Underground Utilities Locator Kit

User's Manual

Guang Zhou Zheng Neng Electronic Technology.,Ltd.

—— Catalogue ——

Safety Instruction

Thank you for purchasing our company's intelligent Utility integrated locator. In order to better use this product, please be sure to:

——Read this user manual, the operator must fully understand the manual instructions and skillfully operate the instrument before the actual test.

——Strictly abide by the safety rules and precautions listed in this manual.

- This instrument is designed, produced and inspected according to the IEC61010 safety specifications.
- In any case, special attention shall be paid to the use of this instrument.
- Pay attention to the labeled text and symbols of this instrument body.
- The instrument is designed with over-voltage protection, but shall avoid direct contact or direct connection to charged conductors.
- Before use, confirm that the instrument and accessories should be in good condition, and the insulation layer of the instrument and test line can be used without damage, exposure and breaking. Break the casing or test line.
- **It is normal for the coupling clamp to produce a howling call when transmitting the signal.**
- **When the coupling clamp transmits a signal, it will produce a large magnetic suction. At this time, the jaw must be opened after the transmitter power must be turned off.**
- **When using the direct connection output mode, do not connect the red and black test line to the running power cable.**
- **In order to ensure personal safety, nail test must be done before maintenance and sawing of the identified cable.**
- During the measurement process, do not contact the exposed conductor and the circuit being measured.
- Verify that the connection plug for the wire is tightly inserted into the instrument interface.
- The test wire must be removed from the test wire before pulling out from the instrument. Do not touch the output jack to avoid electric shock.
- Do not measure in flammable places, the spark may cause an explosion.
- Do not place and store the instrument for a long time in the place with high temperature and humidity, dew and direct sunlight。
- If the instrument is wet, please keep it before drying.
- Battery voltage low symbol display, please charge in time.
- If the tester is not in use for a long time, please charge the battery once every 3 months.
- The use, disassembly, calibration and maintenance of this instrument must be operated by authorized personnel.
- The maximum output voltage of the transmitter is 150 Vpp. Do not contact the output clip

and target line while working!

- If the instrument causes danger to continue to use, it should be stopped immediately, sealed up immediately, and handled by an authorized institution.
- The " ⚠ " symbol in the instrument and the manual is a safety warning sign, and the user must strictly follow the contents of this manual for safe operation.

I .Brief introduction

Intelligent Utility detector, also known as Utility locator, Path Locator, is a very comprehensive path detection instrument. It has pipeline path detection, cable identification, fault search and other functions. The instrument is composed of transmitter, transmitting current clamp, receiver, receiving flexible current clamp, connecting test line, A-word frame (optional), etc.

Intelligent Utility detector can be used for path detection, pipeline survey and depth measurement of metal pipelines and underground cables under trenchless excavation. The instrument uses a variety of filtering technologies, has anti-interference ability, and can accurately locate and measure the depth. It is suitable for the detection and patrol of various underground metal pipeline, pipeline management and maintenance, municipal planning and construction, power supply and other departments, and is one of the necessary instruments of pipeline maintenance units. This function is realized by the signal transmitter, receiver, signal transmitting clamp and connecting test line. The instrument has the following characteristics:

1. Multiple detection modes: classical positioning mode, wire cruise mode, signal distortion measurement mode;
2. Classic positioning mode: compass, direction and signal amplitude display, visually display the left and right direction of the pipeline。
3. Lead cruise mode: 360 omnidirectional pipeline path indication, continuous display of depth, current, and pipeline relative position. The interface is simple and intuitive, and it can be operated without experience
4. Signal distortion measurement mode: the peak and trough wave form should be displayed at the same time. In the field without distortion, the peak and valley value position should be consistent, and the field shape should be symmetrical relative to the centrol line.
5. Current direction determination (partial frequency), can be calibration current direction, eliminate adjacent line interference, to prevent tracking errors.
6. Full digital high-precision sampling processing: stable and reliable, ultra-high sensitivity, extremely narrow reception frequency band, strong anti-interference ability, can fully inhibit the power frequency and harmonic interference of adjacent running cables and pipelines.
7. Multiple detection frequencies: 13 active detection frequencies and 2 passive detection frequencies.
8. Transmitter a variety of signal output: direct output, caliper coupling, induction method.
9. Transmitter digital amplifier power output, automatic impedance matching, automatic protection.

Cable identification is designed for power cable engineers and cable workers to solve the technical problems of cable identification. It can be used to identify live and blackout cables. The user can accurately identify one of the target cables from multiple cables through the instrument to avoid serious accidents caused by mistaking live cables. For cable identification, 20 cables can be pre-calibrated at the transmitter and then received and identified at the remote end, which greatly saves the time of engineering personnel to and from calibration operation and improves work efficiency. The cable identification is successfully marked with √, and the non-target cable is marked with ×, which can quickly

and automatically identify the target cable. The function is realized by the cooperation of signal transmitter, receiver, signal transmitting clamp, connecting test line and flexible caliper**.**

Signal transmitter: used for pipeline path detection and cable identification. The device can add identification signals to the target cable through direct connection output, caliper coupling, induction method, and other methods. There are 13 different pulse signals of 250Hz, 577Hz, 640Hz, 1.28kHz, 2.56kHz, 3.20kHz, 4.09kHz, 8.19kHz, 10.2kHz, 33 kHz, 66 kHz, 82 kHz, and 197 kHz. The maximum signal output power is 15W, and 6 levels are adjustable, adapting to different application environments, making pipeline detection and cable identification more accurate and reliable. Instrument built-in large function rate can be charged with lithium battery, automatic impedance matching, automatic protection. The transmitter adopts the integrated special toolbox design, its box can withstand the pressure of about 200kg, the host 5 inches of the capacity touch LCD display, real-time dynamic display signal output status and battery usage.

Transmitter clamp: suitable for caliper coupling method. The transmitter clamp couples the signal emitted by the transmitter to the target cable, and the jaw size is Φ125mm. The transmitter clamp is directional, and the transmitted signal flows in from the direction indicated by the arrow on the transmitter clamp.

Receiver: Used for pipeline path detection and cable identification. Built-in multiple shielded 3D antennas, It can effectively identify 13 different pulse coded current signals of 250Hz, 577Hz, 640Hz, 1280Hz, 2.56kHz, 3.20kHz, 4.09kHz, 8.19kHz, 10.2kHz, 33kHz, 66kHz, 82kHz and 197kHz generated by the transmitter. It can also identify 50Hz and 60Hz power frequency signals and RF signals with center frequencies of 33kHz and 82kHz. Using 4.3 inch capacitive touch LCD screen, real-time dynamic display 360° omnidirectional pipeline path indication, depth, current and relative position of the pipeline.

]**Flexible current clamp:** Used for cable identification. The current clamp is a Roche coil, which has excellent transient tracking ability, can quickly identify the pulse width frequency signal generated by the transmitter, and is suitable for thick cables or irregularly shaped conductors. The inner diameter of the clamp is about 200mm, which can clamp the cable below Φ200mm, without disconnecting the measured line, non-contact measurement, safe and fast.

Special note: When the power failure cable is identified: it is strictly prohibited to access the live cable. Live cable identification is only applicable to three-core armored cables. In recognition, the transmitter clamp and the receiver clamp can not be mixed, and the direction of the input signal should be consistent.

Ⅱ.Technical specifications

Receiver specifications

Function	Utility detector(cable position tracking, direction display, depth measurement, current measurement), cable identification, A-frame fault detection (optional function)
Power	8.4V large capacity rechargeable lithium battery
Input mode	Built-in receiving coil, flexible caliper, A-frame (optional function)
Receive frequency	Active detection frequency:250Hz、577Hz、640Hz、1.28kHz、2.56kHz、3.20kHz、4.09kHz、8.19kHz、10.2kHz、33kHz、66kHz、82kHz、197kHz Power frequency passive detection frequency：50Hz、60Hz RF passive detection frequency band: the central frequency is divided into33kHz、66kHz、82kHz、197kHz
Utility detector modes	Wide peak method, narrow peak method, sound valley method
Utility detector display modes	Classic positioning mode, wire cruise mode, signal distortion measurement mode
Utility detection Scope of detection	Direct connection method: generally can reach the cable length of 0~20 kilometers, mainly determined by the grounding resistance, cable resistance and cable buried depth Coupling method: generally can reach the length of the cable 0~10 kilometers, mainly determined by the grounding resistance, cable resistance and cable buried depth Induction method: suitable for cables with buried depth less than 2m
Depth and current	Display the cable depth and current value in real time
measurement depth	0-20m
Deep precision	Flat position precision accuracy: Central axis position of the target cable or pipeline:

	± 5% (buried depth in 0-3m) -10% (buried depth in 3m-20m)
Positive and wrong prompt	Excluding the interference of adjacent cables, in the measurement of adjacent cables, the measurement of the adjacent cables can be distinguished according to the different signal strength and the measured current phase of the adjacent cables. In the process of tracking the cables, the phase dial and pointer can be observed to distinguish the measured cables and the adjacent cables
Sound instructions	FM tone with signal intensity
Capacity of resisting disturbance	Very narrow receiving frequency band and unique digital processing method can fully suppress the power frequency and harmonic interference of adjacent operating cables and pipelines
Interference distance	When using the coupling method and the induction method, the transmitter will produce interference in close distance. The distance of interference is related to the transmitting power and frequency. The greater the power, the higher the frequency, the stronger the interference.The minimum distance of the receiver free from the transmitter interference often needs to be determined by test: Utility detection: 5m away, 20m away as no interference Cable identification: the coupling method beyond 2~5m can be confirmed as no interference
Cable identification	Identification mode: flexible caliper intelligent identification; Number of calibrable cables: 1~20; Calibration value: the current percentage of the received signal and the transmitted signal between 75% and 135% of the calibration value is one of the conditions for successful identification; Directionality: the transmitter clamp, receiver clamp must be in the same direction as the loading signal, which is one of the conditions for successful identification
Cable identification Range of detection	Direct connection method: can identify the signal with a circuit resistance of 0 Ω ~ 8 kΩ (generally, the length of the cable can reach 0~20 km, mainly determined by the grounding resistance and cable resistance) Coupling method: can identify the signal with circuit resistance of 0 Ω ~ 1 kΩ; (generally the cable length is 0~6 km, mainly determined by the grounding resistance and cable resistance)
Display	4.3 LCD color screen LCD (highlight screen), visible in the sun
Touchscreen	Yes

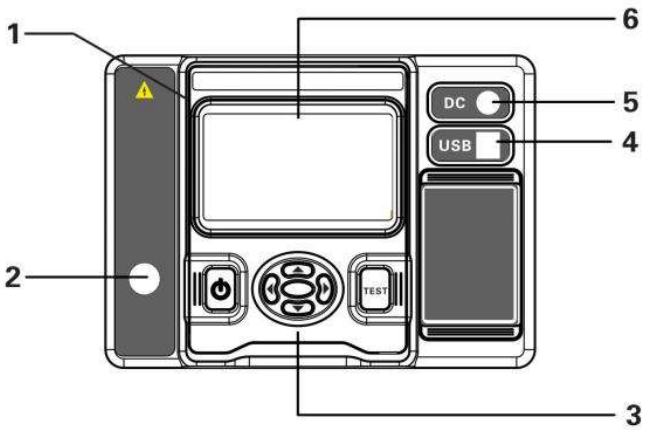
Size	350mm(length)×155mm(width)×700mm(high)
Weight	Around 2kg
Connection interface	Type-C USB Interface, air socket
Coil inner diameter	φ200mm(A larger caliber can be customized as needed)
Working temperature and humidity	-10℃～40℃；below 80%Rh
Store temperature and humidity	-10℃~50℃；≤95%RH, No knot dew
Withstand voltage	AC2000V/rms(Before the front and rear ends of the shell)
Suitable for safety regulations	IEC61010-1 CAT Ⅲ 600V，IEC61010-031，IEC61326，Pollution grade 2

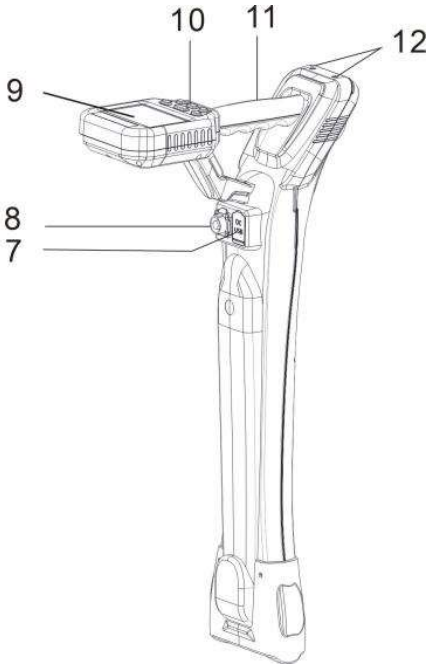
Transmitter specifications

function	Multiple frequency signal transmission modes
Power	10.8V Large-capacity rechargeable lithium battery
Output method	Direct connection method, caliper coupling method, induction method
Output frequency	250Hz、577Hz，640Hz，1.28kHz，2.56kHz，3.20kHz，4.09kHz，8.19kHz，10.2kHz，33kHz，66kHz，82kHz，197kHz
Output mode	Automatic identification, according to different accessories
Output power	15W max，The 9 gear adjustable
Impedance	Automatic real-time impedance matching and protection function
Direct output voltage	150Vpp max
circuit	With overload and short-circuit protection

protection	
Display	5 寸 LCD Color screen LCD
Touch screen	Yes
Instrument size	320mm(length)×275mm(width)×145mm(high)
Weight	Transmitter about 3.85kg; The transmitter clamp is about 1.18kg
Charger	DC 11.1V 3A
Dimensions of transmitter clamp	Length, width and thickness 297mm×194mm×39mm
Launch clamp inner diameter	φ125mm
Length of transmitter clamp	3m
P-wire	Red test line 3m, black test line 3m
Connection interface	USB interface, DC interface, aviation socket
Resist compression	The transmitter adopts an integrated special tool box type design, and the box body can withstand the pressure of about 200kg
Withstand voltage	AC 3700V/rms(Before the top surface and bottom surface of the instrument box)
Electromagnetic characteristics	IEC61326(EMC)
Suitable for safety regulations	IEC61010-1(CAT Ⅲ 300V、CAT IV 150V、Pollution grade 2)

Ⅲ. Structure





1. Transmitter
2. charging port transmitter output port
3. Button of transmitter
4. Transmitter USB interface
5. Transmitter DC charge interface
6. Transmitter LCD
7. Receiver signal output port transmitter button
8. Receiver signal output interface
9. Receiver LCD
10. Receiver buttons
11. Receiver handle
12. Receive speaker

Ⅳ. Instrument operation

1. Basic receiver operation

Button boot，After starting up, the wire cruise mode interface of the pipeline detection function is entered by default, and the frequency is 3.20 kHz and 10dB gain is selected by default. If the flexible caliper is connected before starting up, the cable identification interface will be entered.

