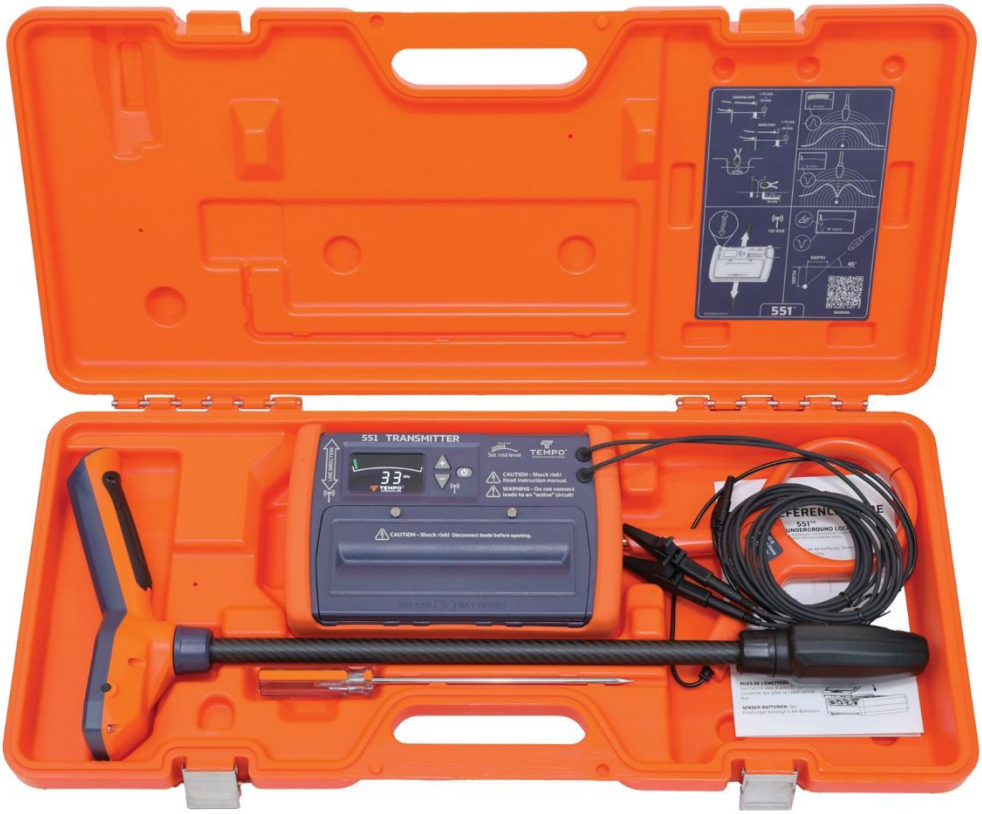
INSTRUCTION MANUAL

TEMPO®
COMMUNICATIONS



551™
Advanced Underground Locator

Read and understand all the instructions for use and safety information before you use this tool. To receive updates about this product and its use register at www.tempocom.com.

Table of Contents

Description

The 551 Advanced Underground Locator is an intuitive, all-in-one locating device to give you tools to locate lines in a variety of situations.

The kit consists of two key components—Transmitter and Receiver—to apply and detect signal, respectively, onto buried metallic lines such as:

- Electrical Cables
- Communications Cables
- Irrigation Control Wires
- Tracer Wires
- Metallic Pipes
- Metallic Fish Tape

Purpose of this Manual

The purpose of this manual is to familiarize you with the safe and effective operation and maintenance procedures for the 551 Advanced Underground Locator. We aim to keep this manual up to date with product changes.

Safety

Safety is essential in the use and maintenance of Tempo tools and equipment. This manual, along with any markings and warnings on the equipment, provides information to help avoid hazards and unsafe practices during use. Observe all the safety information provided.

Important Safety Information

SAFETY ALERT SYMBOL

This symbol is used to call your attention to hazards or unsafe practices which could result in an injury or property damage. The signal word, defined below, indicates the severity of the hazard. The message after the signal word provides information for preventing or avoiding the hazard.

⚠DANGER

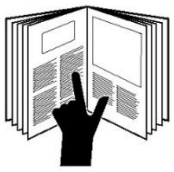
Immediate hazards which, if not avoided, WILL result in severe injury or death.

⚠WARNING

Hazards which, if not avoided, COULD result in severe injury or death.

⚠CAUTION

Hazards or unsafe practices which, if not avoided, MAY result in injury or property damage.



⚠WARNING

Read and understand this material before operating or servicing this equipment. Failure to understand how to safely operate this tool could result in an accident causing serious injury or death.

⚠WARNING

Electric shock hazard:
Contact with live circuits could result in severe injury or death.

⚠WARNING

Electric shock hazard:

- NOT TO BE DIRECTLY CONNECTED TO ANY LIVE CIRCUIT.
- Ensure that any circuit to which the transmitter is connected or that the user may inadvertently touch is safely isolated from any hazardous power source.
- If in doubt use the inductive clamp or antenna system.
- The output of the transmitter may cause damage to remote equipment if that remains connected, apply care and disconnect sensitive equipment at both ends before tracing cables.
- Avoid exposure to excessive rain or moisture. If the product becomes visibly wet, for safety wipe dry before use.
- Use this unit for the manufacturer's intended purpose only, as described in this manual. Any other use can impair the protection provided by the unit.
- Use test leads or accessories that are appropriate for the application. Refer to the category and voltage rating of the test lead or accessory.
- Inspect the test leads or accessory before use. They must be clean and dry, and the insulation must be in good condition.
- Before opening the battery cover, remove the test leads from the circuit and shut off the unit.

⚠WARNING

Fire / Explosion hazard:
Do not use this tool in an explosive atmosphere or connected to wires entering an area with explosive atmosphere. Failure to heed this warning could result in severe injury or death.

⚠CAUTION

Electric shock hazard:

- Do not connect the transmitter to any active circuits.
- Avoid listening to the receiver through the headset at high volume levels for more than a few seconds at a time. Use only the Tempo recommended headset.

