signal is calibrated, do not change the instrument's output frequency and output power, otherwise recalibration is necessary.

In the cable identification interface, select the appropriate frequency so that the detection current display is not less than 0.3mA, the calibration status box shows the "" icon, and the display is stable, then the calibration operation can be carried out.

Initial calibration: The receiver is turned on without calibration, and it enters the pre-calibration state by default. The identification result box shows "",

indicating that it asks whether to perform calibration; Press the key to perform calibration. When the "OK" icon is displayed in the pending calibration status box and the recognition result box shows the recognition result, the calibration is successful.

Note: After calibration is successful, the frequency cannot be changed by pressing the keys.

Recalibration: If the receiver has been recalibrated, you need to press the key to exit the current cable identification interface. At this point, the interface prompts "Do you want to delete all calibration data?" By pressing the keys to select "Yes" and then pressing the key, the previously calibrated data will be deleted and the cable can be recalibrated. If no recalibration is required, select "No".

Multi-cable calibration: After completing the **calibration of the first cable (cable number L1) through the initial** calibration operation, use spray painting or other methods to mark L1 on the cable (for easy identification); Then hold the second cable in place with the coupling transmitter clamp of the transmitter and the flexible receiver clamp of the receiver. Press the key to select the second cable number, such as L2. When the second cable number is selected, the identification interface corresponding to that number is in an uncalibrated state, at which point the user can **calibrate the second cable following the initial** calibration steps. After the same calibration, use spray painting or other methods to mark L2 on the cable.

If you want to calibrate a third cable or more, you need to follow the same

steps as before, clamp the third cable with the coupling transmitter clamp and the flexible receiver clamp, operate the receiver to select the third cable number, perform the calibration operation, mark it, and so on.

Each frequency and each cable number has its own calibration operation. After calibration, when conducting remote cable identification, the near operator must be informed that the transmission frequency is the same as the calibrated frequency, and the transmitter's transmission frequency and transmission power should not be changed at will. Otherwise, they must return to the near end of the cable for recalibration.

When calibrating another cable for identification, calibrate the new identified **cable through the operation of multi-cable** calibration. Or use the same cable number and **calibrate the new cable through the recalibration** operation.

For the same cable, different frequencies and different amplitudes can be combined for parameter calibration, and for the same cable, 10 combinations of parameters can be calibrated. For example, L1 number calibration frequency is 640Hz, 1280Hz, transmitter output power is 5 stops; L2 number calibration frequency is 640Hz, 1280Hz, transmitter output power is 10 stops; L3 number calibration frequency is 3.2kHz, transmitter output power is 5 stops; At this point, L1, L2, and L3 refer to the same cable. The advantage of this method is that some cables may be too long or the impedance of the ground loop is too high, and one frequency or gain cannot be identified, and another frequency or gain needs to be used for identification. After the multiple combination parameters are calibrated,

the operator does not have to run back and forth.

5.4 Identification Process

A. Confirm that the output of the transmitter is normal

The following operation takes the clamp coupling method as an example. The identification operation of the direct connection method is basically the same as that of the coupling method.

B. Proximal identification confirmation

Cable identification: The transmitter coupling clamp is clamped near the cable, the arrow direction points to the far end of the cable, the flexible current clamp is at least 2m away from the transmitter clamp to clamp the cable (no need to be far away using the direct connection rule) to prevent receiving interference, the arrow on the interface of the flexible current clamp points to the far end of the cable, adjust the frequency to be consistent with the transmission frequency on the transmitter, adjust the output power of the transmitter to the maximum, When the receiver detects the maximum current, there is a "" icon to indicate; Try switching the frequency and output power to achieve the best measurement results. Follow the calibration operation steps mentioned above; After calibration, the ratio box of the measured current to the calibrated current shows 75% to 135%, the current direction box shows a green arrow pointing to the right, and the recognition result box shows a "green √ icon" accompanied by a "beep - beep" prompt sound.

Note: This step helps to confirm what output power and what frequency is appropriate.

When using the clamp to couple to the line, the current is much smaller than the direct connection method, and the maximum gain should be used as much as possible. The clamp coupling method cannot show the voltage and current coupled to the pipeline.

