Rejuvenation Instructions

#270 – RF Locating

This NRI covers the following:

- How to use the Rigid SR-60/20 Locator and ST-305 5-watt Transmitter.
- How to locate splices, neutral corrosion, and other anomalies.
- How to change settings of the Rigid Locator.

Patents: https://www.southwire.com/services/cable-rejuvenation

WARNING: It is dangerous working around energized high-voltage systems, pressurized systems, and chemicals. Always work in accordance to the Field Operations Safety Handbook (FOSH) or other local governing safety standards.

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Equipment Setup

1. Determine outside interference.

a. Open the menu of the RF Locator and activate the recommended frequencies given at the end of this NRI.

b. Use the locator and follow the expected cable path without the transmitter.

- This will determine the amount of outside interference.

Figure 1: Rigid SR-60/20 Locator.

2. Set up the RF transmitter.

- The 5 Watt (W) Radio Frequency (RF) transmitter is suitable for many URD cables.

Figure 2: Rigid ST-305 5-watt transmitter.
Part #: 0-EL-RF-LOC/XTR

a. Check that the transmitter holds two or more bars of signal strength, otherwise the batteries will need to be replaced soon.

b. Select one or a combination of frequencies available on the transmitter for locating the cable path and anomalies.

c. Enable the locator's 60Hz power line frequency.

d. Sweep the area on both ends of the cable for energized power cables.

Figure 3: Transmitter face plate.

3. Locate the cable path.

DO NOT DISCONNECT THE CONCENTRIC NEUTRALS FROM GROUND.

a. Insert a ground spike 6 inches deep near both ends of the cable that is not on the suspected path of the cable. A screwdriver can usually be sufficient.

b. On the end opposite the transmitter, use a lightweight jumper wire to connect the cable conductor to the ground spike.

c. Connect one transmitter lead to the conductor and the other lead to the ground spike.

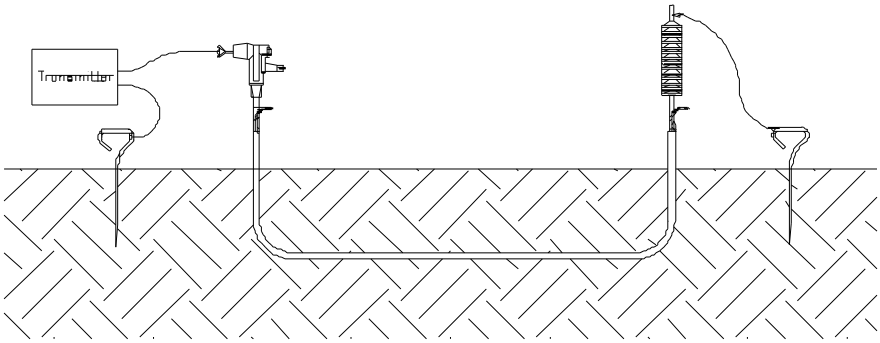

Figure 4: Connecting to ground spikes. **DO NOT REMOVE NEUTRALS FROM GROUND.**

d. Place the transmitter and ground spike as far from the suspected cable path as possible.

- Twisting the lead cables around each other can minimize the RF signals emanating from the transmitter and leads.

e. Check that the locating frequencies match between the transmitter and locator.

f. Walk the entire cable path to verify the provisional length and velocity of propagation (VOP) set on the TDR.

- The cable path is visible on the locator screen.
- Mark the path with paint as needed.

Figure 5: Walking the cable length.

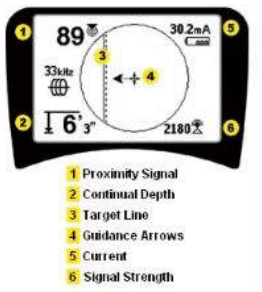

Figure 6: An example of the locator's display

g. Turn off the transmitter and verify that the signals from suspected anomalies are not external interference.

h. Turn the transmitter back on when finished.

4. Pinpoint splices and neutral corrosion.

a. Connect one transmitter lead to the conductor and the other lead to the neutrals.

Figure 7: Connect the alligator clips to the cable.