Servicing:

- There are no user serviceable parts within 551, do not disassemble.
- High voltages can be present inside the transmitter.
- Contact Tempo's Support Team (details below)

Failure to observe these precautions may result in injury and can damage the instrument or connected equipment.

⚠WARNING

Beware of the hazards associated with utility access areas and underground work areas.

- Hazards can include explosive or flammable gases and toxic fumes.
- Observe the safety practices and procedures of your company, the local utility, and any other governing body.

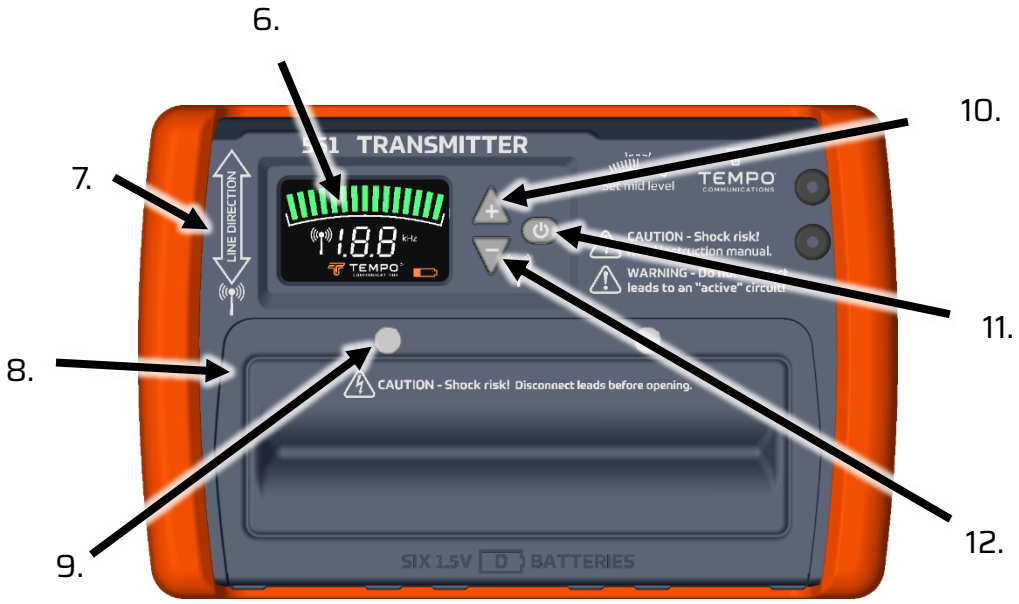
Failure to observe these warnings can result in severe injury or death.

Part Identification

Kit

1. 551 Transmitter
2. 551 Receiver
3. Ground Stake
4. 551 Carry Case
5. Inductive Coupler Clamp

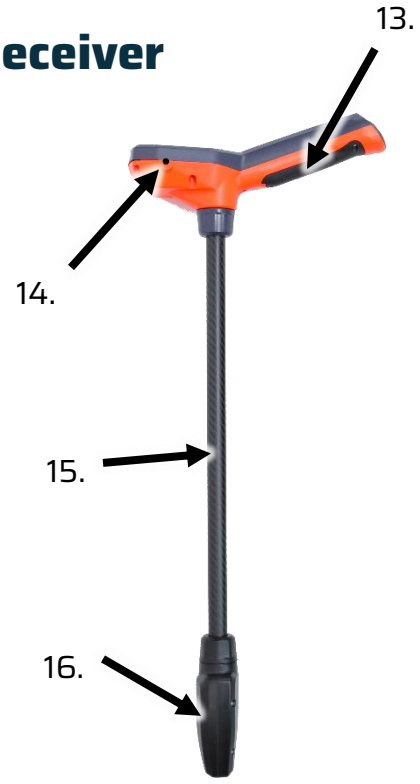
Transmitter

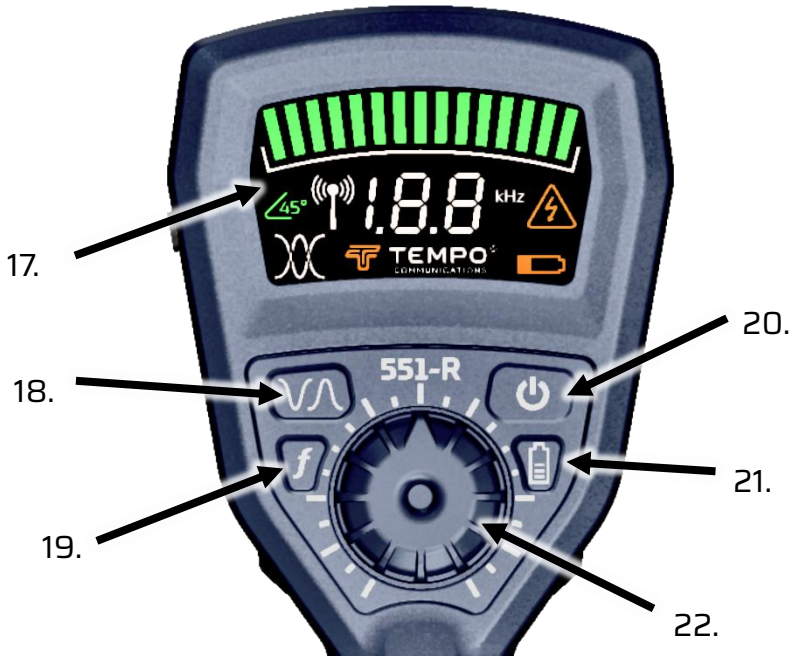


6. Display LCD
7. Induction Mode Orientation
8. Battery Cover
9. Battery Cover Thumbscrew
10. Output Level Up* / Select Dual Frequency Mode
11. Power ON/OFF
12. Output Level Down* / Select Induction Mode

*Not applicable to European model 551EU-T

Receiver





13. Battery Cover
14. Headset Jack
15. Antenna Pole
16. Antenna Tip
17. Display LCD
18. Peak/Null Toggle
19. Frequency Select
20. Power ON/OFF
21. Battery Level
22. Sensitivity Wheel

Display Indicators

Transmitter

23. Signal Current Meter
24. Induction Mode
25. Frequency (kHz)
26. Numerical Display
27. Low Battery

Receiver

28. Signal Reception Meter
29. Induction Frequency
30. 45-Degree Angle
31. Peak/Null
32. Frequency (kHz)
33. Passive AC
34. Numerical Display
35. Low Battery

Operation

Transmitter

Before starting you must ensure that the Transmitter is set up properly.