1.1 Cable line detection interface

Press the "M" button short or click the corresponding position of the screen to switch the wide peak、Narrow peak、Sound valley response mode;

Under the pipeline detection function, long press the "+" and "-" buttons or slide left and right on the LCD to switch wire cruise mode, classic positioning mode and signal distortion measurement mode. The rich detection function can meet the requirements of cable detection in different occasions.

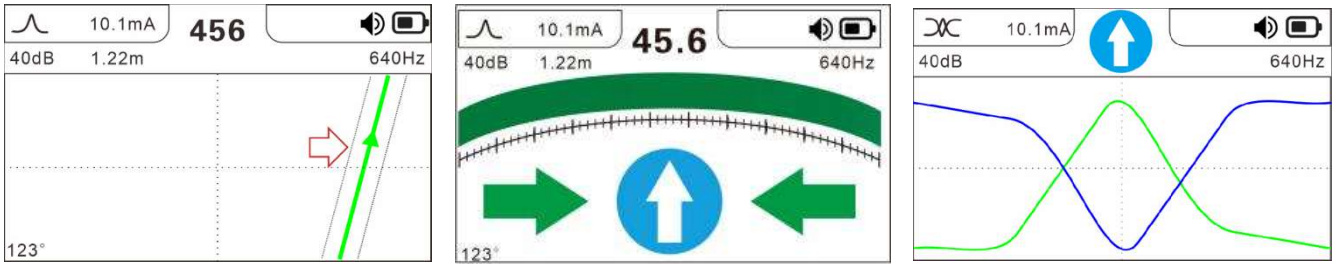


Figure 4-1 Interfaces of the three modes

Press "F" short or click on the corresponding position on the screen to switch the frequency;

Lead cruise mode, classic positioning mode, signal distortion measurement mode switchable frequency: 50Hz, 60Hz, 250Hz, 577Hz, 640Hz, 1.28kHz, 2.56kHz, 3.20kHz, 4.09kHz, 8.19kHz, 10.2kHz, 33 kHz, 66 kHz, 82 kHz, 197 kHz, a total of 15 frequencies are available.

Short press "+" and "-" keys or click the corresponding position on the screen to change the gain strength.

The gain adjustment range is 0 to 96dB

In wire cruise mode and classic positioning mode, select 577Hz, 640Hz, 1280Hz, 2.56kHz, 3.20kHz, short press the "i" key or click the corresponding position on the screen to calibrate the signal direction and prevent tracking errors.

1.2 Cable identification interface

The flexible current clamp is inserted into the receiver and automatically enters the cable recognition mode:

When you choose to enter the cable identification interface for the first time, the following conditions will occur:

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

b) If there is a saved calibration data in the instrument, it will enter the **deletion interface**. Tip: Whether to delete all calibration data. Select Yes or No by pressing the + and- -keys or by clicking the appropriate position on the screen. If Yes and then press M, all previously saved calibration data will be deleted; if No and then press M, the saved calibration data will not be deleted. After completing the selection operation, the instrument automatically switches to the cable identification interface.

c) To identify a new cable, you must delete all the previously saved calibration information and recalibrate the new cable.

Delete the existing calibration information interface is as follows:

Select No No Delete Select Yes Delete

Figure 4-2 Delete interface of cable identification and calibration information

After entering the cable identification interface:

Press "+" and "-" button or click the corresponding position of the screen to switch the cable number L1~L20, a total of 20 cables.

Press "F" or click on the corresponding position on the screen to switch the frequency: 577Hz, 640Hz, 1280Hz, 2.56kHz, 3.20kHz. Partial frequencies have a specific display interface.After the wiring is completed, long press "i" or click the corresponding position on the screen for calibration, and the frequency cannot be changed after the calibration is completed。

(For details, see Chapter 6, Section 5, cable identification of the specification).

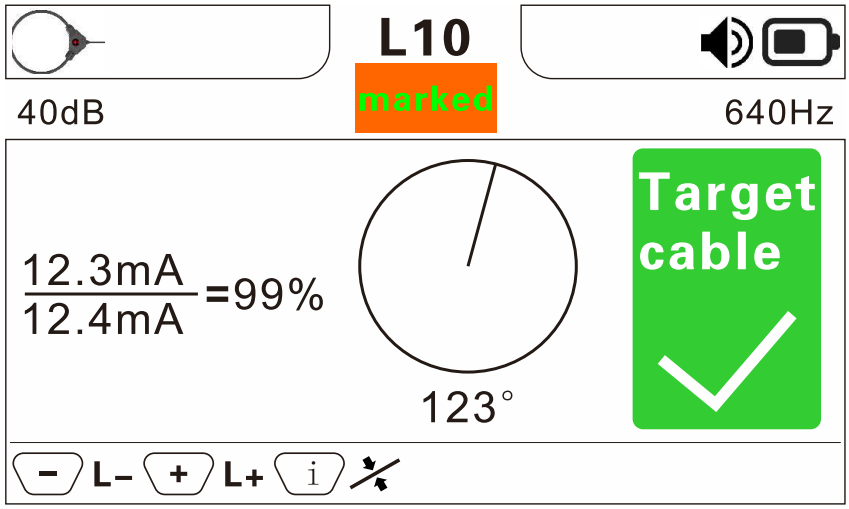


Fig. 4-3 Cable identification interface diagram

1.3 Instrument Settings

Long press "M" key or click the screen corresponding position into the setting interface, in this interface has eight options bar, respectively in English switch, horn setting, sound setting, brightness, scan, test, automatic shutdown, USB setting, about / version, press the "+", "-" key select the corresponding bar, press "M" to confirm, enter the corresponding function interface or change the corresponding Settings. Press the "i" key to return to the previous level interface

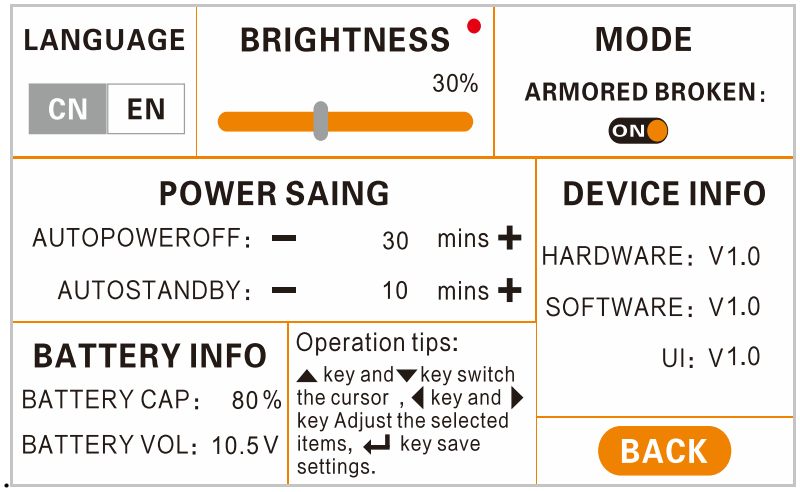


Figure 4-5 Receiver setup interface

Move the cursor to the "scan test" bar and press "M" to enter the scan test. Display the signal intensity of different frequencies in the current position, and short press "+", "-" or click the corresponding position key on the screen to change the gain intensity.

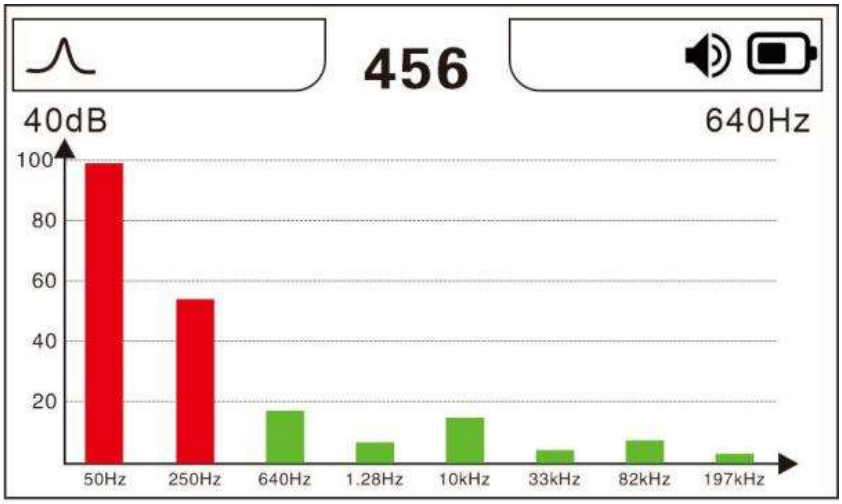


Figure 4-6 Scan frequency test interface

Move the cursor to the Chinese and English switch bar, press the "M" key or click the corresponding position on the screen to switch the Chinese and English display.

Move the cursor to the horn setting bar, press the "M" key or click the corresponding

position on the screen to open or close the instrument signal intensity prompt sound.

Move the cursor to the sound setting bar, press the "M" key or click the corresponding position on the screen to prompt mode.

Move the cursor to the brightness setting bar, press the "M" key or click the corresponding position on the screen to set the brightness of automatic, high, medium and low, which automatically adjust the appropriate brightness according to the actual light.

Move the cursor to the automatic shutdown bar, press the "M" key or click the corresponding position on the screen to select the time of automatic shutdown: five minutes, ten minutes, never close. Select "Never close", then the automatic shutdown function is not enabled。

Move the cursor to the About / version bar, press the "M" key or click the corresponding position on the screen to enter the display only version information.

2. Basic transmitter operation

2.1 Signal emission for pipeline detection or cable identification

The instrument automatically identifies and switches different output modes according to different accessories: coupling output mode, direct connection output mode and electric induction output mode. Under the output interface:

PUT▲、▼Key or click the corresponding position on the screen to switch the frequency250Hz、577Hz、640Hz、1280Hz、2.56kHz、3.20kHz、4.09kHz、8.19kHz、10.2kHz、33kHz、66kHz、82KHz 和 197kHz。

Put◄ 、 ►Key or click on the corresponding position of the screen to adjust the output power, 6 gear adjustable.

Long press "Output" button or click the corresponding position of the screen to start output, short press "Output" button or click the corresponding position of the screen to stop output.

The interface diagram is as follows:

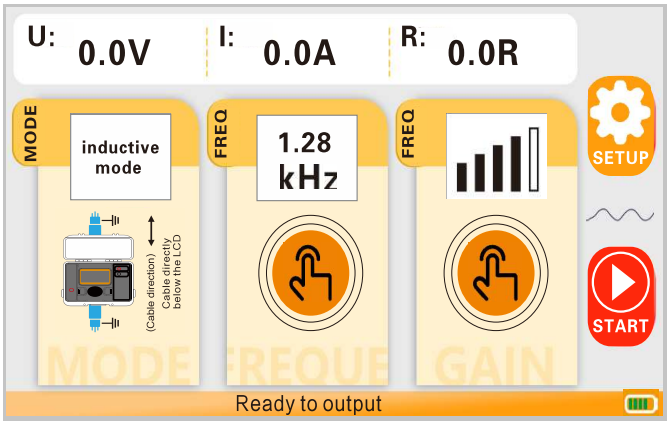


Figure Figure 4-7 The signal emission interface

2.2 Instrument setting

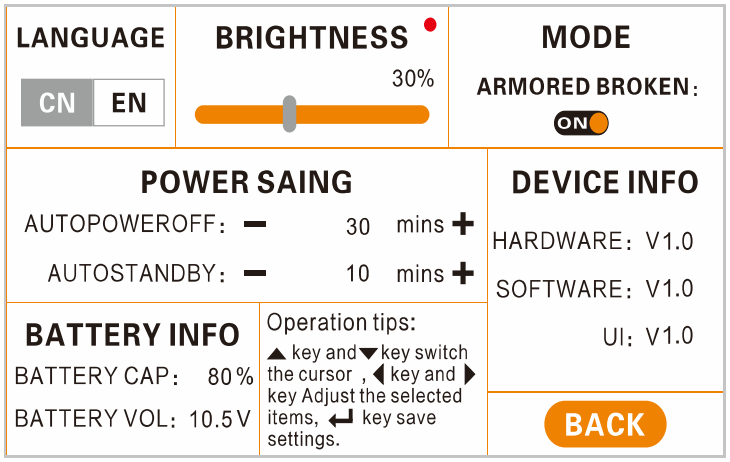


Figure 4-8 Transmitter setting interface

Put Key or click the corresponding position on the screen to enter the setting interface, there are 7 option bars in this interface, respectively, language setting, brightness setting, mode setting, automatic shutdown time, automatic standby time, battery information, instrument information,Put 、 Key select the corresponding column,Put 、 key， Change the corresponding settings.Put the key can return to the upper level interface.