- The conductor should be grounded at the opposite end from the transmitter.
- The transmitter should “chirp” once every few seconds to signify continuity.

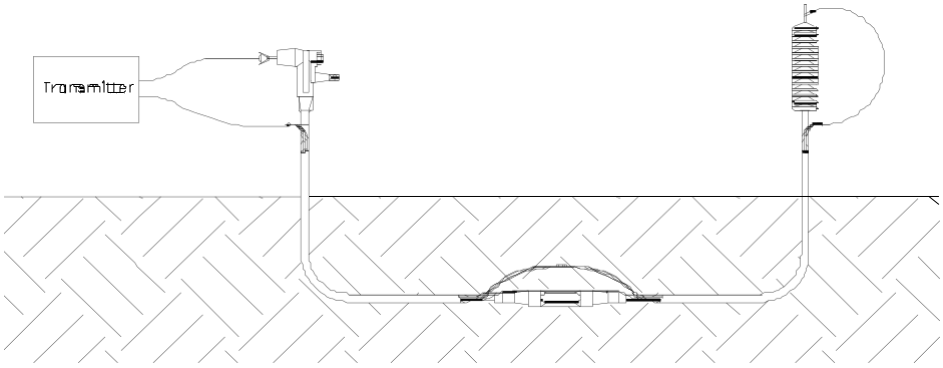

Figure 8: The transmitter sends a signal down the cable. **DO NOT REMOVE NEUTRALS FROM GROUND.**

b. Place the transmitter as far from the suspected cable path as possible.
   - Twisting the lead cables around each other can minimize the RF signals emanating from the transmitter and leads.

c. Start about 25 ft (7.5 m) from the approximate splice location located by the TDR.

d. Move directly over the marked cable path, toward the anomaly requiring pinpointing.

e. Make a mark every 6 inches (15cm). Continue doing this 25 ft (7.5 m) beyond the approximate location.

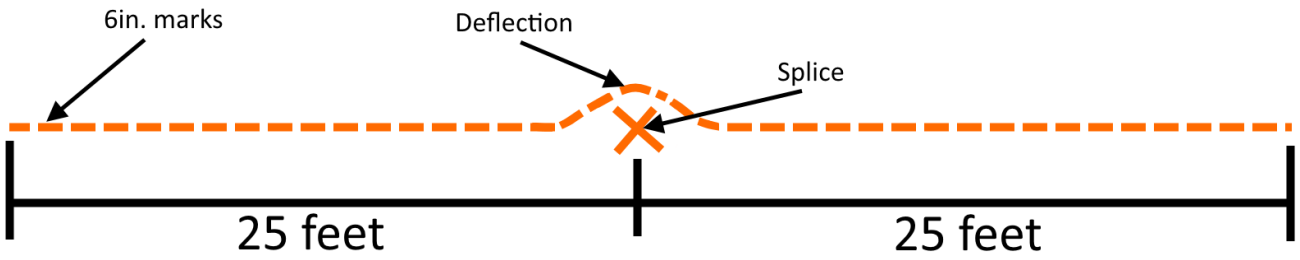

Figure 9: Make a mark every 6 inches. Continue this 25ft beyond the approximate location.

f. Search for the maximum signal strength along the 50 ft (15 m) of marks.

g. The RF signal typically begins to increase 6 ft (2 m) from the splice or corrosion.

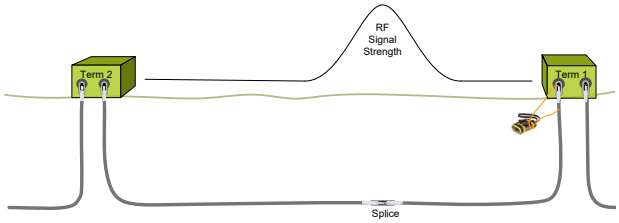

Figure 10: Signal strength and splice location.

h. The cable path often appears to jog right or left out of the trench line near a splice.
   - The depth reading directly over the anomaly may not be accurate.
   - Note the cable depth several feet away from the anomaly.

i. Note where the signal strength increases, where it reaches maximum, and where it returns to baseline strength.

j. The splice or neutral is generally under the signal maximum.
   - Mark an “X” and note the cable depth.
   - Call an experienced person for any assistance needed.

k. Look back at the series of 6 inch marks. The job where the splice is located may be apparent.