C. Remote identification

After calibration is successful, leave the transmitter in place. After leaving the calibration point, the calibration cannot be changed, nor can the transmitter and receiver transmit frequencies or the transmitter's output power be altered. Reach the remote location where identification is needed, hold the cable with the flexible caliper and identify one by one.

Note that the direction arrow of the flexible caliper remains pointing to the end of the cable.

If the target cable is clamped, the detected current is not much different from the calibrated current, the direction of the current can be measured, and it meets the following judgment criteria:

- The detection current is not less than 0.3mA.
- The detection current is greater than 75% of the rated current value and less than 135%.
- The current direction shows a green arrow pointing to the right.
- Refer to the **5.6 flexible caliper current measurement instructions** when the frequency range is above 8.19kHz.

If the above conditions are met, it indicates the target pipeline, the identification result shows a "green mark √ icon", and the receiver is

accompanied by a "beep - beep" prompt sound. If the above criteria are not met, it indicates that it is another nearby pipeline, and the identification result shows "red × icon" or "black? Icon, no prompt tone, is a non-target cable.

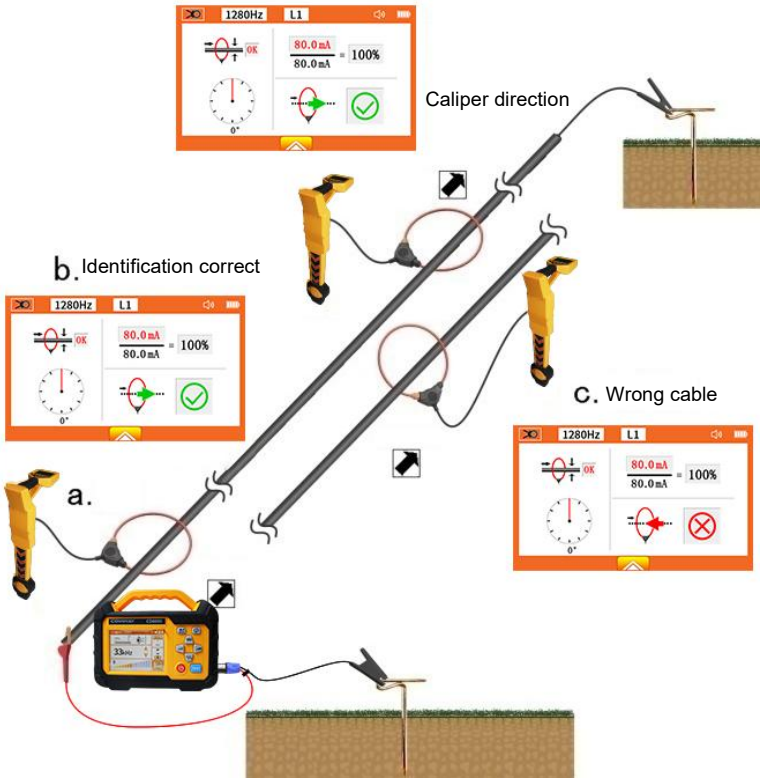


Figure 46 Schematic diagram of cable identification

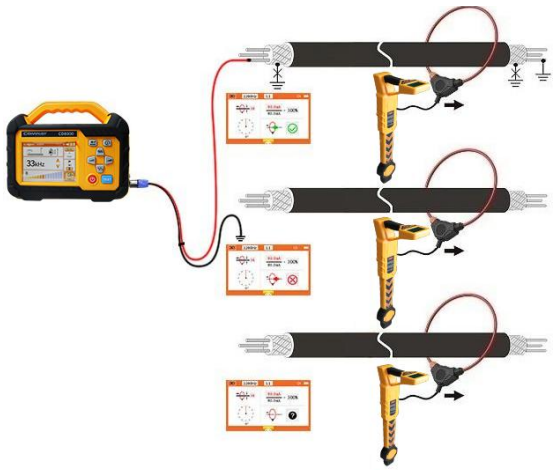


Figure 47 Wiring detection for power failure identification (direct connection method)