IMPORTANT SAFETY INFORMATION

⚠CAUTION

Electric shock hazard:

- Do not connect the transmitter to any active circuits.
- Live circuits can present a hazards to the user and equipment.
- Tracing signal may present a hazard to connected devices. Disconnect all electronic devices where possible.

Failure to observe these precautions may result in injury and can damage the instrument or connected equipment.

IMPORTANT: To ensure that the Transmitter is producing optimum signal, check that the low battery indicator is not illuminated. Performance may be impaired if signal is low.

Signal Application Methods

There are three methods of applying signal with the 551 Transmitter:

- Direct Connection (1.75 kHz + 33 kHz Simultaneously)
- Inductive Coupler Clamp (33 kHz Only)
- Transmitter Induction (133 kHz)

Direct Connection – (1.75 kHz + 33 kHz Simultaneously)

For locating in general, it is best to use Direct Connection where possible to apply a strong, isolated signal to a line. With the 551 Transmitter, it is even more beneficial to Directly Connect in that Dual Frequencies can be simultaneously applied.

With the Transmitter OFF, connect the removable alligator clips to the ends of the leads. Clip one of the leads to the metallic conductor of the line to be located and the other lead to a good earth ground using the ground stake provided in the case (Fig. 1).

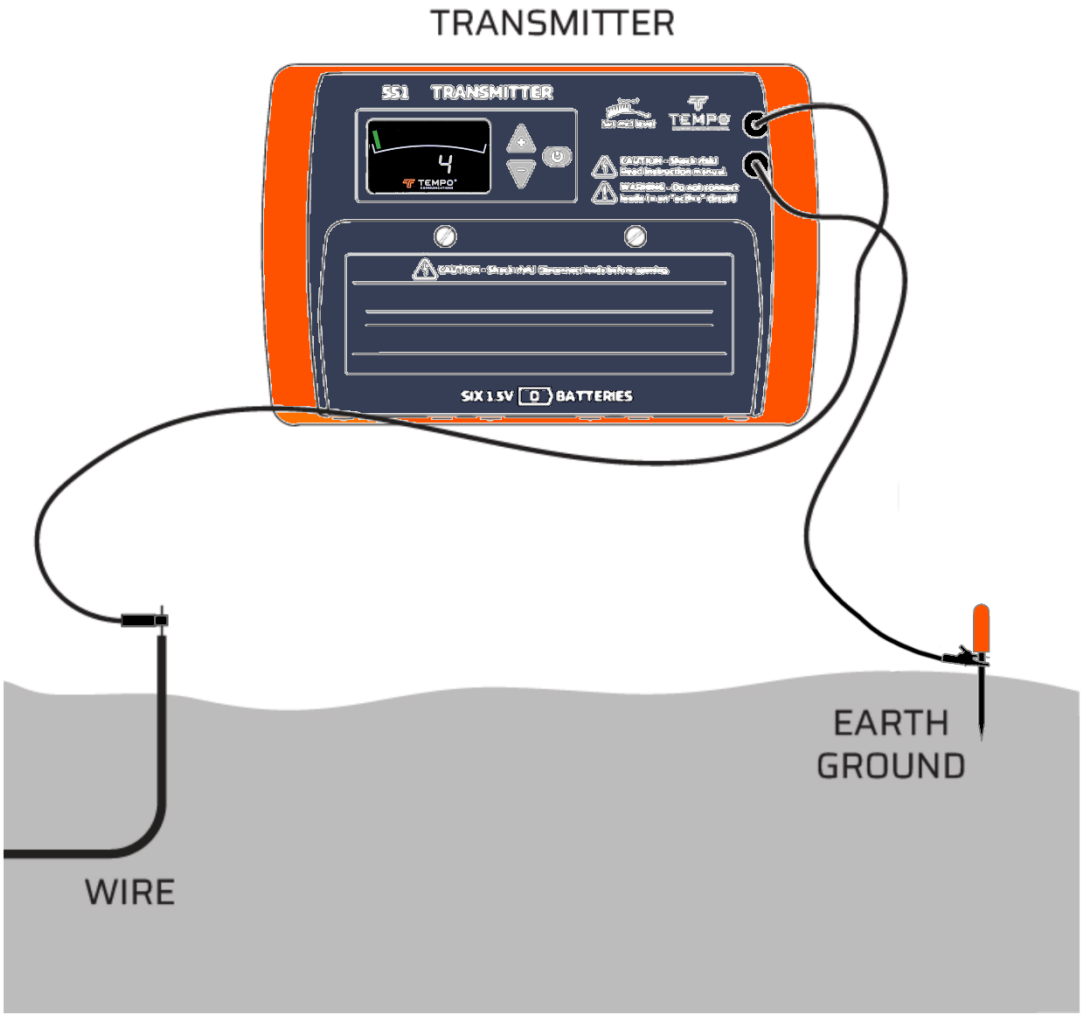


Figure 1. Transmitter Direct Connection (“Metal-to-metal”)

Ideal placement of the Ground Stake is 2-3 feet off to the side of the path of the buried line where the line enters the ground.

For unshielded multi-conductor cables, attach directly to all the conductors (fig. 2) for the strongest signal and to avoid applying the Transmitter's voltage across any devices that remain connected, for example "2-Wire" irrigation control cables connected to decoders (refer to our "2-Wire Application Note for Locators" for more information).

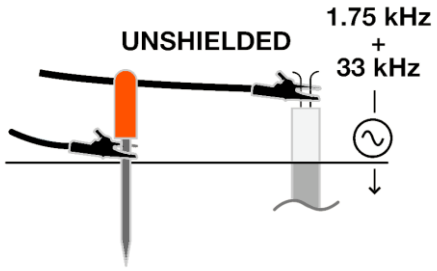


Figure 2. Attaching to Unshielded Cables

For shielded cables, attach directly to the shield itself for the strongest signal rather than the inner conductor(s) (fig. 3).