Move the cursor to the Language Settings bar,Put 、 Key or click the corresponding position of the screen to switch the Chinese and English display.

Move the cursor to the brightness settings bar， Put 、 Key or click on the corresponding position of the screen to change the LCD brightness: 10%~100%.

Move the cursor to the Mode Settings bar， Put 、 Key or click the corresponding position of the screen to open the armor damage mode, this mode is only suitable for the cable identification function, in the pipeline search mode open will cause signal interruption output.

Move the cursor bar for an automatic shutdown time， Put 、 Key or click the corresponding position of the screen to select the time of automatic shutdown: 1~99 minutes, the instrument will not automatically shut down under the output.

Move the cursor bar for an automatic standby time， Put 、 Click or click the corresponding position of the screen to select the time of automatic standby: 1~99 minutes. When the instrument reaches the standby time without operation, it automatically adjusts the LCD back brightness to 10%, and exits the standby mode during operation.

Battery information bar, displays the battery voltage and battery remaining capacity.

Instrument information, display the instrument hardware version, software version, UI version.

X.The output of the transmitter

There are three methods for transmitter to transmit signals from pipelines: direct connection method, caliper coupling method and induction method. This chapter introduces the general operation of these methods. For cable detection, the operation and precautions of the three methods will be specially introduced in Section 3 according to its particularity.

Attention	**Electricity, danger! It must be operated by trained and authorized personnel, and the operator must strictly follow the safety rules, otherwise there is a danger of electric shock, causing personal injury or equipment damage.**
	During outage pipeline detection and cable identification (using direct output), confirm that the target cable has been outage and the conductor cores at both ends are separated from the system.
	During live line detection and cable identification (using caliper coupling output), no operation of the target cable is not required, and the sheath at both ends of the pipeline must be well grounded.
	It is strictly prohibited to open the transmitting pliers when the signal to avoid damage to the machine. The launching pliers shall be opened and closed again after the launching machine.

1．Direct connection method

Access the direct connection test clip to the output interface, open the transmitter, and the instrument can automatically identify the external accessories. Select the corresponding frequency and power according to the application requirements. When cutting and reconnecting the red lead, check the good connection by paying attention to the current and resistance on the display. When the connection condition is poor or the pipeline grounding resistance is too large.

a) Factors affecting the wiring quality include:
b) Rust of the pipeline connection point: clean the wiring area with a steel wire brush
c) Poor grounding: insert the ground nail into the wet ground. Wet the surrounding ground with water. If there are still problems, try connecting to the manhole

Around the cover. Avoid connecting to the fence fence, otherwise it may generate echo signal current along the wall and interfere with the positioning signal.

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

energy waste.

When attached to the iron material, sometimes the proper protruding site may r found, and the clamp may not be held. In this case, use the optional magnet to line and clamp the red clip onto the magnet. A good example is the connection lighting circuit. Common practice is to connect the sheath of the lighting cable t check cover of the street lamp. When connected to the inspection board it will p cable through the plate and sheath. Usually, there is no protrusion on the cover clamping, so a magnet provides suitable holding points on the cover plate.

1.1 Interface introduction

Access the direct connection test clip at the output interface , Enter the connection method signal transmission interface.

After selecting the appropriate frequency and power, long press "Output" o "START" to output. When the normal output, The symbol shall not touch the part of the cable during this period in case of electric shock.

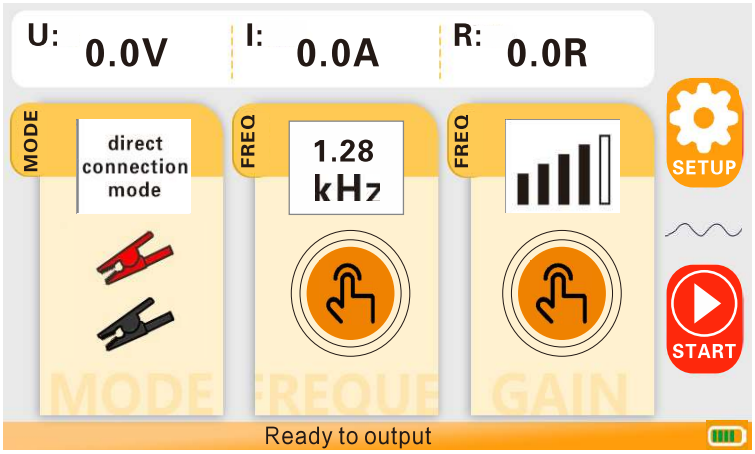


Figure 5-1 Output interface diagram of the direct connection method

1.2 **Straight connection line** The direct connection method is to connect the output line of the transmitter directly to the metal pipeline, and inject the signal directly. Scope of application of direct connection method: tap water pipeline, gas pipeline, communication cable, power cable, cathodic protection pipeline test point or other access points, and continuous metal structure with long line characteristics.The current generated by the transmitter flows through the pipeline, into the earth at its contact site, or into the earth through the distributed capacitance between the pipeline and the earth, and finally returns to the transmitter. The current on the line generates electromagnetic field radiation, and the receiver detects the line through the receiving magnetic field.

Compared with other methods, the direct connection method can obtain the maximum emission current, so if conditions permit, the direct connection method should be used as far as possible.

1.2.1Wiring mode when measuring the metal pipes

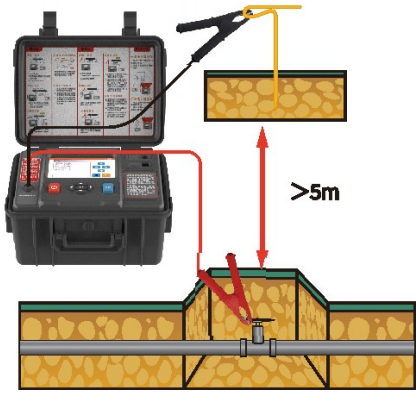


Fig. 5-3 Wiring diagram for direct connection of metal pipe

As shown in the figure, for direct connection operation, insert the red and black test line into the transmitter. Insert the ground nail into the ground perpendicular to the line and maintain a distance above 5 meters. Black test clip connected to the ground pin. Connect to the target pipe with a red test clip line.

1.2.2Measure the wiring mode of the shutdown cable

Cable path detection and unique identification occupies an important position in the field of metal pipeline detection, compared with a single continuous metal structure of metal pipe, cable is composed of several core wire and metal armor, the structure and use of the difference of the detection of the signal, different connection will produce different electromagnetic field, detection effect will be different, so this chapter describes the signal transmission mode of cable detection separately.

1.2.2.1Core-earth connection (anti-interference, recommended)

Core wire-earth connection method is the best wiring mode for path detection and identification of offline cable (uncharged cable out of operation), which can not only give full play to the function of the instrument, but also can anti-interference to the maximum extent, as shown in the figure below

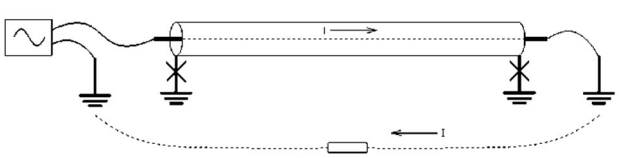


Figure 5-5 Schematic diagram of the signal flow direction of the core wire-the earth connection method

The ground wire at both ends of the cable metal cover should be untied, and the ground end of the zero line and the ground wire of the low voltage cable should also be untied. The

red wiring clamp of the transmitter is a good core wire, and the black wiring clamp is clamped on the ground pin into the ground. At the opposite end of the cable, connect the corresponding core wire into the underground ground grounding pin.

Note: try to use the grounding pin rather than the grounding net! At least at the opposite end of the cable, the grounding pin also needs to be a distance from the grounding net, otherwise the ground wire will return on other cables, which will affect the detection effect.

The current will flow from the transmitter through the core wire, into the earth at the opposite end of the cable, back to the proximal end and back to the transmitter. Clear signal characteristics, can make full use of the function of current direction determination; the signal flows through the well insulated core line, not flowing to the adjacent pipeline, especially to the cross metal pipe, and is most suitable for path search in complex environment. In addition, the cable is grounded, and the signal voltage flowing through the cable is very low, so it is difficult to produce capacitive coupling to the adjacent line, so as to reduce interference.

Due to the resistance and distributed capacitance between the core wire and the earth, the current will gradually decrease with the increase of distance. But if well grounded, can not be considered.

The method of connecting the core wire and the earth is complicated to use, but the effective current on the target cable is the largest, and it is not easy to be disturbed by the adjacent cable. If the cable is well insulated, the transmitting current will not flow to other crossed metal pipelines. Therefore, this method should be preferred in a particularly complex environment.

1.2.2.2 Sheath - Ground connection (not recommended for potential problems)

Connection reference figure:

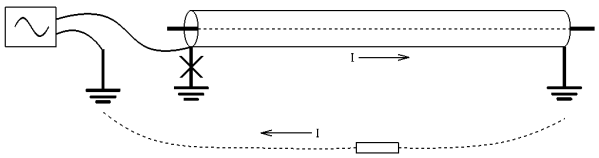


Figure 5-7 Schematic diagram of the flow direction of the shield-earth connection signal

As shown in the figure above, untie the grounding wire of the near end of the cable of the sheath, the grounding of the zero line and the ground wire of the low voltage cable should also be untied together, the cable sheath of the opposite end should be kept grounded, the signal is added between the sheath and the grounding pin **(the grounding network can not be used)**, and the cable phase line should remain suspended. The current flows from the transmitter through the shield, into the earth at the opposite end of the

cable, back to the proximend and back to the transmitter. There is no shielding in this connection method, so the signal generated on the ground is the strongest, and the signal characteristics are relatively clear. Similarly, the signal will gradually decay from near to far due to the presence of the sheath-earth distribution capacitance.

Potential problems: If the insulation layer outside the shield (armor and copper shield) is damaged, part of the current will flow into the earth from the damaged point to form a diversion, resulting in a sudden decrease of the current after the damaged point and affect the reception.

1.2.2.3 Phase line-sheath connection method (simple wiring, but difficult to eliminate adjacent line interference)

1、Do not open the ground copper braid at both ends of the cable, and the cover is grounded.

2、The red output end of the proximal transmitter is connected to the red test line and one end of the core line, and the black output end of the transmitter is connected to the black test line and connects to the protective layer.

3、Short circuit to the distal core and cover.

Connection reference figure:

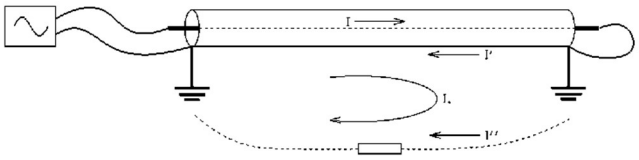


Figure 5-9 Schematic diagram of phase line-sheath connection method signal flow direction

As shown in the figure above, the transmitting signal is applied between the first phase of the cable, the terminal phase line and the sheath are short circuit, and both ends of the sheath shall be kept ground.

If a single cable is laid, the signal will flow from the transmitter through the core wire, and then return through the sheath and the earth loop. Because the shield (armor and copper shield) is composed of continuous metal, the total resistance is large, the current will return through the shield and a small part of the current will return through the earth. Because the core line current and the sheath current are reversed, the effective current that can generate the magnetic field signal at a certain distance is the difference, and the value is equal to the resistive current returned through the earth. In addition, due to the mutual sense between the core wire-sheath loop and the guard-earth loop, the inductive current can also be generated in the guard-earth loop through electromagnetic induction. The combined effect

is that the effective current is equal to the vector sum of the resistance current and the induced current of the earth loop (there is a phase difference). Depending on the actual situation of the site, the effective current may account for a few to ten percent of the total injected current

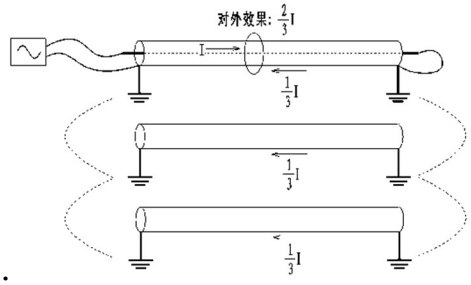


Figure 5-10 Shunt effect of the parallel cable

As shown in the figure above, if there are other cables laid in the same path (both ends are the same), the return current is mainly diverted by the sheath of several cables. For example, if three cables are in the same path, the sheath return current of the three cables accounts for 1 / 3 each. The effective current is forward, accounting for 2 / 3 of the injection value, and the adjacent line current is reverse, accounting for 1 / 3.