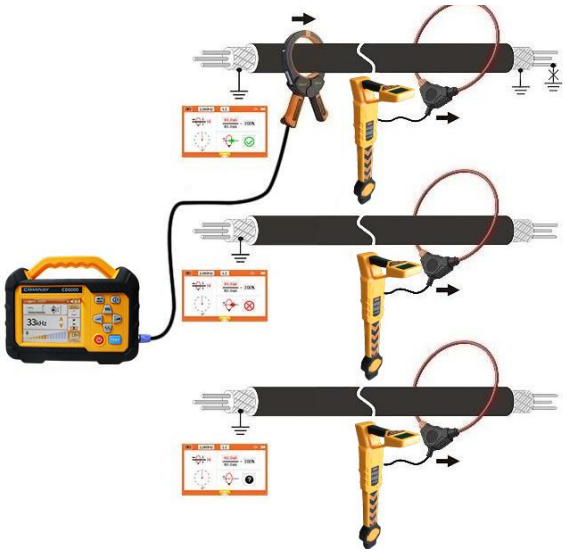


Figure 48 Live identification (coupling method) wiring test

Figure 49 areas prone to interference with flexible coils

Note: Do not measure near the coil interface to avoid error.

Clip to the right side of the target cable display

Green mark √ icon

Card on the right side of the non-target cable

entificatio Red × icon or black? ICONS

note meaning	When remote identification, please perform an identification operation on all cables once. Whether it is a live cable identification or a power outage cable identification, the identification result will be **unique**. If two checked cables appear, please refer to the following precautions to analyze and check for errors.

Notes:

If two or more cables show

a "green √ icon", or all show a "red × icon or black? Special attention must be paid and no hasty conclusion should be drawn. This situation is likely due to incorrect wiring method of the transmitter. The following errors should be checked first:

- Calibration is incorrect or does not wait until the detection current signal is stable for calibration.
- The direction of the current caliper is inverted (opposite to the direction it was calibrated).
- Instead of seizing the target cable in the identification, only a few adjacent wires were seized.
- The transmitter frequency doesn't match the receiver frequency.
- The gain at calibration is inconsistent with the gain at identification.
- Test current less than 0.3mA.
- The target cable is damaged or disconnected.
- There is dirt in the jaws of the caliper. Wipe it clean and recalibrate and identify.
- After calibration, the receiving frequency of the receiver and the output power of the transmitter were changed without recalibration.
- The cable number on the receiver does not match the mark of the stuck cable on the transmitter.
- If you still can't determine, power off the target cable and use the power-off cable identification method to identify it!

5.5 Multi-cable identification

1. At the near end of the cable, switch the different calibration numbers by pressing the keys to calibrate ten cables from L1 to L10; The following operation takes the clamp coupling method as an example, and the direct connection method's multi-cable identification operation is the same as the coupling method.

2. Reattach the transmitter caliper to the first marked cable (the cable marked with L1), operate the receiver keys to switch the cable number, select the L1 number, come to the far end of the cable where identification is needed, identify the cable corresponding to the L1 number according to the steps and criteria in **Section 5.4** above, and mark the cable accordingly.

3. Contact the nearby user via mobile phone and ask them to attach the transmitting clamp to the second marked cable (the cable marked with L2), operate the receiver to select the L2 number, and continue to follow the cable identification steps to identify the cable corresponding to the L2 number and mark it accordingly. And so on, so as to identify multiple cables in sequence.

Note: "Near end" means the end close to the transmitter, and "far end" means the place where the engineer needs to identify the corresponding cable.

5.6 Flexible caliper current measurement

Other frequencies except 640Hz, 1280Hz, 2.56kHz, 3.20kHz can only measure current, cannot measure phase and calibrate, thus cannot make intelligent judgments, but can make manual judgments based on current values.

For frequencies 8.19kHz, 33kHz, and 82kHz, due to the higher frequency, the distributed capacitance leakage of the signal between the cable and the ground is greater, and the measured current values will gradually decrease with increasing distance.

The signal injection method and precautions of the caliper current measurement method are basically the same as those of the smart caliper method.

Smart identification should be used first, while current measurement is only used as an aid.