Excavating Splices

- Splices must be excavated and replaced with new connectors and IAs as in **NRI 533 200A Splices** and **NRI 573 600A Splices** for maximum circuit reliability.
- All excavations must use the “2 measurement rule” in the **Tips and Troubleshooting** section.

Tips and Troubleshooting

1. Difficulty finding the cable path.

If there is difficulty finding the cable path:

- Use the maximum transmission strength available.
- Disconnect the alligator clip lead from the neutrals and connect to a grounding spike placed as far from the cable as possible.
- Remove the ground from the cable at the opposite end of the transmitter.

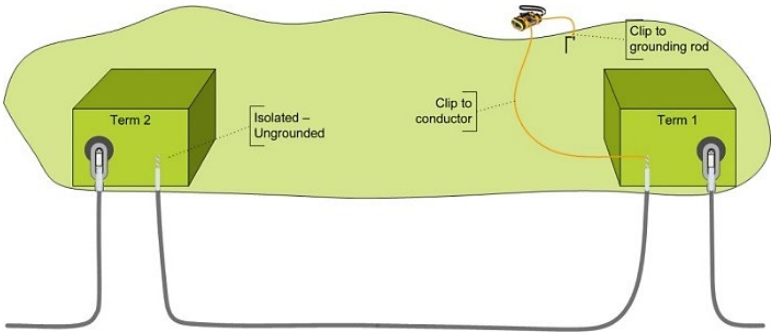

Figure 11: Cable path locating.

This configuration boosts the signal for locating the cable path but lowers the sensitivity to pinpoint individual impedance anomalies. After locating the cable path, restore the connections to those called for in step 4b.

2. Two measurement rule.

Before any excavation may begin and to avoid digging holes at the wrong location, there must be two independent measurements indicating where to dig.

Commonly, the two will be a TDR and a wheeled measurement from a single termination and an RF measurement directly above the splice or corrosion.

If it is not possible to use an RF measurement, two TDR measurements from opposite ends of the cable should be used.

a. With paint, mark a “1” for the measurement from Term 1 and a “2” for the measurement from Term 2.
b. Multiply the distance from the “1” to “2” by the distance from Term 1, then divide by the cable length. This is the offset length.
c. Draw an “X” the offset length away from mark “1” towards mark “2”.

   Example: The cable is 300 ft long. The distance to the splice from Term 1 is 100 ft, and the distance between marks “1” and “2” is 9 ft:

$$9ft\ x\frac{100ft}{300ft} = 3ft$$

- Draw an “X” 3 ft from mark “1” towards mark “2”.
- **NOTE:** Half of the time, the “1” is closer to Term 1 and “2” is closer the other half. The formula above works the same in either case.

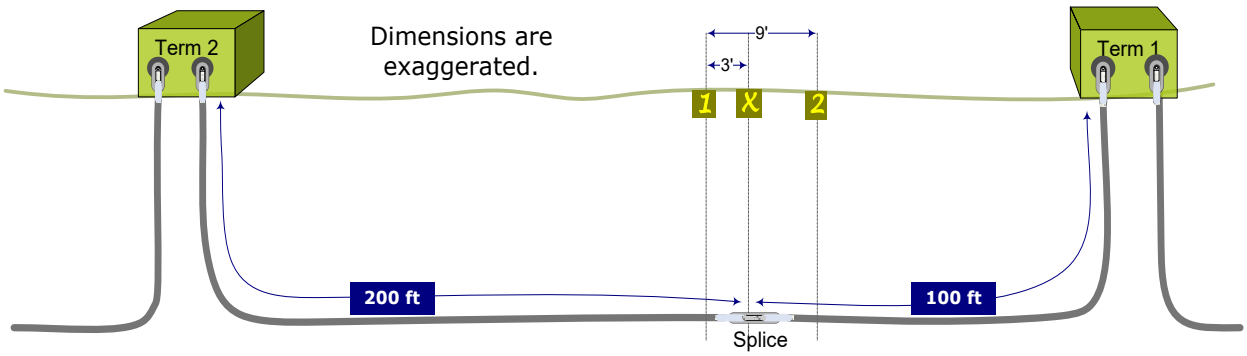

Figure 12: Two measurement rule to locate splices.

d. If the distance between mark "1" and mark "2" is greater than 4% of the cable length (e.g., 12 ft for a 300 ft run; 16 ft for a 400 ft run, etc.), then the assumed VOP is wrong, or there are unrecognized loops or jogs in the cable run.

e. Re-confirm the cable path and review the "Dealing with a cable loop" troubleshooting rule.

f. Adjust the VOP as needed and repeat.