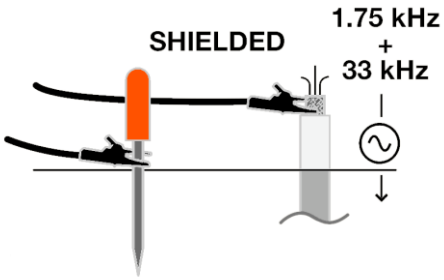


Figure 3. Attaching to Shielded Cables

If the connection point to the buried line is indoors, it is best to run a jumper wire between the Transmitter and the Ground Stake placed outside near the point where the line exits the building. Alternatively, the Transmitter can be placed next to

the Ground Stake and the jumper can be extended to the indoor point of connection to the line.

Once connection is achieved, activate the Transmitter by briefly holding down the Power Button. Observe the Transmitter's Signal Current Meter at the top of the display and increase the Output Level* (Up Button) until a mid-range reading (30% to 70%) is achieved. If increasing from one level to the next causes the meter to skip past a mid-range reading, use the lower output level.

*Not applicable to EU model.

If the signal current is left maxed out on the meter, the Transmitter will engage an automatic power back-off, lowering the output power. This will ensure that the batteries are not quickly consumed needlessly and will only occur when there is more than enough signal current flowing through the line to be detected for very far distances and from very deep in the ground.

Grounding for Direct Connection

If a mid-range reading is not obtainable, you may not have enough of a ground connection in the buried line and/or the Ground Stake.

Ensure that the Ground Stake is deeply planted into moist, unfrozen soil. Wet the Ground Stake (ideally with salty water) to improve grounding in dry conditions.

If the Ground Stake is well grounded but the reading remains low, then the line is not well grounded. For best results with Direct Connection (especially for 1.75 kHz), ground the far end of the cable to be traced with a spare Ground Stake, if possible (Fig. 4).

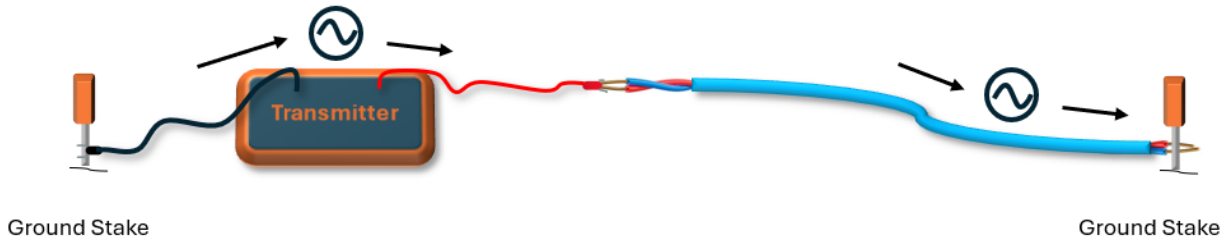


Figure 4. Grounding the far end of the line.

If grounding the far end of the line is not achievable as is often the case, signal can still travel down a line coupled to the earth *capacitively*. The further away the line is buried and the more moisture in the surrounding soil, the more signal current can travel through the line. Higher frequencies can couple capacitively easier than lower frequencies, so higher frequencies will perform better on shorter lines, but they will also tend to spill over or "bleed" onto other nearby lines easier as well. See the "Signal Frequencies" section for more information.

Dual Simultaneous Frequencies

By default, the 551 Transmitter sends both 1.75 kHz and 33 kHz signals through the leads. When directly connected in Dual Frequency Mode, you can switch between 1.75 kHz and 33 kHz on the Receiver to select the better performing frequency for the given situation. One frequency may perform better than another due to line length, distance from the Transmitter, electrical interference, signal "bleed" onto nearby lines, soil conditions, line integrity, etc.

One frequency will transform differently along the line before and after damage than another, and one will attenuate more or less than the other in closer proximity to the end of the line. Side-by-side comparison of 1.75 kHz and 33 kHz as you travel the line will enable you to more easily detect and characterize anomalies,

so experimentation with frequency selection on the Receiver while in Dual Mode is highly encouraged!

With the ability to select between frequencies on the fly without physically changing any Transmitter settings—especially with both Peak and Null modes at your disposal—you can much more effectively characterize the line buried beneath you.

Single Frequency Modes

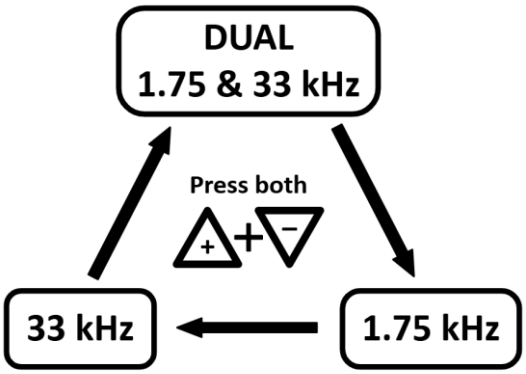


Figure 5. Single Frequency Mode Selection

Should you wish to only Transmit only one of the two Direct Connect frequencies, you can do so by pressing both the Up and Down buttons on the Transmitter—once for 1.75 kHz only, once more for 33 kHz only, and again to return to Dual Mode (fig. 5). You may wish to select a Single Frequency for a mild-to-moderate improvement in battery efficiency on the Transmitter if you only plan to use one frequency, or because you have two 551 Transmitters and wish to transmit individual frequencies to two separate lines and identify/track them separately.

Inductive Clamp – (33 kHz Only)

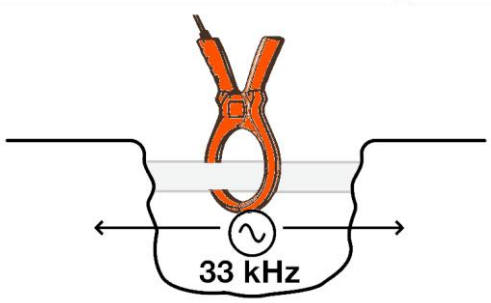


Figure 6. Inductive Clamp

If Direct Connection points are inaccessible or the line cannot be disconnected or de-energized to allow for Direct Connection, using the Inductive Coupler Clamp is another effective method of applying a signal (fig. 6).