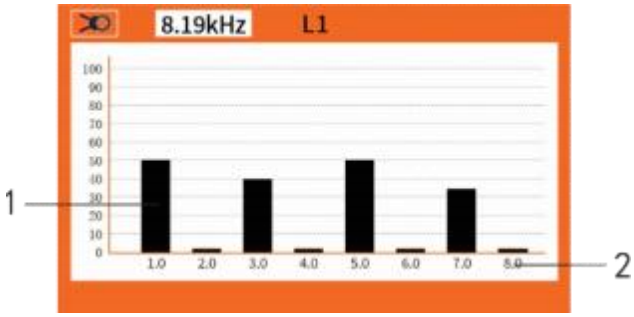


Figure 51 Cable identification interface above 8.19kHz

1. Amplitude bar 2. Timeline

Note: The recognition of frequencies above 8.19kHz needs to be done manually, and the recognition result can only be used as a reference, not as the final recognition result. In the process of cable replacement or other operations, the test results of the cable should be re-verified using the power-off cable identification function of this instrument when the cable is disconnected.

8. Pipeline Grounding Fault Location (Optional Function)

The pipeline grounding fault location function needs to be used in conjunction with the A-frame, using the step voltage method to locate the fault point.

The grounding faults of the pipeline mainly include:

① The insulation protection layer of the insulated pipe is damaged;

② Ground fault of unarmored low-voltage cable;

③ High voltage cable sheath failure (especially for ultra-high voltage single-core cables).

1. Basic Operations

1.1 Receiver Fault Finding interface and operations

When the receiver is plugged into the A-frame, it automatically jumps to the fault location interface.

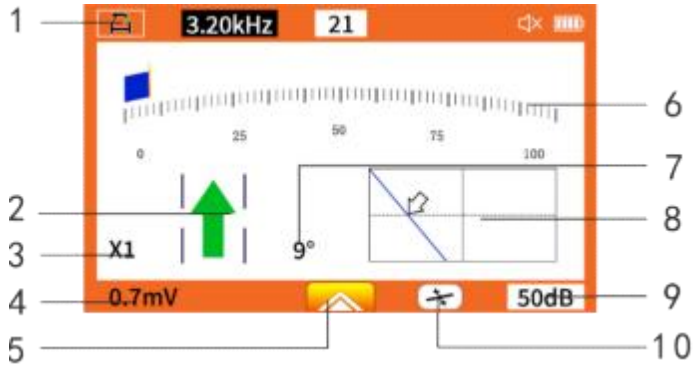


Figure 62 Receiver fault location interface

1. Fault Location mode 2. Fault point direction arrow 3. Magnification 4. Real-time voltage

5. Function Menu interface 6. Amplitude bar 7. Phase 8. Wire cruise

9. Gain 10. Calibration keys

Short press to switch frequencies.

Switchable **frequencies in the fault finding interface**: 640Hz, 1280Hz, 2.56kHz, 3.20kHz.

Short press the switchable gear to increase or decrease the voltage value

Press the key briefly to change the gain intensity, making the voltage value and semaphore easier to observe

Short keys or tap the icon on the screen to get to the function selection menu on that page. Change the parameters of the test by operating on the corresponding function by tapping or pressing the key.

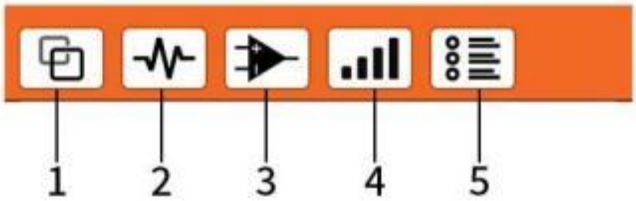


Figure 63 Ground Fault location function menu bar

1. Mode switching 2. Select Test frequency 3. Select magnification

3. Change numerical gain 4. Go to Settings page 5. Remote control

1.2 Transmitter step voltage method interface and operation

Figure 64 Transmitter fault finding interface

Enter the fault location transmitter interface when you press a key or tap the designated position on the screen to fault location

Switch different frequencies by pressing or tapping a designated position on the screen.

Press a key or tap a specific position on the screen to increase or decrease power

After selecting the appropriate frequency, mode, and power, press or tap the button to TEST output. When output normally, the symbol flashes as a prompt. Do not touch the connection wire during this time to prevent electric shock.

2. Transmitter wiring

The transmitter is wired by direct connection. First, unplug all the artificial grounding of the pipeline and keep it reliably floating insulated. The transmitter

works in direct connection mode, the black alligator clip of the direct connection output line is connected to the grounding rod driven into the ground, and the red alligator clip is connected to the faulty pipeline: ① For the protective layer of the insulated pipeline is damaged: The red alligator clip is connected to the metal part of the pipeline. ② For unarmored low-voltage cable grounding fault: The red clip is connected to the fault. ③ For high voltage cable sheath faults: The red clip is connected to the cable sheath.