- **NOTE:** The VOP established by the distance from Term 1 to Term 2 must be the same when measuring in either direction.

3. Dealing with a cable loop.

Occasionally, cable installers may leave a loop of cable as shown in the illustration below. The loop is usually under or near a transformer, but not always. The existence of a loop should be suspected when any of the following is true:

- The wheeled measurement of an RF identified cable path is significantly shorter than the TDR indicated length. The TDR indicated length was determined with a VOP validated on another run of apparently identical cables.
- The RF signal is strong, wide, and confusing at a location along the cable path. Where a cable loop exists:
  - **Strong:** The signal strength is stronger because more than a single piece of cable is broadcasting to the receiver.
  - **Wide:** The signal will extend away from the cable path for a greater distance than where there is a single cable laid in a straight line.
  - **Confusing:** The software in the receiver will have difficulty determining the lay and sometimes the depth of the cable.

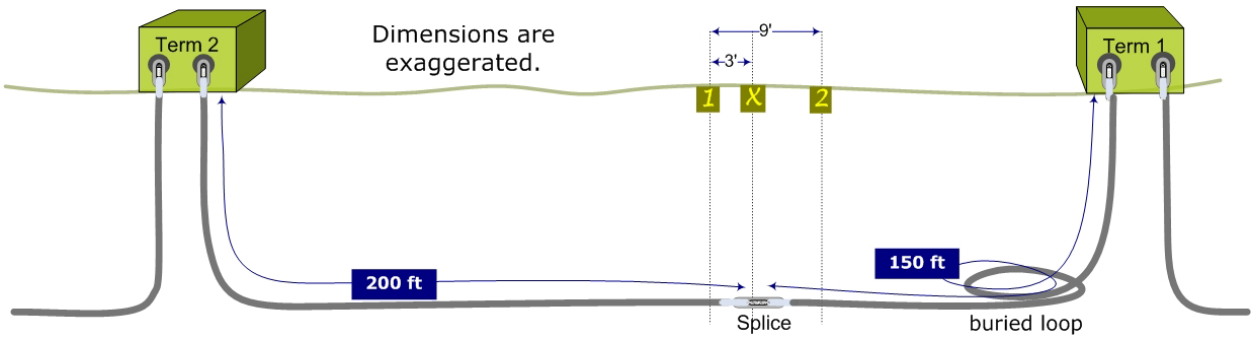

Figure 13: Accounting for cable loops.

After locating where a loop lies, it is possible to use the Two Measurement Rule to locate a splice.

a. Use the TDR to measure the probable cable length (PCL).
b. Use the RF locator to measure the apparent cable length (ACL).
c. Measure the apparent cable length through the middle of the loop.
d. Subtract the apparent cable length from the probable cable length to estimate the loop length (LL).

$$\mathbf{LL = PCL - ACL}$$

Example: If the probable cable length in the illustration above is 350 ft and the apparent cable length is 300 ft, the loop length would equal 50 ft.

e. Follow the "Two Measurement Rule" instructions, but whenever wheeling over the loop, manually advance the wheel by the loop length. In the illustrated example, loop length is 50 ft.