1.2.2.4 Phase indirect method

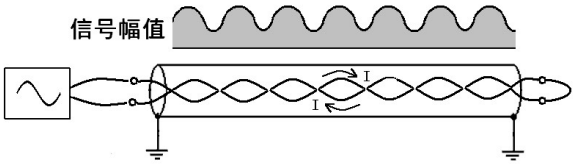


Figure 5-12 Schematic diagram of the phase indirect method signal flow direction

As shown in the figure above, the transmitting signal is applied between the two phases of the cable, and the opposite end of the cable is short circuit. Both phases are twisted inside the cable at the same current value and in opposite directions. Although two phase line is very close, but there is still a certain interval, so the distance between the two phase line and the receiver coil will cause small difference, two phase line here opposite magnetic field direction, but the intensity of the distance of the same, most offset each other, but there are still a small number of residual, metal shield shielding will further weaken it, the final remaining signal can be received. Because of the twist, the signal changes periodically in amplitude and direction along the cable path.

During a twisted period, the magnetic flux of external radiation will cancel each other out due to the continuous change in direction 360, so no induced current is generated in the sheath-earth loop.

Because the effective signal is small, using the high frequency signal will be easier to

detect than the low frequency signal. The phase indirect method cannot use the current direction measurement function of the receiver to eliminate adjacent line interference.

1.3 Selection of the transmit frequency

Put◄►Key or dot screen corresponding position switch different frequencies, a total of 13 frequencies to choose from: 250Hz, 577Hz, 640Hz, 1.28kHz, 2.56kHz, 3.20kHz, 4.09kHz, 8.19kHz, 10.2kHz, 33 kHz, 66 kHz, 82 kHz, 197 kHz。

There is no standard for choosing which frequency, which can be flexibly selected according to the following principles and the actual receiving detection effect:

For general cable detection, the default 3.20 kHz frequency is recommended, unless the phase indirect method is used. It has a low frequency, long propagation distance, and not easy to sense other pipelines; moreover, the receiver receives 3.20 kHz signal more than 1.28 kHz, with strong anti-interference ability and easy to distinguish。

- For long distance cables (longer than 2-3km), if the 3.20 kHz signal is used, there will be a large attenuation at the longer distance, the signal is not easy to receive, and the phase will also shift. Therefore, a 1.28 kHz emission signal is recommended to detect long-distance cables.
- 577Hz, 640Hz, 1.28kH, 2.56kHz and 3.20 kHz are composite frequency signals, and the receiver can track positive and false signals.
- For the phase indirect method, high frequency (4.09 kHz ~ 82 kHz should be preferred).
- Generally, well-grounded cables or pipelines can complete most of the test by using the default 3.20 kHz.
- The long distance cables is selected at lower frequency (577Hz~3.20kHz). The low frequency signals have a long propagation distance and are not easily sensitive to other pipelines; both are composite frequency signals and the receiver can track positive and false signals.
- General pipelines can be tracked at medium to high frequency (8.19 kHz), the signal transmission distance is relatively far, and the induction of other pipelines is not very strong.
- The high resistance pipelines (such as the floating cable core at the opposite end, pipes with anti-corrosion layer, cast iron pipe, etc.) can be selected at high frequency (33 kHz, 66 kHz, 82 kHz or 197 kHz), although the high frequency signal radiation capacity is strong, but the transmission distance is close, and it is easy to sense other pipelines.
- In the case of normal detection, the low frequency should be preferred.

Matters need attention

- Selection of grounding pin position: In order to ensure the detection effect, the grounding pin should be more than 5m away from the pipeline, and the black

grounding wire should be perpendicular to the pipeline direction as far as possible.

- Do not connect the black ground clip to the water pipe or other pipelines, otherwise there will be emission signals on these pipelines, thus interfering with the normal detection of the target pipeline.
- There should be no other pipelines between the ground pin and the target pipeline, otherwise these pipelines will also sense the transmitting signals, resulting in interference. It can be checked by the passive detection method before hitting the grounding pin.
- Ensure good connection: If the line is insulated or corroded, make sure the red test clip is directly connected to the metal part of the line.
- It may be insulated between different sections of pipelines or between fittings and pipes, or if insulation, direct connection cannot be used, or it is necessary to connect the two parts of insulation. Check method: After confirming that the wiring is correct, open the transmitter to observe the output current. If the current is too small, so that it cannot be detected normally, it may be pipe insulation.

1.4 Output power regulation

Put  Key or click on the corresponding position of the screen to increase or decrease the output power. It's divided into six grades.

- The output level shall be adjusted according to the actual needs:
- A large current can facilitate stable detection and accurate sounding.
- At higher frequency (10.2kHz and above) and very shallow depth (within 1m), the higher output current may appear receiving saturation distortion, resulting in the nonlinearity of the receiver response and sounding error. At this time, the output level should be appropriately reduced. The receiver is prompted ⚠ when the receiver is saturated.
- Reducing the output power can effectively extend the battery power supply time, but it should not be considered too much.

2. Caliper coupling method

- The caliper coupling method is suitable for an exposed line, but does not (or does not allow) access to its metal parts, and both ends of the line are grounded (especially for power cables). Without any operation of the tested cable, test the transmitting current clamp on the cable.
- The circuit model of the caliper coupling signal can be equivalent to the transformer: the magnetic core of the caliper can be used as the magnetic core of the transformer, the internal winding of the caliper is the primary of the transformer, the pipeline-earth loop can be equivalent to the secondary (single turn) of the transformer, the primary current is provided by the transmitter, and the pipeline-earth coupling produces the secondary current.

- The advantage of the caliper coupling method is convenient operation, no electrical connection with the pipeline, but will not have any impact on the normal operation of the pipeline, and can reduce the induction of other pipelines; the disadvantage is less than the direct connection method, especially the two ends of the pipeline must be well grounded, but some pipelines cannot meet this requirement.
- Both ends of the cable sheath must be well grounded, otherwise the coupling current decreases with the increase of the grounding resistance. The size of the coupling current is closely related to the circuit resistance (mainly the grounding resistance at both ends), the smaller the resistance, the greater the current, on the contrary, the larger the resistance, the smaller the current, the small to a certain extent, the normal detection cannot be conducted.
- If the two end cover is not grounded or the cover is disconnected, the caliper coupling method may not be used。
- When the launch clamp is stuck into the cable, the arrow direction on the clamp points to the end of the cable.
- During pipeline detection, keep the receiving clamp and the transmitting clamp 2-5m away. For cable identification, keep the receiving clamp and transmitter pliers as far as possible.

2.1Interface introduction

Access the coupling transmitting clamp at the output interface. The transmitter operates in coupled mode, and the screen is shown below:

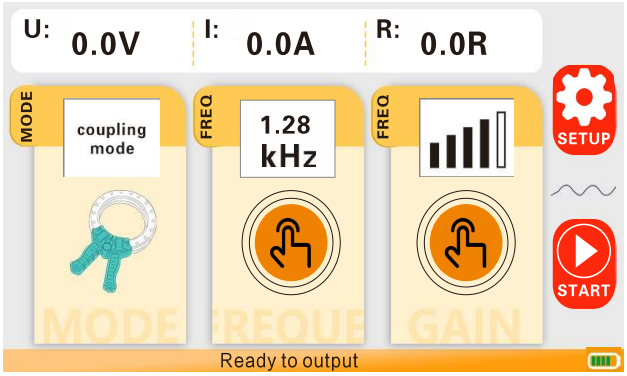


Figure 5-13 Caliper coupling output interface

2.2 Caliper coupling wiring

After the coupling clamp input line is connected to the transmitter, the coupling clamp traps the exposed part of the pipeline, as shown in the figure below:

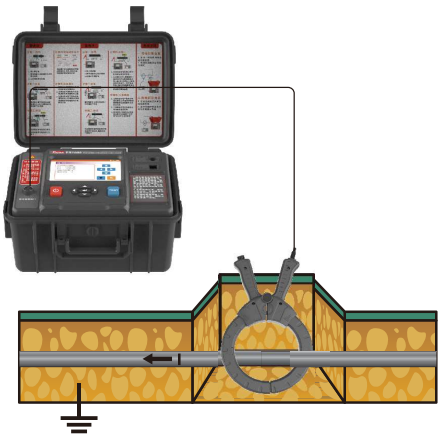


Figure 5-14 Caliper coupling method wiring diagram (Stuck in the cable body)

There shall be no grounding bus between the transmitter clamp and the receiving clamp.

Fig. 5-15 Operation cable caliper coupling method 1 (card cable body)

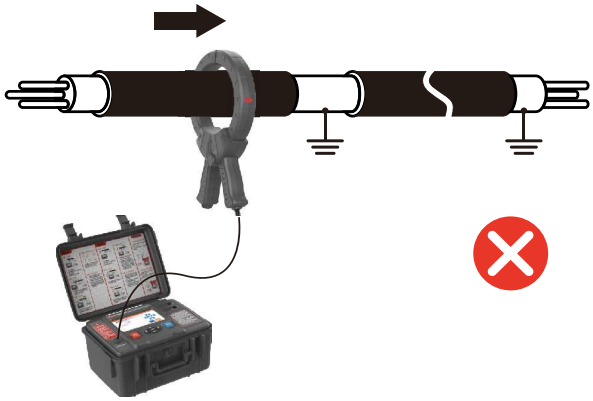


Figure 5-16 Demonstration of error operation

As shown in the figure above, this method can be used for ordinary three-phase package operation cable detection. Transmitter output calipers, the caliper stuck cable body (note not above the ground line), the caliper equivalent for the transformer, the primary cable metal sheath-the earth circuit equivalent to the transformer secondary (single turn), the size of the secondary coupling current and circuit resistance (mainly at the ends of the ground resistance) is closely related, the smaller the resistance, the greater the current.

However, the current obtained by the cable through the caliper coupling is small, so a large output level should be selected in order to strengthen the detection effect.

Stuck cable sheath grounding wire:

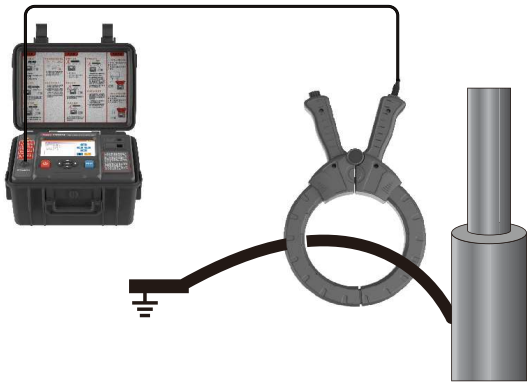


Fig. 5-17 Operation cable caliper coupling method 2 (stuck cable grounding wire)

As shown in the figure above, this method is suitable for the detection of ultra-high voltage single-core operating cables. Because the power frequency current flowing through the single core cable is very strong, and there is no three-phase offset effect of the three-core cable (relatively small zero order current), if the caliper is stuck in the cable body, it is easy to cause the magnetic saturation of the caliper and cannot send the signal. At this time, the caliper should be stuck in the protective grounding wire.

Because the sheath of long-distance ultra-high voltage single-core cable will cross and interconnect at every certain distance, the signal will flow from the sheath of one phase to the other phase at the interconnect point, and attention should be paid to distinguish during detection and tracking.

For the three-core package cable, if the site conditions, the card cable body is difficult, can also use the method of card cable grounding cable, but should not be used as far as possible, in some special cases, may cause signal characteristics (including amplitude and phase) unexpected changes.

Matters need attention

- Both ends of the pipeline must be grounded to sense the signal. The grounding can be continuous grounding (e. g., uninsulated pipes) or either terminal grounding (e. g., metal armor of high voltage power cables grounding at both ends).
- They may also be insulated between different segments, or between fittings and pipes, try to electrically connect them, otherwise caliper coupling will not be used.
- Whether the current can be effectively induced on the pipeline can only be judged by the detection effect of the receiver. If the normal detection cannot be achieved, other signal transmission methods will be used.

- When the pipeline is stuck, ensure that the jaw of the calipers are completely closed and ensure that the jaw is free of foreign matter and rust.

2.3 Frequency selection

Put ◄ ► Key switch at different frequencies.

There are always 12 frequencies available: 250Hz, 577Hz, 640Hz, 1.28kHz, 2.56kHz, 3.20kHz, 4.09kHz, 8.19kHz, 10.2kHz, 33 kHz, 66 kHz, and 197 kHz.

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

2.4 Output power regulation

Put ◄ ► Key to increase or reduce the output power, a total of 6 levels.

The current coupled to the pipeline using calipers is much less than the direct connection method, and the maximum output level should be used as far as possible. The caliper coupling method cannot show the voltage and current coupled to the line.