Remove the alligator clips from the leads and plug the leads directly into the Inductive Clamp. Set the Transmitter to output level 1 or 2* for best results (level 3 and above will only impede performance and reduce battery efficiency). The Signal Current Meter will be mid-range at Output Level 2, so just like for Direct Connection, the meter remains a useful guide when using the Inductive Clamp.

*Not applicable to EU model.

The Inductive Clamp induces signal at 33 kHz *only*; it does not induce a 1.75 kHz signal whether in Dual Mode or 1.75 kHz Single Frequency Mode. When using the Inductive Clamp, you must set the Receiver to 33 kHz to track signal.

The Inductive Clamp is best used in 33 kHz Single Frequency Mode for an improvement in battery efficiency (performance is unaffected).

Transmitter Induction – (133 kHz)

When buried lines are inaccessible via Direct Connection or for access with the Inductive Clamp, the Transmitter's Induction Mode can be used to broadcast a 133 kHz signal from the Transmitter's integrated Inductive Antenna onto lines below.

Place the Transmitter on the ground above the line according to the orientation depicted to the left of the Transmitter's display (fig. 7).

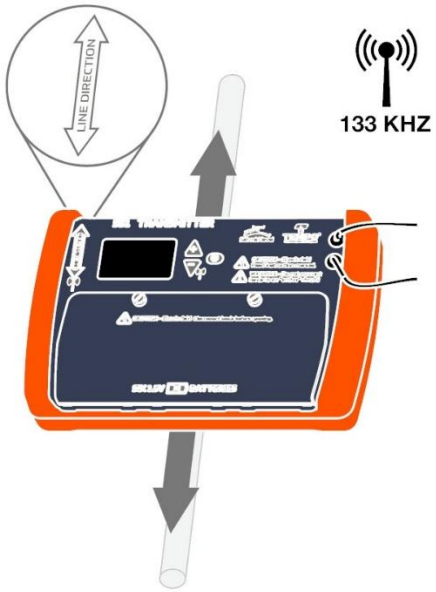


Figure 7. Transmitter Induction

Turn on the Transmitter and press the Down Button until you see the Broadcast Antenna icon appear on the display.

The Transmitter is now emitting a signal at 133 kHz which will be induced to lines below, so be sure to set the Receiver to 133 kHz when tracking the Induction Mode signal.

Grounding for Inductive Coupling

The line must have grounding on either side of where the Inductive Clamp or Transmitter Induction is utilized—either directly (shield bonded to ground, ground wire bonded to ground, etc.) or capacitively (buried in the ground for some distance).

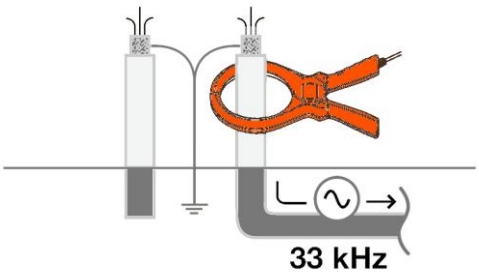


Figure 8. Inducing Signal

Whether with the Inductive Clamp or with Induction Mode, a coax cable at a pedestal where the shield is bonded to ground, for instance, would carry signal on the shield of the cable in the direction away from where it is grounded (fig. 8). Similarly, an electrical cable in conduit from an electrical box will carry an induced signal away from where the ground wire is bonded to ground.

Clamping the Inductive Clamp around the exposed end of a pipe or cable that sticks up out of the ground, on the other hand, will not apply signal to the buried portion—at least not unless a jumper cable is used to bond the exposed end to a grounded stake.

Receiver

Passive Mode

The 551 Receiver will detect live AC current when in Passive Mode, the default "frequency" when first turning on the Receiver. A signal from the Transmitter is not required for tracing lines in Passive Mode; it detects the 50 Hz or 60 Hz Alternating Current* flowing through the line (fig. 9).

*Alternating Current is at a frequency of 60 Hz in some parts of the world (North America) while it is 50 Hz for other parts of the world (Europe, Asia, Africa, Australia).

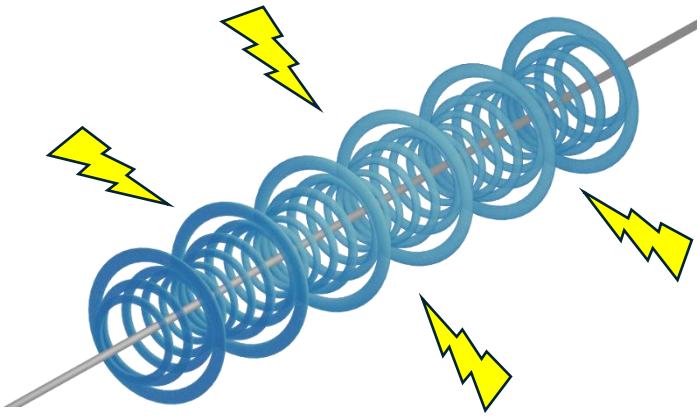


Figure 9. Alternating Current

CAUTION: If a power cable is perfectly balanced then no net magnetic field will be detectable. Never rely on purely passive cable location techniques to prove a cable is safe to touch or not a digging hazard.

Digital Mode

By default, Passive detection starts in “digital mode.” Where 50 or 60 Hz electrical power hum harmonics are detected, a synthesized buzz is generated in proportion to make this potentially hazardous signal more prominent.

Analog Mode

Press and hold the “f” button on the Receiver in Passive Mode until “An” appears on the display; the audio will switch from a loud and clear digital representation of the AC being detected to a direct analog representation. This can be useful to verify that the Receiver is detecting a 50 Hz or 60 Hz current, or in environments with much higher amounts of AC “buzz” (but will often be too hard to hear to trace lines unless using a headset).

To return to the Digital tone, press and hold the “f” button once again until “di” appears on the display.