4. Dry hole.

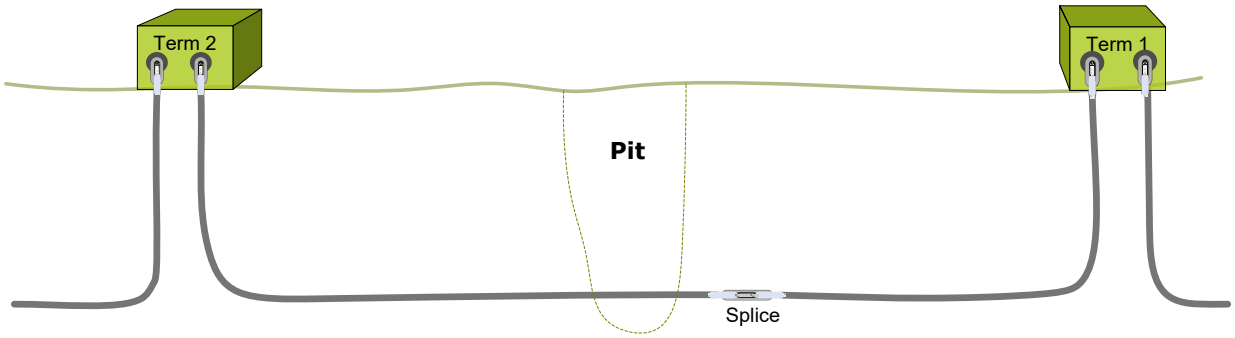

Figure 14: An example of a dry hole.

Occasionally a dry hole may be encountered. Follow the steps for the appropriate type of dry hole.

When the cable is not found:

a. Run the RF locator in "cable locate" mode again.

b. Climb down into the dry hole to determine a direction and distance to the cable path.

When the splice is not found within 3 ft of the designated location:

a. Review all previous steps for errors.

b. Use the RF locator to re-pinpoint the splice.

If the splice still cannot be located:

a. Attach an equipotential grounding mat to the neutrals using a hot stick.

b. Attach the TDR as indicated in steps 1, 2, and 3.

c. While watching the TDR signal, change the local cable impedance from the grounding mat with one of the following two methods:

- Utilize slack in the neutrals to deflect the neutrals away from the cable.
- If insufficient slack, while on an equipotential grounding mat or using a hot stick, apply a bonding jumper (at least the size of the conductor) to the exposed neutrals at the two ends of the pit. Then snip the neutrals one at a time. Wear hot gloves and dielectric boots while performing this step.

d. Do this until the location is visible to the TDR operator.

The deflected or snipped neutral location appears as a new splice. The neutral anomaly moves on the TDR display as the deflected neutrals or neutral jumper move toward and away from the conductor. This is helpful if the real splice and snipped neutral are close.

a. Measure the distance between the snipped neutrals and splice by putting Cursor 1 at the splice start and Cursor 2 at the deflected or snipped neutrals start.

- The distance displays on the TDR.
- Instructions can be provided to the excavation team to proceed.

b. Spike the cable to confirm grounding if the snipped neutral and splice are close together.

c. Cut the cable and add a Dutchman with new cable between the old splice(s) to the snipped neutral.

d. If the distance is too long, repair the neutral.

- To repair the neutral, complete the neutral cut and wrap the two neutral ends into a pigtail.
- Crimp on a new piece of copper between the two pigtails.
- The new copper should have more ampacity than the original neutral wires and should be tie wrapped into intimate helictical contact with the insulation shield.
- If the cable is jacketed, use a Raychem© wrap-around heat-shrink re-jacketing sleeve or equivalent.

Restoring Ridgid SR-20 or SR-60 Locators to Factory Default Settings

a. Open the menu by selecting and pressing the menu key  .

b. Use the up and down arrows to scroll to the information screen; then to the last item on the menu marked with  .

c. Press the select key  with the information screen highlighted to display the device information for your locator.

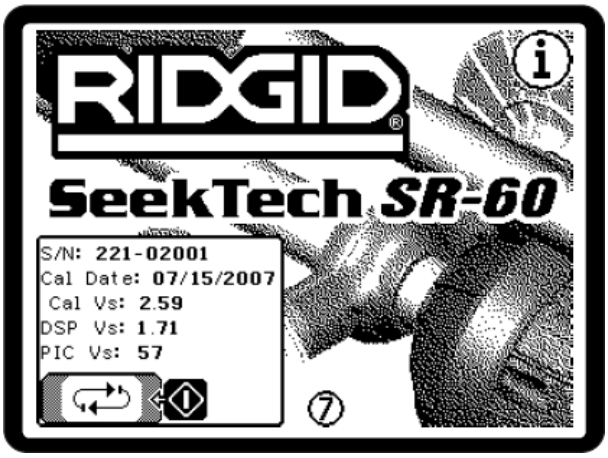

Figure 15: Locator landing screen.

d. Press the select key  . Use the arrows to highlight the "check" symbol  next to the Restore Factory Defaults  selection.

e. Press the select key  to restore defaults, or press the menu key  to exit without restoring default settings.