3. Induction method

When the pipeline has no exposed point, the induction method should be used; before the ground excavation, exploring the underground pipeline is mainly used.

The transmitter uses the built-in radiation coil to radiate the high frequency electromagnetic field (primary field), the metal pipeline-earth circuit couples to produce the inductive current, the induced current reradiates the electromagnetic field (secondary field), and the receiver receives the secondary field for pipeline detection.

The advantages of induction method are that it is convenient to operation and use, without wiring, and does not make any form of electrical connection with pipelines. It is especially suitable for pipeline detection without exposed point, and is also the main means of regional pipeline exploration. The disadvantage is that the pipeline induction current is less than the direct connection method and caliper method, especially when the pipeline depth is large, the effect is poor for pipelines less than 2m; meanwhile, all pipelines within a certain range can sense signals, but it is difficult to identify specific pipelines.

3.1Interface introduction

Without access to the accessories, the transmitter works in the induction mode, and the screen displays as follows:

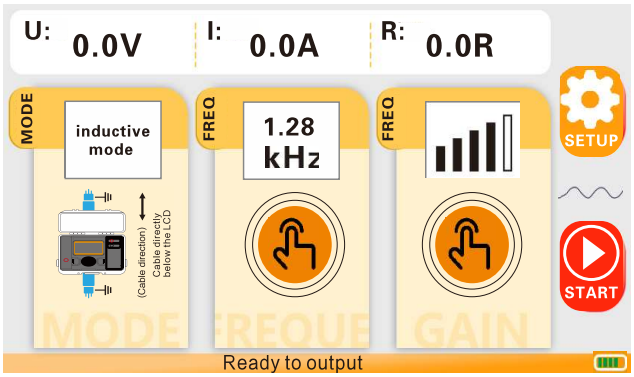


Figure 5-18 shows the output interface of the induction method

3.2 Placement of transmitter

The transmitter does not need to connect to any accessories when using the induction method.

For pipeline detection: place the transmitter horizontally on the ground above the expected pipeline, and the cover plate of the transmitter opening and closing direction is vertical to the expected pipeline direction. During the detection process, it should cooperate with the receiver and adjust according to the actual direction and position of the detected pipeline, as shown in the figure

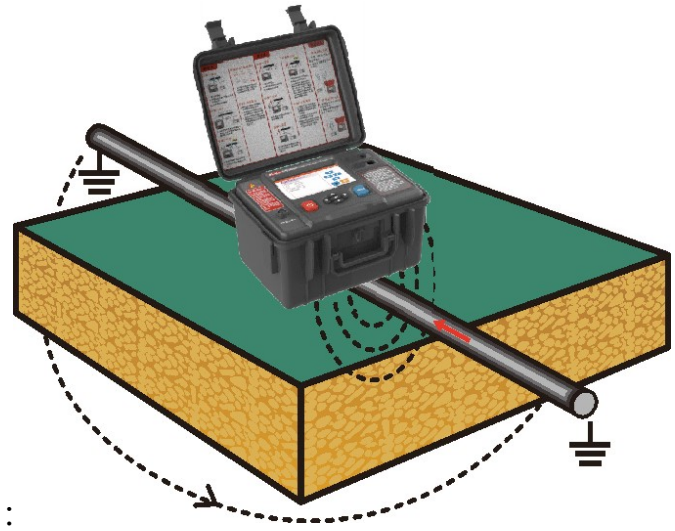


Figure 5-19. Induction method

For pipeline area exploration: in the area to be explored, two people need to operate, the transmitter and receiver move synchronously at a certain distance, and keep the direction of the transmitter and receiver

Matters need attention:

- Both ends of the pipeline must be grounded to sense the signal. The grounding can be continuously grounded (e. g. uninsulated pipes) or grounded at both ends (e. g. both ends of the metal armor of high voltage power cables).
- Pipelines with good insulation and not grounded at both ends will not be able to use induction method. For example, some low-voltage cables have no metal armor, or the

armor is not grounded, nor can they use induction method or obtain poor effect.

- The transmitter cannot be placed on the metal manhole cover, nor used on the reinforced concrete pavement, otherwise the signal will be blocked by the manhole cover or steel mesh, and cannot be effectively applied to the pipeline below.
- In addition to radiating signals to the pipeline, the transmitter also inevitably radiates to the surrounding space, which will cause interference to the reception, so when using the induction method, the receiver and the transmitter must be separated by a certain distance (receiving distance).
- 3.3 Frequency selection

Put◄►Key switch at different frequencies.

There are three optional frequencies: 33 kHz, 82 kHz, and 197 kHz, and the default is 33 kHz.

Matters need attention:

- Low frequency induction effect deviation, but the signal propagation distance is far, and it is not easy to produce interference.
- High frequency induction effect than low frequency, but the propagation distance is close, and easy to sense other pipelines。

The high resistance pipeline should be detected with high frequency, which will be difficult to sense the applicable signal by using low frequency.

3.4 Power regulation

Put▲、▼Key to increase or reduce the output power, a total of 6 levels.

Matters need attention:

- Using a lower output level can effectively reduce the induction of other pipelines and shorten the transmission distance.
- To detect deep pipelines, the output level should be appropriately increased.
- Because the transmitter cannot measure and display the current induced by the pipeline, it can only try repeatedly and choose flexibly according to the detection effect of the receiver.

4. Zero line / ground line / sheath injection method

This method can be used to detect the low voltage cables in operation. Because the sheath of many low voltage cables is not grounded, or the sheath is discontinuous, or the grounding is not good enough, so the caliper coupling method cannot be used.

This method does not make any changes to the cable, and injected high frequency signal, will not cause adverse effects on the running line.

At the user end, the red connector of the transmitter shall be connected to the zero line, ground wire or cover, and the black connector clamp into the underground ground pin, as shown in the figure below:

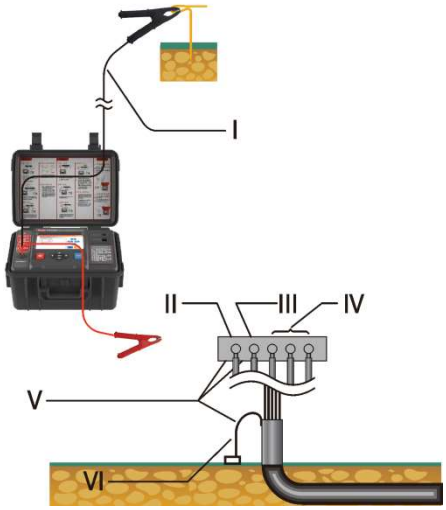


Figure 5-20 Injection method of zero line / ground wire / sheath for running cable

Matters need attention:

Safety warning: The cable is live, and the wiring must be operated by relevant qualified or qualified power staff!

- The signal must be transmitted at the user end. If the signal is transmitted at the substation end, the signal will be injected into all outgoing lines to distinguish the target cable.
- Selection of grounding pin position: to ensure the output effect, the grounding pin should be placed 5m away from the cable, and the grounding wire should be as perpendicular to the cable direction as far as possible.
- If the zero line is not grounded at the user side, it is preferred to use the zero line to inject the signal.
- Because the sheath of low voltage cable is mostly discontinuous, if the sheath injection signal is too weak, or the signal is interrupted somewhere in the cable path during the detection process, the zero line / ground line can be used for injection.
- Because all the zero line / ground wire or sheath of the outgoing line are in parallel in the substation room, part of the current will be diverted on the outgoing lines of other cables. Although the signal can be detected, the strength is weak, and attention should be paid to the distinction in the actual test.
- When detecting the high voltage running cable, if the caliper coupling method is used to receive the signal or the signal is weak, the grounding resistance of the sheath at both ends of the cable is too large. At this time, it can be injected through the sheath.
- When detecting the single-core ultra-high voltage running cable, the caliper coupling method fails, and the sheath injection method can be used.

Ⅺ.Detection by the receiver

1. Pipeline detection

Select 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 line.

Line detection using the receiver built-in coil induction method

The receiver does not connect to any external accessory sensor and automatically identifies it as built-in coil induction.

Avoid interference

When we are close to the transmitter, we make sure that we will not be disturbed by it:

- When using caliper method or induction method, the transmitter will produce interference in a short distance. The distance of 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 requires a test to be determined, but 5m outside the caliper method and 20m outside the induction method.

1.1Set the reception frequency

Boot default 3.20kHz, press "F" button to switch frequency. The transmit and receive frequencies must be the same.

The following frequencies / bands are available:

There are 15 frequencies available for wire cruise mode interface, classic positioning interface and signal distortion measurement interface: 50 Hz, 60Hz, 250 Hz, 577Hz, 640Hz, 1.28kHz, 2.56kHz, 3.20kHz, 4.09kHz, 8.19kHz, 10.2kHz, 33 kHz, 66 kHz, 82 kHz, 197 kHz.

1.2 Gain adjustment

Press "+", "-", to make the gain adjustment.

1.3 Select the measurement mode

Press "M", you can select three response modes: broad peak, narrow peak and sound valley.

- Broad peak mode  :

The strongest signal is directly above the line. The advantages are high response sensitivity and large response range; the response curve changes slowly, which is not conducive to the differentiation of parallel pipelines.

- Narrow peak mode  :

Similar to the broad peak method, the advantage is steeper, which facilitates the

differentiation of parallel lines; the disadvantage is reduced sensitivity.

- Sound valley mode :

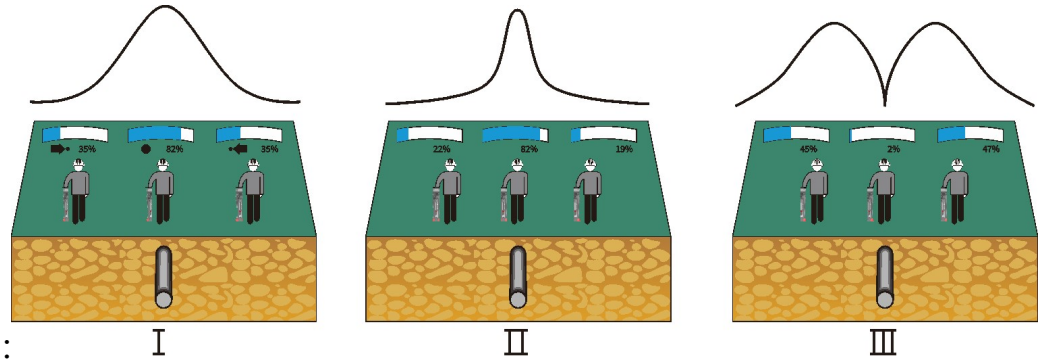
The signal is the weakest directly above the pipeline, and the signals on both sides change rapidly. The advantage is the precise positioning of target pipeline; the disadvantage is easy to interference, and error response may occur under strong interference.

By selecting different measurement modes, the user can observe the amplitude change of the signal for pipeline detection.

Use the peak mode (wide or narrow peak) to find the point with the strongest signal and start the pipeline detection from this point. With the receiver left to right, the signal amplitude will decrease on both sides to track the peak position (the strongest signal point in peak mode) or the valley position (the most vulnerable signal in sound valley mode) until the path of the whole pipeline is found.

When using the sound valley mode, the tracking speed can be increased, the signal is weakest directly above the pipeline, and the signal on both sides increases rapidly. However, the sound valley mode is susceptible to interference, so change to peak mode at intervals to verify the correct position of the pipeline。

The responses in different modes are shown in the following below



a. broad peak b .Narrow peak c. Trough

Figure 6-1 Signal responses in different modes

1.4Introduction to the wire cruise mode interface

When the receiver approaches above the line, the blue analog line in the center of the screen shows the line position below the receiver and the arrow in the center points to the cable; when the receiver is directly above the line, the arrow becomes the origin for quick tracking of the line.

Observe the signal amplitude and determine the position of the cable under different measurement modes. See Section 1.3 for details. The recommended signal amplitude value is

shown at around 60.

Observe the direction of the arrow in the pipeline position. If the position arrow is to the right, the cable is on the right and should move to the right, but not to the left. When the arrow turns into dots and moves left and right slightly, the arrow will reverse and the receiver is directly above the cable.

Observe the signal direction arrow to determine the current direction. See Section 1.6 for details. Only 577Hz, 640Hz, 1.28k Hz, 2.56kHz, 3.20kHz shows the current direction.