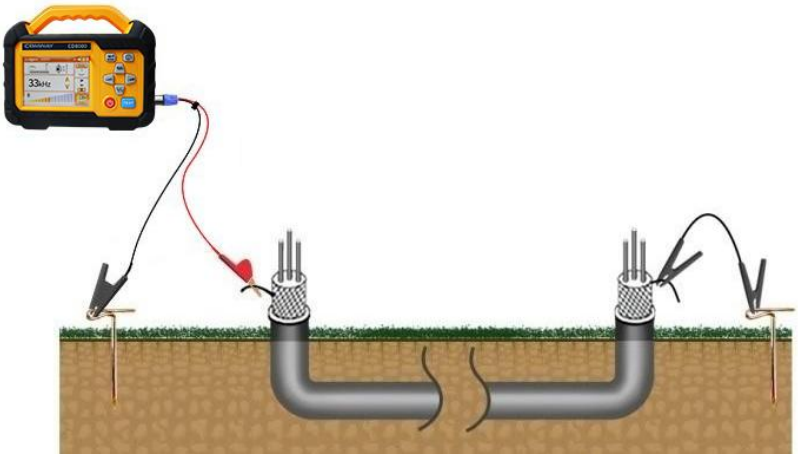


Figure 65 Fault Location Transmitter wiring

Notes:

- The location of the grounding pin: The grounding pin should be placed at least 5 meters away from the pipe, and the black grounding wire should be as perpendicular as possible to the direction of the pipe.
- Do not connect the grounding clamp to the water pipe or other pipelines, otherwise it will interfere with the normal positioning.

- Try to keep no other lines between the grounding pin and the target line, and use a passive detection method to check before inserting the grounding pin.
- When it is not convenient to use a grounding needle to ground the signal at a substation, a grounding grid can be used as the grounding point, but if the fault occurs within the range of the grounding grid, the instrument may not respond correctly and miss the check.
- When checking for faults, use the mixed signal 640Hz, 1280Hz, 2.56kHz, 3.20kHz, and set the output power to the maximum.

3. Fault Location

The detection principle is: The location signal emitted by the transmitter flows through the cable, flows into the ground from the fault point, passes through the ground and returns to the black clamp of the transmitter. Fault location can precisely measure the voltage intensity when the location signal leaves the conductor and enters the ground. The fault location signal propagates out of the fault point and generates a signal field around the fault point. This signal field is the detectable area. And this signal field is the same as the signal field near the grounding pin, they have the same size, and this size depends on the soil conditions and the severity of the grounding fault. The A-frame gets A signal value when the signal field receives the location signal, and the signal indicates the direction of the fault point, with A larger signal quantity as it gets closer to the fault point, until the signal quantity is the smallest when the fault point is in the middle of the two pins of the A-frame.

3.1 Near-end validation test

Before officially starting the search, a verification test should be conducted near the grounding pin to determine if this method is suitable for fault location. If the receiver can detect a strong enough signal near the grounding pin and has the correct direction response, it indicates that the injected signal is strong enough to meet the fault detection requirements; The signal is strongest near the grounding pin. If there is no correct response here, it indicates that the fault resistance is too high and the injection current is too small to perform fault detection.

1) **Grounding pin signal field verification test:** Back against the grounding pin and at A distance from an A-frame, with the **arrow of the A-frame pointing towards** the faulty end (the end of the pipeline), insert the A-frame probe into the ground. Adjust the gain appropriately and observe the signal value and direction. If the direction is stable and the signal value is at a larger value, it indicates that the signal reception is normal. Normal signal troubleshooting direction shows forward:. If the signal value is very small, the troubleshooting direction may jump back and forth between and, indicating that the injected signal is too small to cause the semaphore to be unstable. Possible causes: Wiring error, or the fault resistance is too high to form an effective test current.