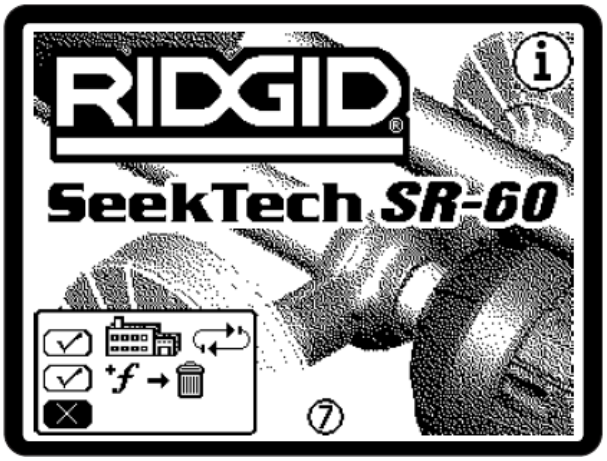

Figure 16: Selecting factory reset.

Selecting Frequency Settings for Cable Locating

a. Open the menu by selecting and pressing the menu key .

b. Use the Up and Down arrow keys to highlight and activate the following radio frequencies by pushing the key:

- 33kHz
- 8kHz
- 1kHz

c. Activate the following ranges in the Radio Frequency Mode:

- 4-15K
- >15K
- ∞

d. Activate the following power line frequencies shown with the symbol, if available:

- 60Hz
- 60Hz (5th)
- 60Hz (9th)

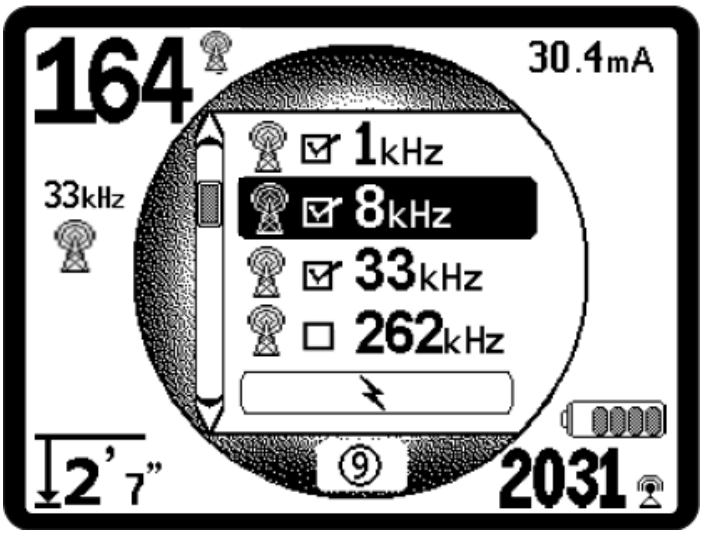

Figure 17: Enabling frequencies.

e. Deselect any other frequencies. A check mark indicates an active frequency.

f. Press the menu key to return to the locator operation screen.

NOTE: If the Battery indicator on the transmitter does not have more than one bar of charge, the transmitter will not operate correctly.

- It may provide distorted signals, which will be picked up by the locator.
- Change the batteries if this occurs before altering locator settings.

RD-400 Locator

The RD-400 locator set consisting of the RD-400PXL2 receiver and the RD-400LCTX transmitter are excellent for locating cables and splices on Cablecure power cable injection projects. The locating procedures that follow can also be adapted to locating other utilities such as telephone cables.