Active Frequencies

A general rule of thumb for line locating is to start by tracing with the lowest frequency and raise the signal frequency as needed if low frequencies do not perform well. The benefits of low frequencies are that they are best for long distances and low amounts of signal “bleed” or spillover to other nearby lines, but they will not work well in some situations, and the use of higher frequencies is required.

1.75 kHz

The lower of the two Direct Connection frequencies, 1.75 kHz, is a good low frequency signal for general electromagnetic line locating. For very long runs, 1.75 kHz will typically perform best and will not bleed over to other lines as much as higher frequencies. Being closer in frequency to 50/60Hz power, it is more prone to interference from electrical lines and devices than higher frequencies.

33 kHz

The higher of the two Direct Connection frequencies, 33 kHz, is a mid-range frequency signal for locating. It will perform better than 1.75 kHz on shorter runs or on lines that are not directly buried (such as metal fish tape in a conduit). It is more resistant to electrical interference from power hum, but slightly more prone to signal bleed (crosstalk).

133 kHz

This frequency is only used with the 551 Transmitter's Induction Mode. The highest of the Receiver's available frequencies, 133 kHz is easiest to induce with the compact internal antenna.

Peak/Null

Peak and Null modes are available for all Receiver frequencies, Passive and Active.

Peak Mode

When the Receiver is in Peak Mode, it provides tone when near or above the line carrying signal, with a gradual decrease in signal away from the line.

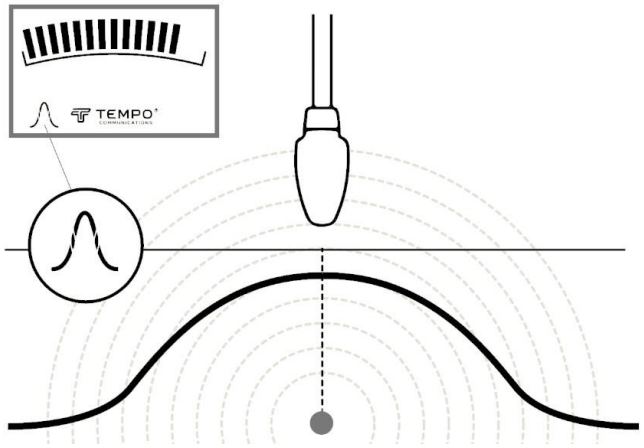


Figure 10. Peak Mode

This can be useful for quickly tracking a cable path as it is intuitive and simple to follow.

Be advised that the orientation of the tip of the Receiver also determines how much signal is received: maximum signal is received when the handle is parallel above the line, while no signal will be received when the handle is perpendicular to the line. Note that this orientation-dependent cancellation can also be used to one's advantage to determine the direction of the line while standing in one location!

Null Mode

When the Receiver is in Null Mode, most signal is received to either side of the line with a very sharp decrease to the point of complete cancellation when oriented directly at the line.

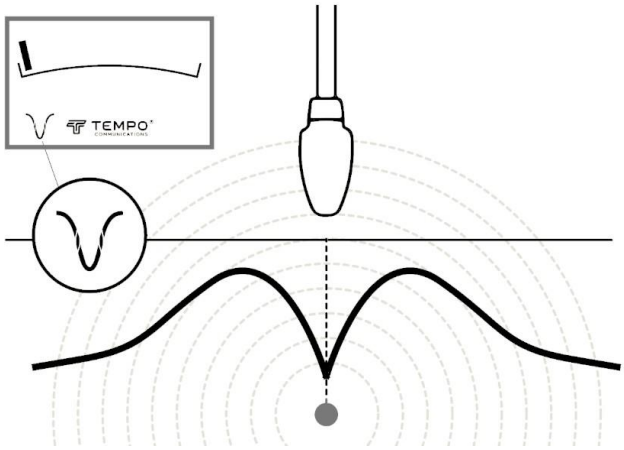


Figure 11. Null Mode

This is most useful for pinpointing, inspecting, triangulating depth, etc.; Null Mode is more sensitive to faults, splices, and solenoid valves which create "hot spots" of signal.

Depth Triangulation

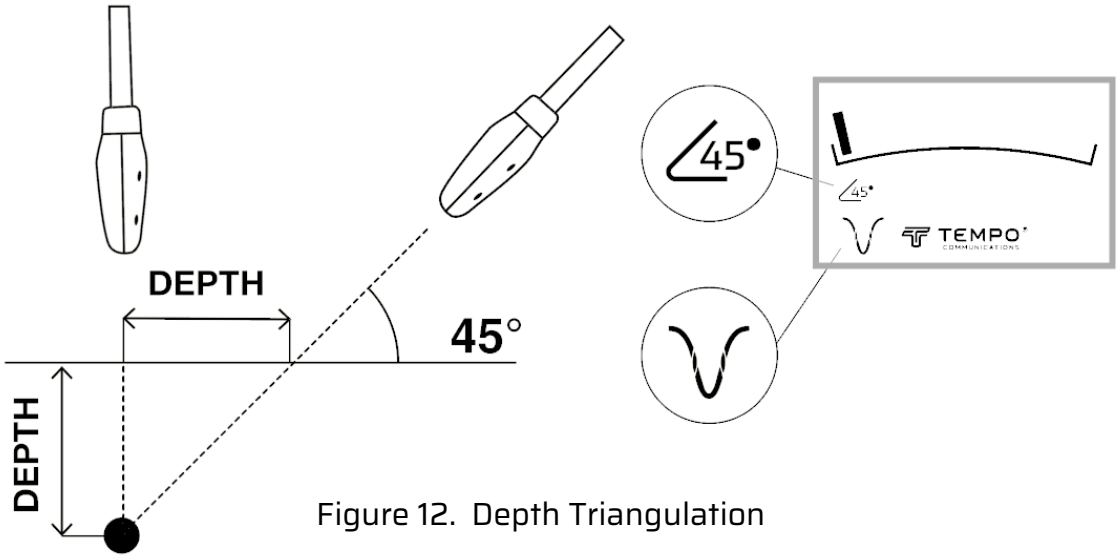


Figure 12. Depth Triangulation

To determine the depth of the line, use Null Mode. Hold the Receiver with the tip pointed vertically downwards and mark the ground directly over the path. Turn the Receiver sideways to the path and tip it 45 degrees. When close to 45 degrees, the "45-degree" indicator will illuminate in the display, turning brighter when closer to a true 45-degree angle. Move the receiver directly away from the pre-marked path, maintaining the 45-degree angle until a null is detected once again. Mark the spot on the ground where the tip of the Receiver is pointing. The distance between these two points approximates the line depth.