2) **Determine the response range:** Start near the grounding pin near the line, with the arrow of the A-frame pointing towards the end of the line, and gradually move away from the transmitter for the test. If there are no other ground fault points nearby, the signal quantity will gradually decrease and the direction of fault detection will start to jump as the distance increases. Record

the position just when the signal can still be correctly distinguished, and the distance from this position to the grounding pin is the maximum one-way response range of this fault. The response range at the fault point is generally smaller than that at the grounding pin, considering the environmental factors of the pipeline burial (such as the ultra-high voltage cable is laid in the cable trench and can only be tested outside the trench). Therefore, it is recommended to take 1/3 to 1/2 of the measured response range as the test interval. For example, if the response range is 20m, the recommended interval for testing is 6 to 10m. When conducting troubleshooting tests at this interval, it can prevent the fault point from being missed due to excessive spacing, and it can also speed up the test. Outside the response range, follow the line of the pipeline path detection direction until you enter the response range where the next fault point is located.

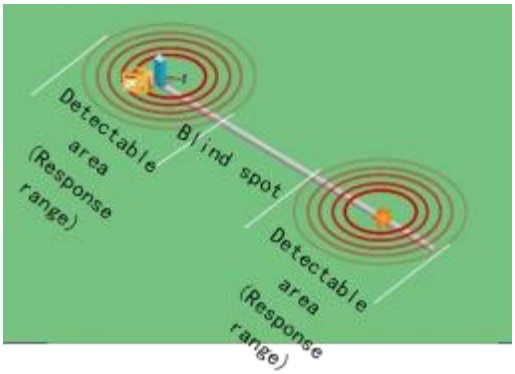


Figure 66 Response range

Note: If the grounding grid of the substation is used as the grounding of the transmitter, confirmatory tests cannot be conducted. The recommended general test spacing is 3 to 5 meters, which can meet most requirements without too much impact on efficiency. If the fault resistance is high, reduce the test spacing appropriately.

3.2 Troubleshooting and Location

1) **Away from the ground pin signal field:** Start from the near end of the pipeline, face the end, carry the receiver and the A-frame, keep the **arrow direction** of the A-frame forward (pointing to the end of the pipeline), and detect at approximately equal intervals and receiving gain each time. At the start, the signal is strong and stable because of the proximity to the ground pin, with the arrow pointing forward. As the distance from the grounding pin increases, the signal quantity gradually decreases.

2) **Approaching the fault point signal field: When the** fault point is relatively close, that is, when the signal field of the grounding pin overlaps with that of the fault point, the signal quantity will start to increase immediately after decreasing to a certain extent, indicating that it has entered the fault point signal field; If the fault point is far away, it will enter the blind spot of detection, that is, not near the fault point signal field, and the signal cannot be detected using the A-frame. At this time, just continue along the line until you find the place where the signal quantity starts to increase and the troubleshooting direction arrow becomes stable again, indicating that you are approaching the fault point and the arrow direction is pointing towards the fault point.

3) **Enter the fault point signal field:** After approaching the fault point, observe the direction of the arrow: If the fault point is in front, the arrow is forward; If you have crossed the point of failure, move the arrow backward. Approach the point of failure step by step as indicated by the arrow, gradually reducing the detection distance during the approach.