1. Receiver controls.

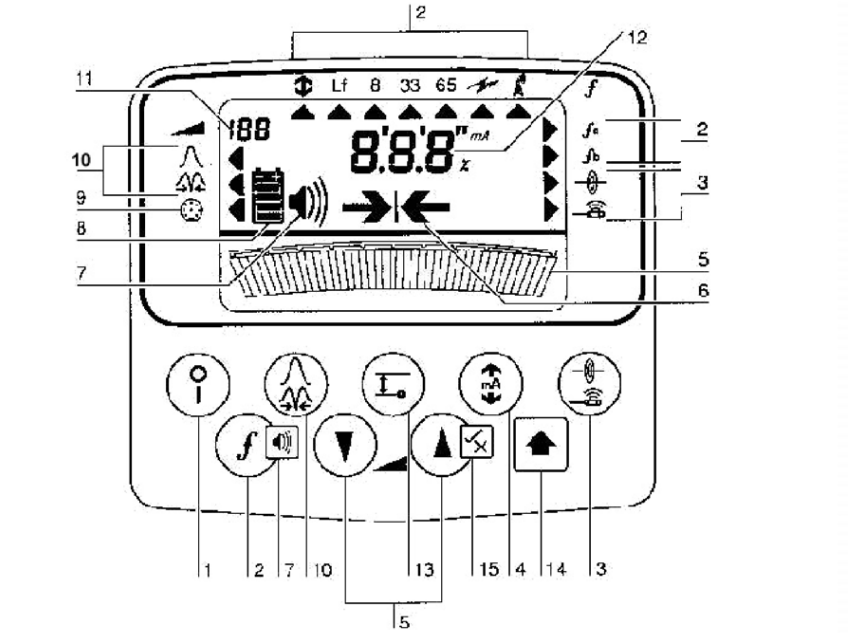

Figure 18: RD-400 PXL-2 Receiver.

1. **ON/OFF**: Turns the receiver power on and off. To save battery life, the receiver will automatically shut off after no keys have been pressed for five minutes.
2. **FREQUENCY**: Selects the frequency the receiver is tuned to. The frequency selected is indicated by the mark on the upper edge of the screen.
3. **LINE/SONDE**: Selects what is being located. In the line position, the receiver is set up to locate cables. In the sonde position, it is set up to locate a sonde (a special antenna inserted into pipes). The selection is indicated by the mark on the right side of the screen.
4. **CURRENT**: Initiates an automatic program that estimates signal current flowing in a cable.
5. **UP/DOWN**: Increases/decreases the gain (amplification) of the signal. The gain setting is indicated on the top left corner of the screen.
6. **DIRECTION**: When the null mode is selected, the arrows on the screen will indicate the direction to the center of the field.
7. **VOLUME**: When shifted, this key will adjust the volume of the speaker. The volume setting will be displayed on the screen.
8. **BATTERY LEVEL**: Displays receiver battery level.
9. **EXTERNAL ANTENNA**: The external antenna can be selected with the PEAK/NULL key if it is connected.

10. **PEAK/NULL**: Switches back and forth between the vertical and horizontal antennas. The selection is indicated by a mark on the left edge of the screen.
11. **GAIN SETTING**: Indicates the gain (signal amplification) setting.
12. **SIGNAL STRENGTH**: The strength of the signal is displayed in the center of the screen.
13. **DEPTH**: When pressed with the receiver in the peak mode, this key will start an automatic depth measuring program.
14. **SHIFT**: Activates the second function of the lower three keys.
15. **SYSTEM CHECK**: When shifted, this key starts an automatic system check.

2. Receiver operation.

a. Hold the receiver.

- When in the null mode, the receiver is using an antenna that is inside the wand in a vertical position.
- The receiver will register a null whenever that antenna is pointed at the cable.
- If the wand is not held vertical, the receiver is not over the cable when the null is detected.
- Let the receiver hang loosely in your hand. Its own weight will make it perfectly vertical.

b. Adjust the gain.

- Manual: Use the UP and DOWN keys to adjust the gain.
- Automatic: If the signal strength display flashes 99, the gain setting is too high. Hold the receiver still, press the gain down key, and wait three seconds. The gain will automatically reset with the strength reading near mid-scale.

c. Maintain the battery.

- The RD-400PXL2 receiver is powered by either 12 AA (LR6) batteries or two 9-volt batteries.

d. Transmitter controls.