Note: If the signal is weak or the interference is strong, the origin does not always appear, with the arrow changes

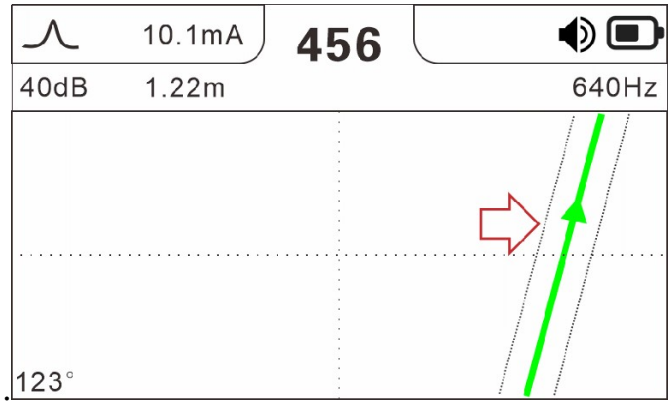


Figure 6-2 The wire cruise mode interface

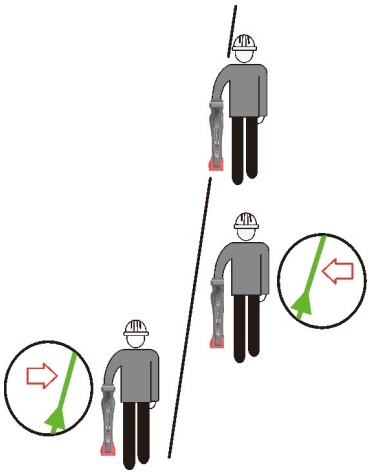


Figure 6-3 Demonstration of wire cruise mode function

Matters need attention:

- The arrow points correctly toward the line either toward the end of the line or toward the transmitter.
- When the adjacent pipeline also has a strong signal, and the receiver is located near it, there will also be an analog pipeline indication, but it shows the adjacent pipeline, not the target pipeline, pay attention to distinguish.
- When the interference of the adjacent pipeline is large, the simulation pipeline indication will deviate. If accurate positioning is required, please refer to subsection 3:

Precise positioning.

1.5Introduction to the classic positioning interface

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

Observe the signal amplitude and amplitude bar, and determine the position of the cable under different measurement modes. See Section 1.3 for details. The recommended signal magnitude values are shown around 60 and the magnitude bars are shown in the middle.

Observe the direction of the arrow. If the arrow is to the right, the cable is on the right and should move to the right, but not to the left. The display length of the line position arrow will be related to the offset distance of the line. The closer to the line position, the longer the position of the arrow, and the shorter the length of the arrow.

Observe the signal direction arrow to determine the current direction. See Section 1.6 for details. This interface is shown at the following five frequencies, 570Hz, 640Hz, 1.28kHz, 2.56kHz, 3.20kHz.

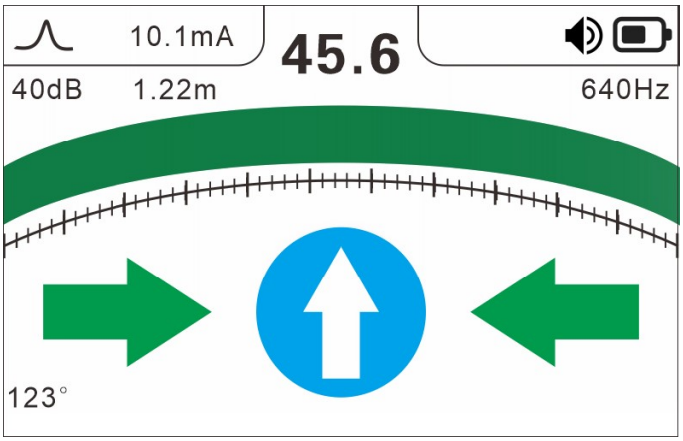


Figure 6-4 Classic Positioning Interface (1)

This interface is displayed at the following 10 frequencies: 50Hz, 60Hz, 250Hz, 4.09kHz, 8.19kHz, 10 kHz, 33 kHz, 66 kHz, 82 kHz, and 201 kHz。

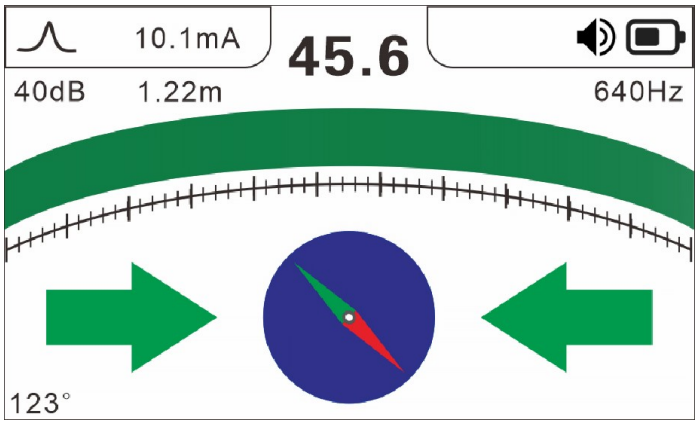


Figure 6-4 Classic Positioning Interface (2)

1.6Introduction to the interface of the signal distortion test mode

The signal distortion test was used to analyze the site shape. This ensures that the user can better feel the reliability of the collected data. This mode generates two figures of peak waveform and valley value waveform at the same time, and the peak and valley value positions should be consistent in the non-distortion field.

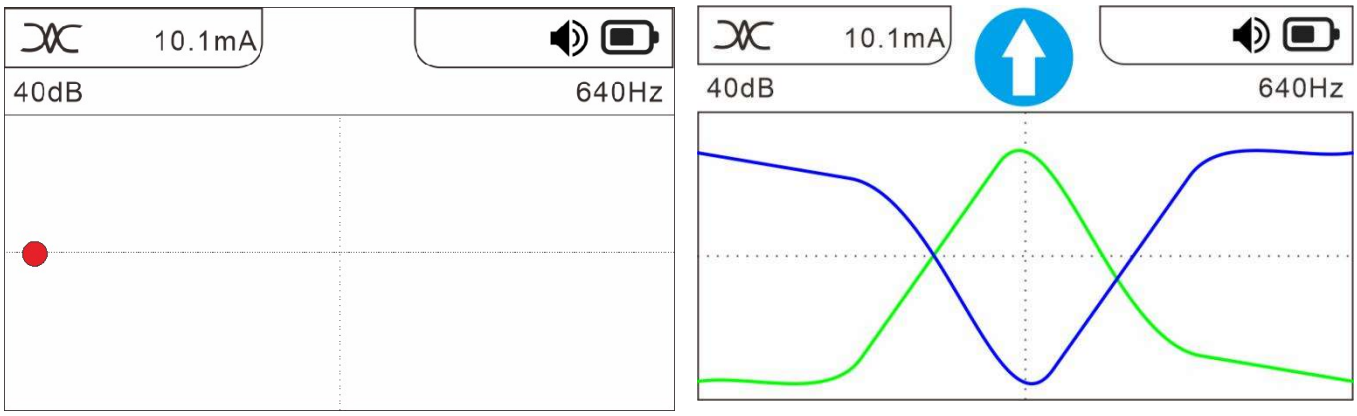


Figure 6-5 (1) Interface diagram of the test for signal distortion

6-5 (2) The signal distortion test interface

If the signal distortion test is required, switch to the 6-5 (1) signal distortion test interface by pressing the + or-key or sliding to the right or left hand on the LCD screen. Position yourself on the side of the pipeline, press the "i" key and steadily go to the other side of the pipeline. The 6-5 (2) signal distortion test interface appears on the screen.

1.7 Current direction determination

The current of the adjacent pipeline is generally smaller than that of the target pipeline, but the response of the receiver is related to the depth of the pipeline. It may be due to the depth of the target pipeline and the shallow adjacent pipeline, resulting in the small gap between the response amplitude above the two, resulting in the inability to distinguish. Other reasons also cause a direct similar current between the adjacent line and the target line, making it more difficult to identify.

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

Use the current direction determination function, must work at the 577Hz, 640Hz, 1280Hz, 2.56kHz, 3.20kHz frequency, other frequencies do not show the pipeline signal direction arrow.

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 the calibration, and the calibration data shutdown will not be lost.

At a distance close to the transmitter but not disturbed (such as 5-10m), identify the position of the target pipeline, directly above it, back facing the transmitter, facing the end of

the pipeline, long press the "i" key, and the popup in the middle of the screen: 

, Ask whether to make front and rear direction correction calibration, if press other keys will cancel the calibration operation, if press "i" key again, confirm the calibration, direction toward the front: pipeline signal direction to green arrow, and point to the front.

When detecting or identifying another line, it must be recalibrated for the target line to be detected.

During tracking the pipeline, observe the pipeline signal direction arrow. If the green arrow points above, it is above the pipeline to be tested. If the arrow points below, it tracks the adjacent pipeline, as shown in the figure below:

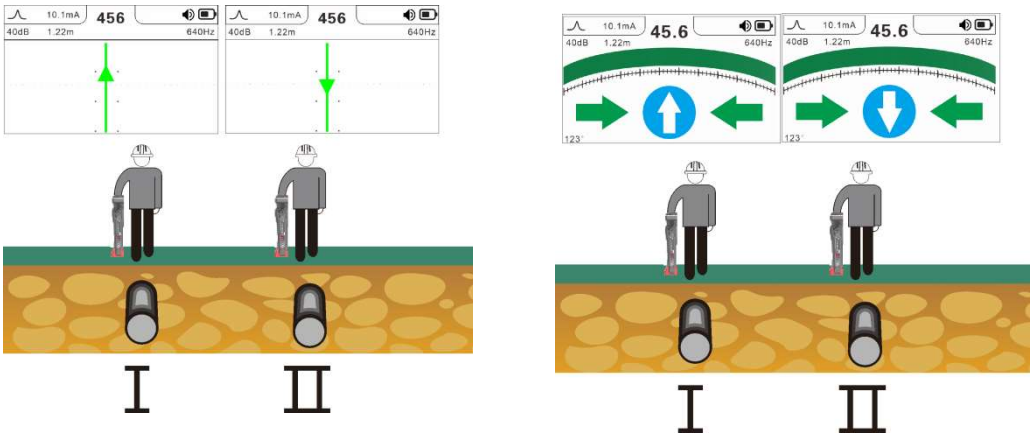


Figure 6-5 Current direction determination

The signal amplitude of adjacent lines may be small or large and may be indicated by arrows.

If it is an ultra-long distance pipeline, the deviation of the phase value will gradually increase due to the influence of the distributed capacitance. When the judgment reaches a certain degree (e. g., greater than 45), it can be calibrated directly above the convinced target pipeline, and the phase value will be displayed 0 again, and the signal direction arrow points directly above in green.

The process of current direction determination is shown in the following figure

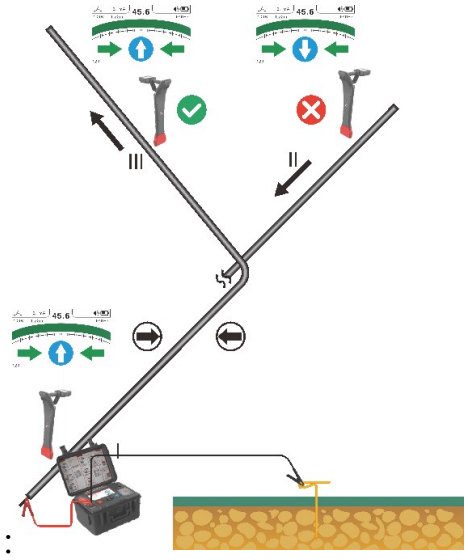


Figure 6-6 Signal direction tracking detection process

1.8 Use the sound output to assist in tracking

The sound output of the receiver speaker can reflect the current signal strength in real time, which can help the tracking pipeline.

Long press OK to enter the Settings interface，Put Key Move the cursor to select the sound setting bar, and press "OK" to turn the signal strength tone on or off.

2. Regional detection

To avoid damage to the pipeline, it is very important to identify unknown pipelines before ground excavation. Here, area exploration is used to identify unknown pipelines. Regional exploration method are divided into passive method and induction method.

2.1Passive source detection

Passive exploration is passive detection, without using the transmitter, adjust the receiver frequency to power frequency / radio frequency, mode to wide peak (or narrow peak), conduct grid search, switch to the signal intensity interface, observe the historical curve, there will be a peak response above the pipeline, and mark on the ground, as shown in the figure below

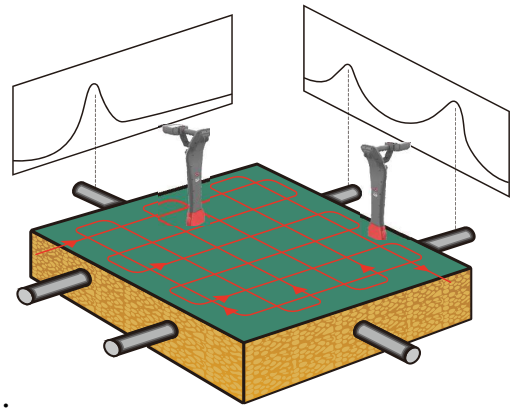


Figure 6-8 Exploration of passive method areas

Power frequency method: the power frequency method receives the power frequency and five harmonic signals of the pipeline, which is especially suitable for exploring the running cable. Some (not all) of other pipelines can also be detected due to the presence of power frequency induced current, so the pipelines detected by the power frequency method cannot be confirmed as power cables. The power frequency receiving frequency is 50Hz, 60Hz and 250Hz.

Radio frequency method: pipelines can sense the radio frequency electromagnetic field in the environment (such as radio signals from various radio stations), and then conduct secondary radiation. The RF method receives this signal and in most cases (not all) can detect lines without power frequency current. To accommodate the different signals, the RF is divided into two frequency bands with a central frequency at 33 kHz and 82 kHz, respectively.

Matters need attention:

- When receiving at power frequency or RF, real-time sounding is not possible.
- In the process of passive detection, the adjustment of gain is very important. Some strong signal pipelines have a strong response at low gain, but the weak signal pipelines need a high gain to detect the gain, so after checking the strong signal pipelines, we need to improve the gain and search again. Strong signal lines show saturation distortion at high gain, but their interference can be excluded by observing existing markers.
- Power frequency and RF detection, or in combination, cannot ensure that all lines are detected.