Big Small Bigger

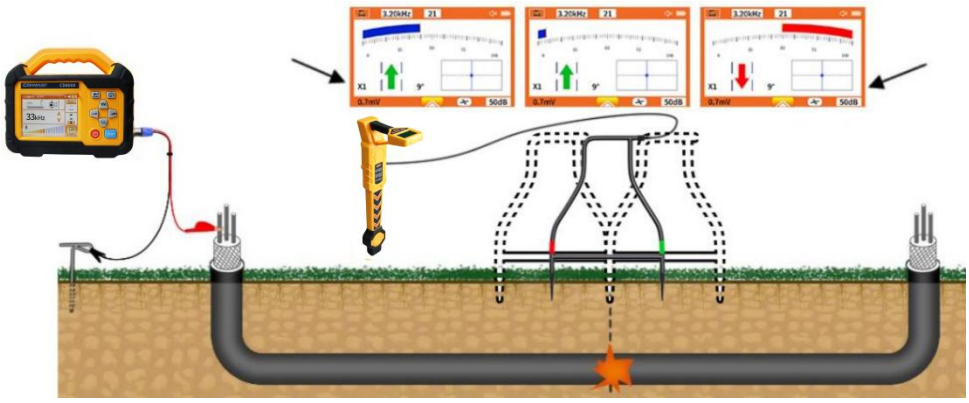


Figure 67 Troubleshooting points

4) **Precisely locate the fault point:** Eventually, when the fault point is exactly between the two probes of the A-frame, the semaphore drops suddenly and changes dramatically with just A slight movement. Move the A-frame at small intervals and you'll find A point where the arrow direction changes abruptly and the signal strength is the lowest, which is the point of failure. At this point, we have roughly determined the location of the point of failure in the front and back directions. Next, we need to determine the position in the left-right direction. On the provisional position of the fault point, rotate the A-frame 90° and again determine the position of the fault point in the left-right direction according to the positioning method in the front-back direction. The point where the two directions intersect is the fault point.

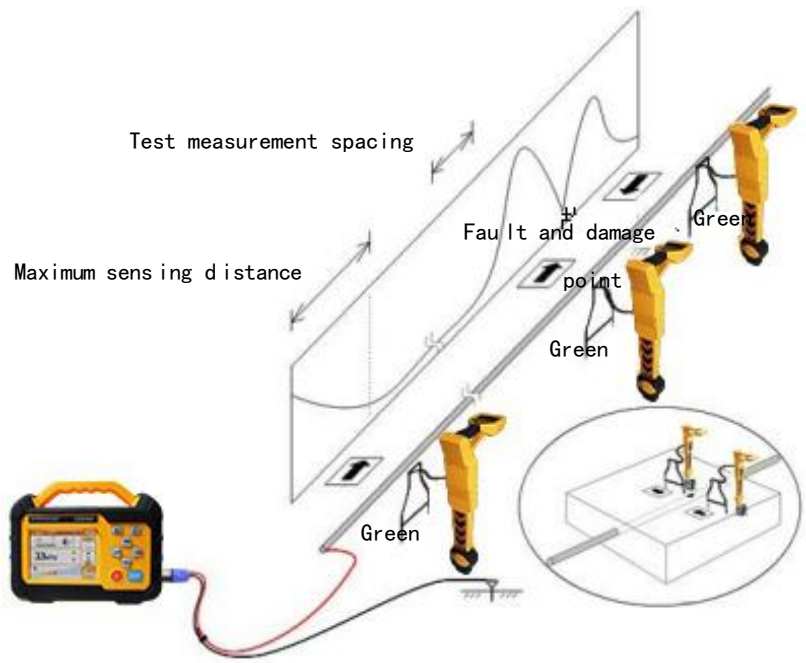


Figure 68 Fault location process

5) **Fault point verification:** Insert the front leg of the A-frame into the fault point just identified, rotate the A-frame with the front leg as the center, and insert the rear leg of the A-frame into the ground at intervals. At this point, the arrow direction on the receiver always points in the direction pointed by the front leg of the A-frame, indicating that the fault point is below the front leg of the A-frame.

The A-frame troubleshooting process is shown in the figure below:

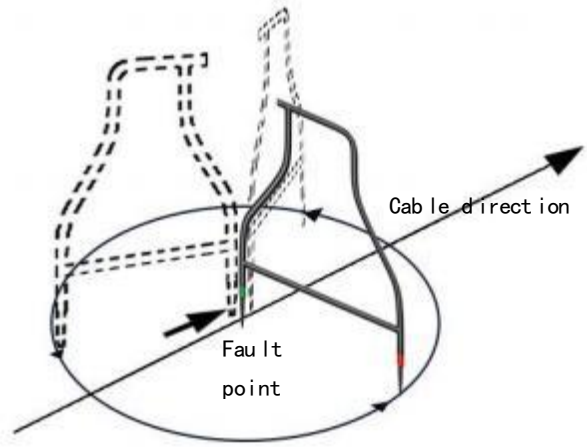


Figure 69 Verify location

3.3 Notes

- When probing, keep the operator facing the end of the line, the A-frame arrow pointing forward (towards the end of the line), and the receiver direction should also be consistent (towards the end).
- When probing, if the surrounding signal interference is significant, try to switch to another frequency signal for troubleshooting.
- During the detection process, adjust the gain according to the size of the semaphore in order to observe the changes in the semaphore.
- If the cable is laid in a cement trench and covered with a cement cover plate, it is better to detect on the soil next to the trench rather than above the cement cover plate.
- If the cable is beneath a hardened road surface, it is best to detect it in the grass/soil beside the road surface. If the ground is too far from the cable, the detection effect will be poor, and the measured spacing should be reduced to avoid missing the fault point.