For higher confidence, repeat on the opposite side of the line; a more accurate approximation of the depth is an average of the two distances of the 45-degree nulls on either side of the line.

IntelliTrack

IntelliTrack noise rejection technology offers signal clarity in noisy environments. This mode significantly improves tracing lines near AC interference, particularly effective when tracing 1.75 kHz. IntelliTrack is available on the 551 Receiver in 1.75kHz, 33 kHz or 133 kHz frequency modes.

To activate IntelliTrack, press and hold the frequency button until an “F” appears on the Receiver LCD display. To deactivate IntelliTrack, press and hold the frequency button until “nF” appears on the LCD display.

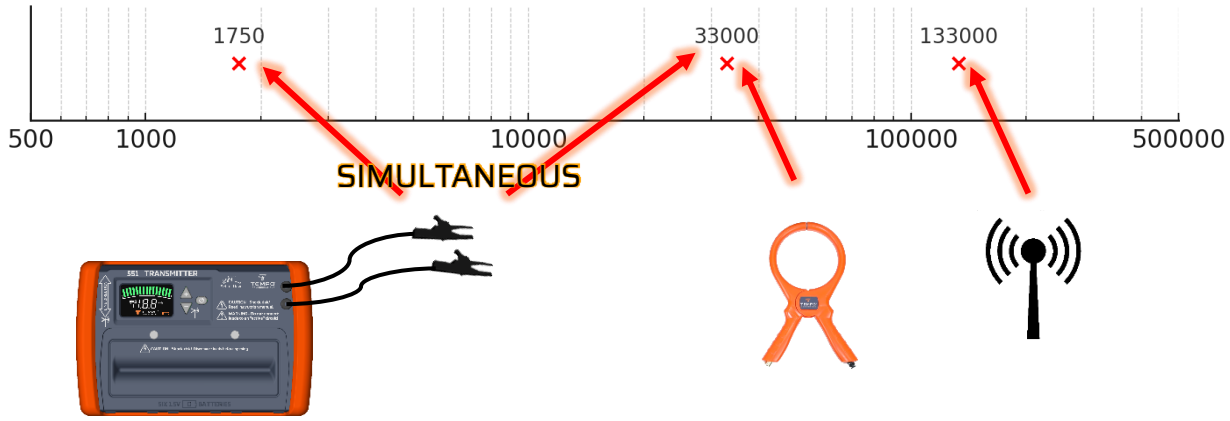
NOTE: For optimal signal acquisition and tracing accuracy while IntelliTrack™ mode is active, avoid swinging the locator rapidly. Use slower, more deliberate sweeping motions.

Battery Level

Press and hold the Battery Level button and the Receiver’s meter will now display the battery level (only works for alkaline batteries).

Frequencies Reference Chart

Frequency	Range	Signal "Bleed"	Electrical Interference	Need for Ground	Overcome Resistance	Induction
Low	↑High	↓Low	↑High	↑High	↓Low	↓Low
High	↓Low	↑High	↓Low	↓Low	↑High	↑High



Low Frequency: 100Hz – 8 kHz

- Best for longer cables
- Direct connection only
- Long-distance, low bleed
- Prone to electrical interference

Medium Frequency: 8 kHz-65 kHz

- Good for most pipes and cables
- Direct connection and signal clamp
- Reasonable distance, some bleed

High Frequency: 65 kHz-500 kHz

- Best for tracking pipes
- Direct connect, signal clamp, induction
- Short distance, high bleed
- Above 150kHz you may interfere with "broadcast radio" services

Specifications

FULL UNIT	
Operating Conditions	
Operating Temperature	14 °F to 131 °F (-10 °C to 55 °C)
Weight	
With Batteries	11.5 lbs
Without Batteries	9.6 lbs
CASE DIMENSIONS	
Length	28 in. (711mm)
Width	12.6 in. (321mm)
Height	4.1 in. (104mm)
TRANSMITTER	
Physical Specifications	
Weight without batteries	2.6 lbs
Weight with batteries	4.3 lbs
Ingress Protection Rating	IP54
Battery Specifications	
Battery Type	6x D cell[2]
Dual Frequency Mode	40 hrs typical
Single Frequency Mode	50 hrs typical
Auto Shutoff	3 hrs
Operating Frequencies	
Direct Connect	1.75 kHz + 33 kHz Simultaneous
Inductive Coupler	33 kHz
Inductive Antenna	133 kHz
Max Output Power	
Direct Connect	3.7W rms[1]
Induction Mode	<1W
RECEIVER	
Physical Specifications	
Weight without batteries	1.0 lbs
Weight with batteries	1.2 lbs
Ingress Protection Rating	IP54
Headset sound pressure level	96±3 dBA SPL max[3]
Battery Specifications	
Battery Type	4x AA cell
Typical Battery Life	35 hrs
Auto Shutoff	1.5 hrs
Operating Frequencies	
Passive	50/60 Hz
Active	1.75 kHz, 33 kHz, 133 kHz

1. Alkaline recommended **2.** 1.8W rms for EU model **3.** When used with Tempo HS-1

Regulatory Compliance

FCC

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

CE

Declaration of conformity is available upon request via email to Support@TempoCom.com

Maintenance

⚠WARNING

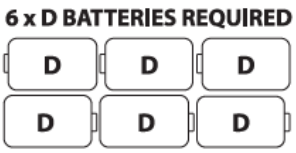
Electric shock hazard:

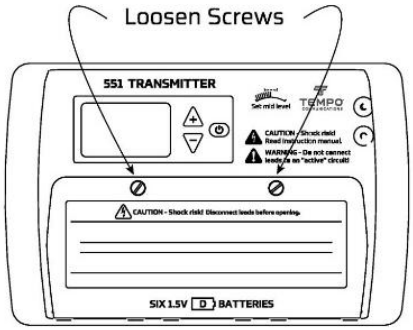
Contact with live circuits could result in severe injury or death.