2.2 Radiographic exploration

Using induction detection requires the transmitter to transmit signals by induction, and two operators. Before exploring, determine the area and pipeline to search through the area, the transmitter is in induction mode, and set the frequency of the transmitter and receiver to be consistent. One operates the transmitter and the other the receiver, the transmitter and receiver are perpendicular to the line. Two people are about 20m apart and move parallel in the direction perpendicular to the pipeline. When the transmitter passes through the pipeline, the signal will be induced to the pipeline, and the receiver will receive the signal. Observe the receiver response, if there is a peak response above the pipeline, it should be marked on the ground, as shown in the figure below:

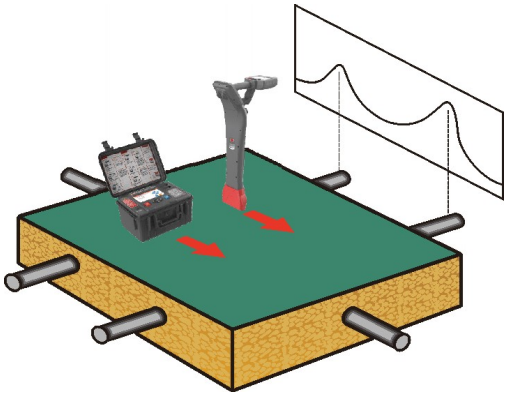


Figure 6-9 Sensing method area exploration

After exploring in one direction, exchange the position of the transmitter and the receiver, and reverse explore again。

Probing is required in all possible directions

After the positions of all lines are marked, the transmitter is placed above each line and tracks each line until it leaves the area to be explored.

Induction exploration is the most reliable way for regional pipeline exploration, but due to the limitations of the induction method itself (for example, the pipeline must be grounded, the concrete pavement with steel mesh can not be used, etc.), all pipelines cannot be explored.

2.3 Comprehensive exploration

Because different methods have their own advantages and limitations, in order to prevent leakage, one, many, and even all methods should be repeatedly explored repeatedly according to the site situation, so as to minimize the possibility of damage to construction pipelines.

3. Accurate positioning

When affected by interference or adjacent pipelines, sometimes a deviation occurs. If it is necessary to locate the pipeline more accurately, the following methods can be used manually:

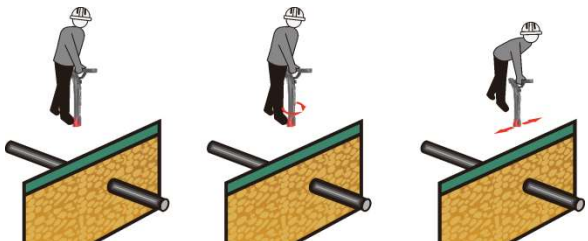
After finding the approximate location of the target line, use the wide or narrow peak method and adjust the appropriate gain:

a. The receiver needs to be kept vertical to the expected pipeline direction to find the point of the maximum response.

b. Do not move the receiver, put it in place to find the maximum response Angle.

c.Need to keep the angle, move the receiver left and right, find the maximum responsive point, and mark.

The above steps can be repeated to improve the positioning accuracy. The operation process is shown in the following figure:



a b c

Figure 6-10 Precise positioning

When using the sound valley method instead, follow the Angle determined in step b to find the corresponding minimum point and mark it well.

If the peak and valley values are the same, the location is accurate. If different, it means that there may be adjacent pipelines, affected by them, the positioning is not accurate and needs to be corrected.

As shown in the figure below, both the peak and valley points are biased to the same side of the pipeline, the actual position is on the other side of the peak point, and the distance from the peak point is half the peak and valley distance

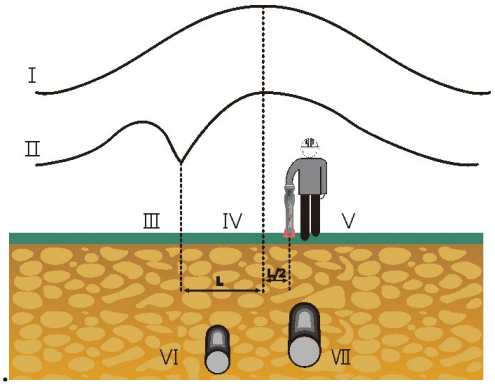


Figure 6-11 Location correction

4. Depth measurement

4.1Automatic depth and current measurement

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

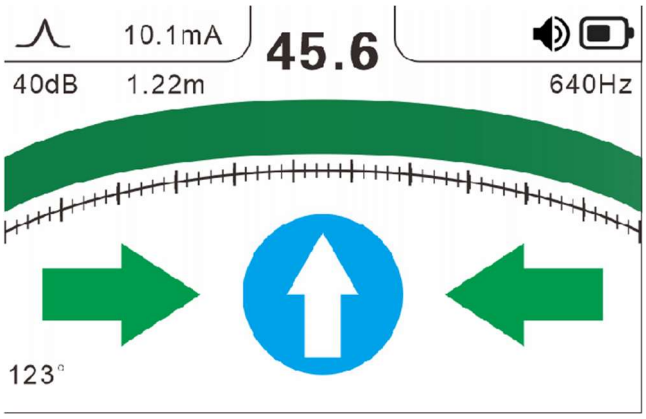


Figure 6-12 Real-time depth and current measurements

1. Classic mode double arrows appear at the same time or in cruise mode, the pipeline is basically in the upper and lower direction, indicating that the receiver is basically directly above the pipeline.
2. The pipeline in the interface is basically in the upper and lower direction (the blue line is vertical at the interface, and the signal in the line points to the front), indicating that the detection direction is basically consistent with the pipeline direction.
3. Phase is not a prerequisite for performing real-time depth measurements, but at 640Hz and 1280Hz, 2.56kHz, 3.20kHz frequencies,

Phase within ± 30 indicates correct tracking, which is currently located above the target line (not adjacent lines), and is an important reference.The depth unit is m (m).

Matters need attention:

- The output of the speaker will affect the real-time sounding volume. Generally, the speaker should be silent as far as possible.
- Method to verify whether the depth value is credible: measure the receiver close to the ground once, increase it by 0.5m and measure it again. If the difference between the two depth data is about 0.5m, the result will be credible.
- Real-time depth and current measurements cannot be performed when using passive passive detection.
- If the induction method is used, the measurement error will be greater than the direct connection or caliper method. If the induction method must be used, then the distance between the receiver and the transmitter shall be above 20m.
- Try not to measure near the pipeline turn or tee (cable T connection), and should ensure that the receiver is more than 5m 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 will be more obvious when the diameter of the pipeline is large.

- The interference of the side-by-side pipelines will increase the sounding error, and the data will be unreliable in serious cases. The precise positioning method can be used to judge whether automatic measurement is used: if the peak point and valley value point coincide, the depth data is credible; if not overlap, there is adjacent line interference, and the greater the peak and valley distance, the greater the depth error.
- Based on the current value, it helps to identify the target line. In some cases, the current of the side by side pipeline is small but the depth is shallow, resulting in the adjacent line signal is larger than the target pipeline signal, which is easy to cause the result of wrong tracking. The current needs to be measured side by side separately, and the line with the largest current (rather than the strongest signal) is the target line.
- According to the change of current value with distance, it can help to analyze the pipeline condition. The transmitter applies a signal to the target pipeline, but with the increase of distance, the current intensity will gradually decrease (gradually leakage back to the transmitter), and the attenuation degree is related to the type of pipeline and soil quality. If the decay rate of the current remains stable without a sudden decrease, the pipeline is normal. If a sudden current drop occurs, one case is because the pipeline has three connections here (cable T connection) and the current is diverted; the other case is because the insulation is broken and ground here.
- The current measurement is carried out on the basis of the correct depth measurement, and if the depth data is not credible, then the current value is also not credible.
  Special attention: in most of the more strict pipeline exploration specification, no matter what kind of equipment, do not adopt the results of the automatic sounding, real-time sounding is very convenient, in some strong transmission signal, less interference, pipeline is not too complex, its accuracy can meet the requirements, but the results can only be used as a reference. A more reliable depth measurement should be manual depth measurement using sound valley 45 method or wide peak 80% method.

4.2 Sonic valley 45° method for manual depth measurement

Using the sound valley method, find the point A with the weakest signal on the pipeline; then tilt the receiver 45 and move to the side of the pipeline until the point B with the weakest signal; then tilt the receiver in the other direction 45, move to the other side of the pipeline, and find the point C with the weakest signal.

In general, deep Depth is equal to AB and also AC. The adjacent pipeline may cause the signal valley to be not directly above the pipeline, so the depth of Depth equals half of BC will be more accurate.

Note that when tilt the receiver, observe the marking lines on the receiver, The receiver is correctly tilted when one sign line is horizontal and the other is vertical to the ground 45

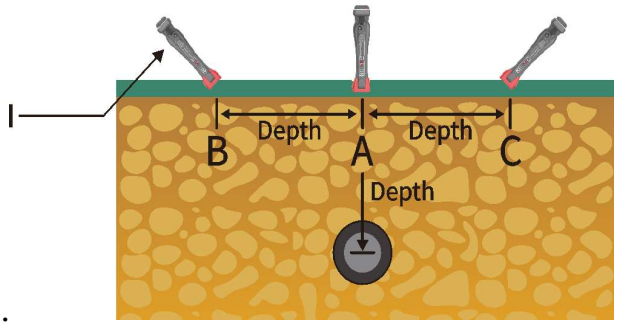


Fig. 6-13 Sound valley 45 method sounding

4.3Wide peak 80% method manual depth measurement

When using the wide peak method (not narrow peak method and sound valley method), find the point with the strongest signal on the pipeline, press the gain knob, and the automatic gain adjustment amplitude is 60%; then move the receiver left and right horizontally, find the two points with signal amplitude weakened to 48%, then the distance between two points will be equal to the pipeline depth, as shown in the figure below:

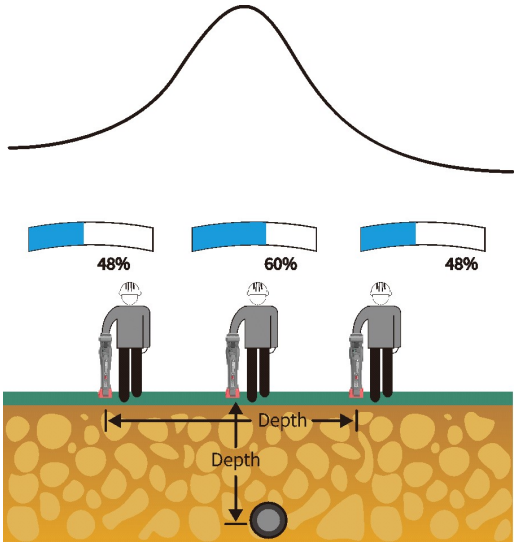


Figure 6-14 Wide peak 80% method sounding

5. Cable identification

In the power construction, the unique identification of cables involves facilities and personal safety, so this is a very strict work. Flexible calipers or stethoscope equipment is required

Power outage cable identification: direct connection method

Live cable identification: the coupling method

5.1 Selection of the signal transmission method

- The frequencies of the transmitter are 577Hz, 640Hz, 1.28kHz, 2.56kHz, 3.20kHz, 4.09kHz, 8.19kHz, 10 kHz, 33 kHz, 66 kHz, 82 kHz, and 197 kHz. The default 3.20 kHz can meet most of the test requirements.
- For non-operating cables, core wire-earth connection is preferred, phase wire-sheath connection is inconvenient, but sheath-earth connection is not recommended.

- The caliper coupling method is preferred for running cables. If not, the zero line / ground line / sheath injection method should be cautious.
- The signal cannot be transmitted by using the induction method.

5.2 Interface introduction

In the startup state, the receiver automatically recognizes the connected accessories and enters the cable recognition mode. The interface is as follows

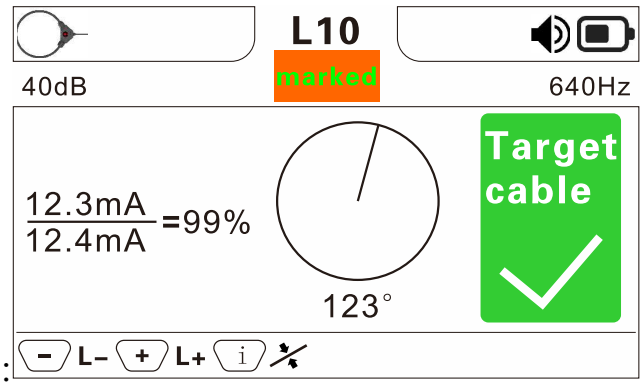


Fig. 6-15 Cable identification interface

The default operation of the receiver is 3.20 kHz, setting the frequency is consistent with the transmitter; the cable recognition mode displays the current value directly and compares the calibration current; the phase dial shows the correct icon Or error icon 。

5.3 calibration

The receiver may pre-calibrate 20 cables or 20 signals for the same cable.