- Detecting directly on a dry hardened surface (asphalt, cement, or brick) is less effective, but wetting the ground with water will improve the effect to some extent.
- This method is largely not suitable for finding phase line grounding faults in armored cables, as the armor has a high possibility of multiple grounding points, and the instrument shows fault points at all armored grounding points, making it impossible to distinguish the true fault location from them.

Warning: The output power and output voltage are high when checking for faults. Be careful!

9. Introduction to Other Functions

1.Sweep frequency test

Do not turn on the transmitter during the test. The coil inside the receiver scans the current environment or cable to detect signal amplitudes at 50Hz, 577Hz, 640Hz, 1280Hz, 3.2kHz, 8.19kHz, 33kHz, and 82kHz in sequence.

1.1 Introduction to Sweep Test Interface

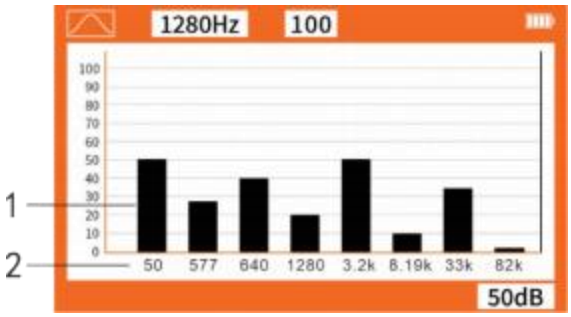


Figure 70 Sweep test interface

1. Amplitude bar 2. Frequency axis

1.2 Field Use

Determine the electromagnetic interference from the environment based on the amplitude bars corresponding to each frequency seen. The larger the amplitude bar, the greater the co-frequency interference in the current environment or cable, so try to avoid using this frequency for detection. The frequency with the smallest amplitude bar should be chosen for pipe detection or cable identification.

10. Battery management

● Charge the **battery in a timely manner. Charge the battery every 3 months when the instrument is not in use for a long time.**

● **Warnings! Do not test if the battery cover is not properly closed, otherwise it is dangerous.**

● **When replacing the battery, pay attention to the battery polarity, otherwise the instrument may be damaged.**

1. The instrument is equipped with a built-in lithium battery pack, which can work continuously for different output levels, but generally can meet the requirement of working for 8 hours a day.
2. When in use, a battery power icon will be displayed in the upper right corner of the screen. Full power indicates full charge, empty and red indicates low voltage, and the battery will automatically shut down after a few seconds when the power is exhausted.
3. When you need to charge, connect the charger plug to the "Charge" socket of the transmitter/receiver and the AC plug of the charger to the 220V/110V mains socket.
4. A red indicator light on the charger indicates that charging is in progress, and a green indicator light indicates that charging is complete.
5. When the device is turned off, it takes approximately 5 to 6 hours for the transmitter to fully charge from the undervoltage state. The receiver takes about 3 to 4 hours.
6. Depending on usage and maintenance conditions, the battery pack can generally perform 300 to 500 charge and discharge cycles. As the number of charge and discharge cycles increases, the battery capacity will

gradually decrease and the working time of the instrument will be shortened accordingly. When it is too short to be accepted, the battery needs to be replaced. The battery is an 18650 lithium battery pack. Please contact the manufacturer to purchase replacement.

11. Packing list

Label accessories

Transmitter	1
Receiver	1
Toolkit	1
Emission current clamp	1 Pair
Connect the test wire directly	1
Grounding pin	2 pins
Double-headed alligator clip test lead	1 (black)
8.4V charger	1 (for receiver)
12.6V charger	1 (Transmitter)
7.4V lithium battery	1 set (in the receiver)
11.1V lithium battery	1 set (inside the transmitter)
Instruction manual, warranty card, certificate of conformity	1 copy

Optional accessories

A-frame + connecting cable	1 set
Receive flexible current clamps	1.
Stethoscope	1
Tracer probe	1

The Company is not responsible for any other losses arising out of use.

The contents of this user manual shall not be grounds for the use of the product for a particular purpose.

The Company reserves the right to modify the contents of the User Manual. Any changes will be made without further notice.