- Before opening the battery cover, remove the test leads from the circuit and shut off the unit.

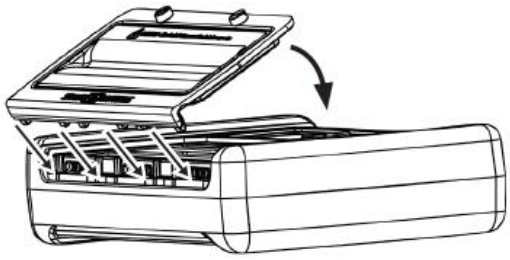
Failure to observe this warning could result in severe injury or death.

Transmitter Battery Replacement

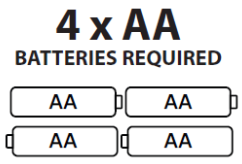




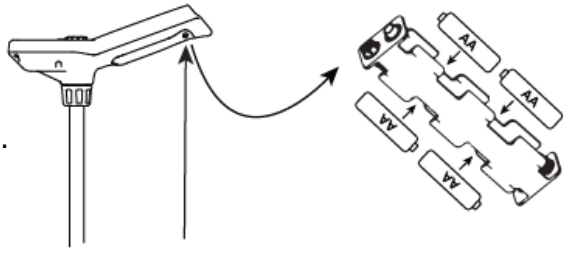
1. Turn off the unit.
2. Disconnect any leads.
3. Loosen thumbscrews.
4. Remove the battery cover.
5. Replace the batteries (observing the polarity indications).
6. Replace the battery cover starting with the bottom and hinging down the top.
7. Finger-tighten thumbscrews.



Receiver Battery Replacement



1. Turn off the unit.
2. Loosen battery cover screws with a #1 cross-tip screwdriver.
3. Remove the battery cover.
4. Dislodge the 2-sided battery tray.
5. Replace 4x AA batteries (2 on top, 2 on bottom).
6. Re-insert battery tray.
7. Replace the battery cover and gently tighten screws.



Unit Test

Transmitter/Leads Test

1. Turn on the Transmitter making sure that the ends of the leads are not clipped together.

The Signal Current Meter should be at one bar. A higher reading is likely a problem with the internal circuitry and requires repair.

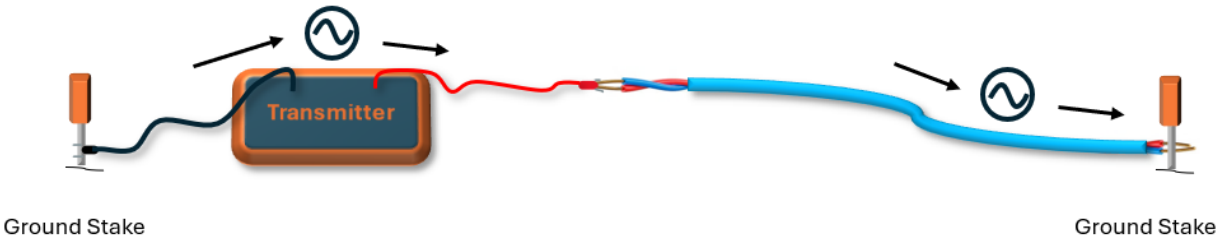
2. Connect the leads together with the alligator clips.

The Signal Current Meter should be at maximum. If the meter is below maximum, replace the batteries. If the meter is at one bar, the alligator clips may not be well connected to the leads.

Transmitter + Receiver Test

1. Set the Transmitter to Dual Mode.
2. Turn on the Receiver and set it to 1.75 kHz.
3. Set the sensitivity to halfway and point directly at the Transmitter. A strong pulsing tone should be heard from the Receiver.
4. Set the Receiver to 33 kHz and repeat Step 3. A strong pulsing tone should be heard from the Receiver.
5. Set the Transmitter to Inductive Mode.
6. Set the Receiver to 133 kHz and hold near the Transmitter. A strong pulsing tone should be heard from the Receiver.

Field Test



1. Lay a wire at least 25 feet in length on the ground outside.
2. Strip the far end of the wire and wrap the end around a screwdriver/ground stake ensuring metal-to-metal contact between the wire and the ground stake.
3. Drive the ground stake into the dirt.
4. Connect one of the leads of the Transmitter to the wire at the near end using the alligator clip.
5. Connect the other lead of the Transmitter to a ground stake driven into the dirt using the alligator clip.
6. Wet the dirt around the ground stakes in dry conditions.
7. Turn on the Transmitter.
8. Inspect the line with both Peak and Null modes.

Signal should travel along the length of the wire for both 1.75 kHz and 33 kHz.

Warranty

Tempo Communications Inc. warrants to the original purchaser of these goods for use that these products will be free from defects in workmanship and material for one year. This warranty is subject to the same terms and conditions contained in Tempo Communications Inc.'s standard one-year limited warranty.

For all Test Instrument repairs, contact Customer Service at +1 800-642-2155 and request a Return Authorization or complete the form on the Repair page of our website at www.TempoCom.com

For items not covered under warranty (such as items abused, dropped, soaked, etc.), a repair cost quote is available upon request.

Note: Prior to returning any test instrument, please check batteries are charged and follow any instructions given by Tempo's customer support.

All specifications are nominal and may change as design improvements and software updates occur. Tempo Communications Inc. shall not be liable for damages resulting from misapplication or misuse of its products.

Do not discard this product or throw away! For recycling information, go to www.TempoCom.com

551™ Instruction Manual

USA Headquarters

Tempo Communications Inc.
1390 Aspen Way,
Vista,
92081
California USA
(+1 800 642 2155)

support@tempocom.com

EMEA Sales Office
Tempo Europe Limited,
Suite 8, Brecon House,
William Brown Close,
Cwmbran,
NP44 3AB
UK
(+44 1633 927 050)

emeasales@tempocom.com

www.tempocom.com