For the same cable, can choose different frequency for a variety of data calibration, after the staff to the far end, through the telephone told the near operator change the transmitter transmission frequency and transmission power, consistent with advance calibration of the data, then identified by the receiver, the operators don't need to run back and forth calibration, improve efficiency.

Live cable identification requires the receiver to first measure the current size and direction of the target cable at the known position of the target cable, as the reference for comparison, and compare the measurement results at the unknown point with the reference, to make the correct or wrong identification judgment. The process of measuring and recording the detection of the current and the current direction is the calibration.

Calibrate near the transmitter and ensure that it is not disturbed. For the caliper coupling transmit signal, leave the transmitter caliper and jam the flexible current clamp on the target cable.

The arrow in the direction of the launch caliper and the arrow in the flexible current clamp are both calibrated at the end of the cable, so that the largest signal is received. Do not change the output frequency and output power of the instrument after each

signal calibration, otherwise it must be recalibrated.

In the cable identification interface, select the appropriate frequency to make the detection current display not less than 0.3 mA and stable, calibration can be performed:

Initial calibration: The receiver is not overcalibrated, enters the pre-calibration state by default, the identification result box shows "?", ask for calibration; press" i " for calibration. The status box to be calibrated shows the "OK" icon, and the identification result box shows the identification result, indicating the successful calibration.

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

Recalibration：If the receiver has been calibrated, press the "i" key to exit the current cable identification interface. At this time, the interface prompts: "whether to delete all calibration data", press "+, -" key to select "Yes", and then press "i" key, the previously calibration data will be deleted, and the cable can be calibrated again. If not recalibration, select No.

Multi-cable calibration：After completing the first cable (cable number L1), mark the L1 (for easy resolution) and apply the coupling transmitter of the transmitter and the flexible receiver for the second cable. Long 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 of the number is uncalibrated, and then the user can calibrate the second cable according to the initial calibration steps. After similar calibration, mark the L2 on the cable using spray paint or other methods.

If the third cable is to be calibrated or more, it is necessary to follow the third cable and select the third cable, select the third cable number, conduct the calibration operation, make the mark, and so on.

Each frequency, each cable number has its own calibration operation. After calibration, the distal cable identification must be notified that the transmission frequency is consistent with the calibration frequency. Do not change the transmission frequency and transmission power of the transmitter at will, otherwise it must return to the proximal end of the cable for calibration.

When identifying the other cable, calibration the new identification cable through the operation of multiple cable calibration. Or use the same cable number to calibrate the new cable through the reset operation.

For the same cable, the parameters can be combined with different frequencies and different large numbers, and 10 combined parameters can be calibrated for the same cable. For example, the calibration frequency of L1 is 1280Hz, the transmitter output power is 5; L2 is 1280Hz, the transmitter output power is 10; the calibration frequency of L3 is 640Hz, and the transmitter output power is 5; the same cable L1, L2, L3. The advantage of this method is that some cables may be too long or the grounding loop

impedance is large, one frequency or gain can not be identified, and another frequency or gain needs to run back and forth.

5.4 Identify process

A、Confirm that the transmitter output is normal

The following operations take the caliper coupling method as an example, and the identification operation of the direct connection method is basically consistent with the coupling method.

B、Near-end identification confirmation

Cable identification: the transmission coupling clamp is stuck in the near end of the cable, the direction of the arrow points to the distal end of the cable, the flexible current clamp should jam the cable from the transmission clamp (the direct connection rule does not need to stay away) to prevent receiving interference, the arrow on the flexible current clamp interface points to the distal end of the cable, the adjustment frequency is consistent with the transmission frequency on the transmitter, the output power of the transmitter is adjusted to the maximum, the current detected by the receiver is the maximum value; the switching frequency and output power can be tried to achieve the best measurement effect. Calibrate according to the above calibration steps; after calibration, the ratio box of measuring current and calibration current shows 75%~135%, the current direction box shows green arrow to the right, the identification result box shows "green icon", accompanied by "di-di" prompt.

Note: This step confirms what output power and what frequency is appropriate.

The current coupled to the pipeline using calipers is much less than the direct connection method, and the maximum gain should be used as far as possible. The caliper coupling method cannot show the voltage and current coupled to the line.

C、Far-end recognition

After successful calibration, leave the transmitter in place. After leaving the calibration point, you cannot change the calibration, nor can you change the transmission frequency of the transmitter and the receiver, and the output power of the transmitter. At the distal position to be identified, jam the flexible calipers and identify them one by one.

Note that the directional arrow of the flexible caliper remains pointing at the end of the cable.

If the target cable is stuck, the difference between the detection current and the calibration current is not large, and the current direction can be measured and meets the following criteria:The detection current is not less than 0.3 mA.

- The detection current is greater than 75% of the calibrated current value, and less than 135%.
- The current direction shows the green arrow pointing to the right.

Refer to 5.6 flexible caliper current measurement instructions for frequency gear above 4.09 kHz

If the above conditions are met, it is indicated that the target pipeline is used, and the identification result is shown as"Green dozen icon", the receiver is accompanied by the "di-di" prompt sound. If the above criteria are not met, it is other adjacent pipelines, and the identification results are shown as"Red tick X" or "black? Icon ", no beep, for non-target cables.

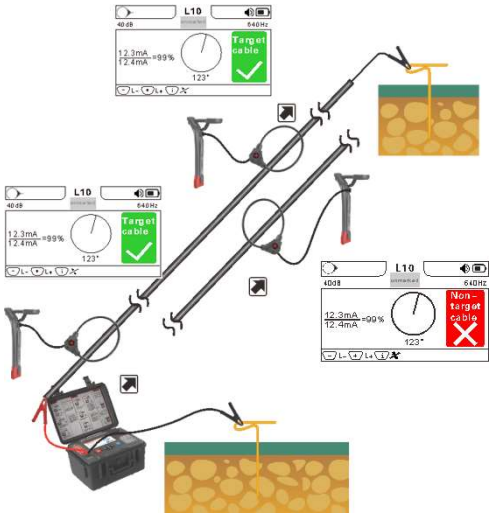


Figure 6-16 Cable identification schematic diagram

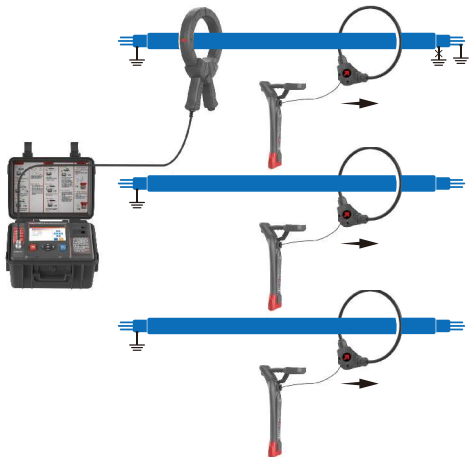


Figure 6-17 Power outage identification (direct connection method) wiring detection

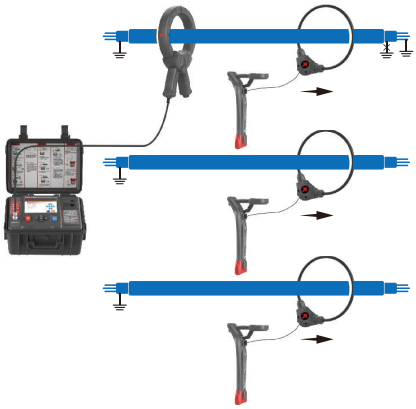


Figure 6-18 Live identification (coupling method) wiring detection

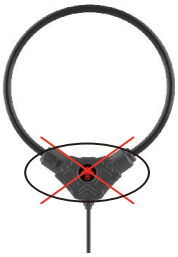
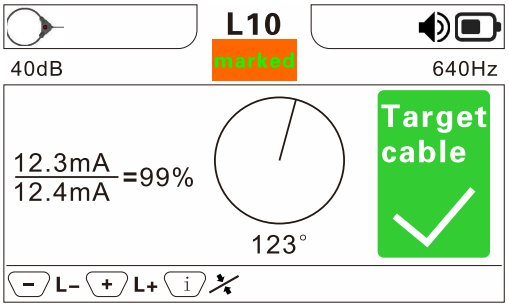


Figure 6-19 Areas of easy interference with the flexible coil

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



The card is displayed to the

right on the target cable

Green virus icon

Figure 6-20 Cable identification result interface

Attention	**Identification all cables once at distal identification. Whether it is the identification of live cable or blackout cable, the identification result will be unique. If there are two checked cables, please refer to the following precautions to analyze and check the error.**

Matters need attention:

If two or more cables all display "green tick √ icon", or all display "red tick x icon or black? Icon ", and observe that the measured current value is not much different, the current direction is the same, it must attract special attention, do not easily draw conclusions, this situation is likely to be the transmitter wiring method is wrong, the following errors should be checked first:

The calibration is incorrect or not equal when the detection current signal is stable.

- Current caliper direction inverted (opposite direction during calibration).
- The target cable is not stuck in the identification, but only a few adjacent lines are stuck
- The transmitter frequency is inconsistent with the receiver frequency.
- Gain at calibration is not consistent with gain at identification.

- The detection current was less than 0.3 mA.
- Target cable is broken or disconnected.
- Caliper pliers have dirt, clean after re-calibration, identification.
- After calibration, the receiver receiving frequency and transmitter output power are changed without resealing
- The cable number on the receiver is inconsistent with the cable mark stuck by the transmitter.
- If it is not possible, please identify the target cable power outage and use the power outage cable identification method!

5.5Multi-cable recognition

1、Press through it at the proximal end of the cable  Key switch different calibration numbers for L1~L20 ten cables. The following operation is the caliper coupling method, and the multi-cable identification operation of direct connection method is consistent with the coupling method.

2、Will launch calipers to the first marked cable (made L1 mark cable), press the "+, -" receiver switch cable number, select L1 number, come to the distal end of the cable, according to the steps of section 5.4 and determine the standard to identify the corresponding cable, make the corresponding mark on the cable;

3、Contact the near terminal user through the mobile phone, ask it to card the launch caliper on the second calibrated cable (L2 marked cable), operate the receiver to select the L2 number, continue to identify the cable corresponding to the L2 number according to the cable identification steps, and make the corresponding mark. And so on, to identify multiple cables in turn.

Note: "proxim" means the end near the transmitter and "distal" is where the engineer needs to identify the corresponding cable.

Ⅻ.Other features

1. Sweep check

During the test, the transmitter cannot be opened. The internal coil of the receiver sweeps the current environment or cable and detects the signal amplitude of 50Hz, 250Hz, 640Hz, 1.28kHz, 10 kHz, 33 kHz, 82 kHz and 201 kHz successively.

1.1 Introduction of the scan frequency test interface

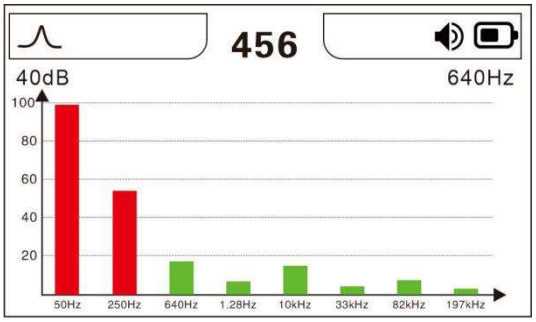


Figure 7-1 Scan frequency test interface

1.2 Field service

The electromagnetic interference from the environment is determined according to the amplitude bar corresponding to each frequency viewed. The larger the amplitude bar, the greater the simultaneous interference of the current environment or cable, so try to avoid using this frequency for detection. The frequency with the minimum amplitude bar should be selected for pipeline detection or cable identification.

Ⅷ. Battery management

●Charge the battery in time, and charge the battery once every 3 months without using the instrument for a long time.

⚠ **●Warn! If the battery cover plate is not covered, the test is prohibited, otherwise it is dangerous.**

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

1. The instrument has a new lithium-ion battery pack, with the different output level, can work continuously for different time, but generally can meet the needs of 8 hours a day.
2. In use, the battery power icon is displayed on the upper right of the screen. The full grid represents the full power, and the full space turns red indicates the battery voltage shortage. When the power is used up, it will automatically shut down after a few seconds.
3. When charging needs, connect the plug of the charger to the "charge" socket of the transmitter / receiver and the AC plug of the charger to the 220V / 110V city power socket.
4. Red indicator indicates charging, and green indicates charging.
5. In shutdown state, it takes about 5-6 hours to recharge from under voltage state and about 3-4 hours for the receiver.
6. Depending on the use and maintenance conditions, the battery pack can generally perform 300-500 charge and discharge cycles. With the increase of charge and discharge times, the battery capacity will gradually decrease, and the working time of the instrument will be shortened accordingly. When the battery is short to unacceptable, the battery needs to be replaced.

IX. packing list

transmitter	1set
receiver	1set
toolkit	1pcs
Transmitter current clamp	1set
Receive the flexible current clamp	1set
Direct connection to test clamp	1pcs
Two-headed alligator clip test line	1pcs（black)
Ground needle	1pcs
Receiver charger	1pcs
Transmitter charger	1pcs
Instructions	1set

The Company is not responsible for other losses caused by the use.

The contents of this user manual do not justify using the product for special purposes.

The Company reserves the right to modify the contents of the user manual. If modified, no further notice will be given.

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