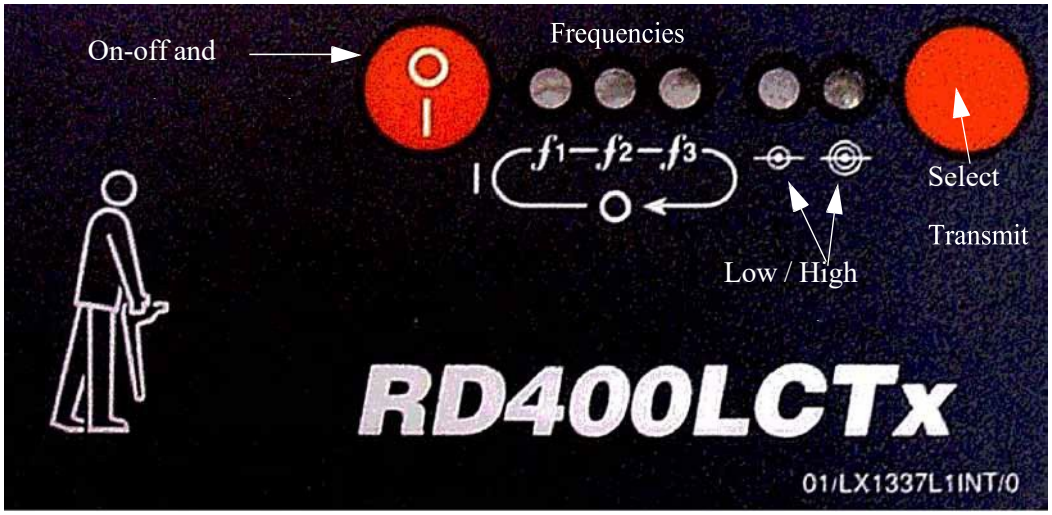

Figure 19: RD-400PXL2 front panel.

- **Output level**: Selects high or low power levels.

- **Frequency**: Selects the output frequencies and turns the unit on and off.

3. Transmitter operation.

a. Connect the leads.

- When the lead wires are not plugged in, the transmitter will automatically activate an internal antenna. The internal antenna will broadcast a strong field from the bottom of the transmitter, which will be induced onto the target utility (and anything else in the vicinity). This method of inducing a signal into the utility is used when it is not possible to make direct contact.
- When the test lead is plugged into the transmitter, it switches the internal antenna off and sends the locating signal out over the test leads. When the leads are connected to a utility, the utility becomes the broadcast antenna. This method is far more efficient at placing a strong signal on the utility.
- NOTE: The connector for the leads needs to be pushed all the way in to work. If you are having trouble transmitting a strong signal, try pushing the plug in firmly.

b. Set the frequency.

- Each time the frequency key is pressed, the transmitter will switch to the next frequency or on and off.
- Press the key once for low frequency (0.5 kHz).
- Press the key again for 8 kHz.
- Press the key again for 33 kHz.
- Press the key again to turn the transmitter off.

c. Select the output power.

- Pressing the output power key will switch the transmitter between low and high power.

d. Use 4 D-cell (LR20) batteries.

e. When the transmitter is turned on, it will make a tone.

- A steady tone indicates that the transmitter is on.
- A beeping tone indicates good direct connection with the utility and the signal has a low resistance loop to flow on.
- No tone indicates dead or weak batteries in the transmitter or the volume is turned down at the receiver.

RD-4000 Locator

The RD-4000 is the newest cable locator from Radiodetection, but will no longer be available in the future. The set consists of the RD4000Rx receiver and the RD4000T3 transmitter. The RD-4000 set has several improvements over the older set that can affect its performance in the field. The receiver has a much better signal to noise ratio, meaning that the new receiver is much more sensitive. The second improvement is that the transmitter has a power output of 3 watts compared to only 1 watt for the RD-400, meaning that the transmitter is capable of emitting three times as much power. The combination of these two improvements requires that the operator adjust both power output of the transmitter and the

gain on the receiver to achieve the optimum response. The RD-4000 has many other new features; please review the owner's manual for in depth instructions (p/n 860327).

1. Receiver controls.

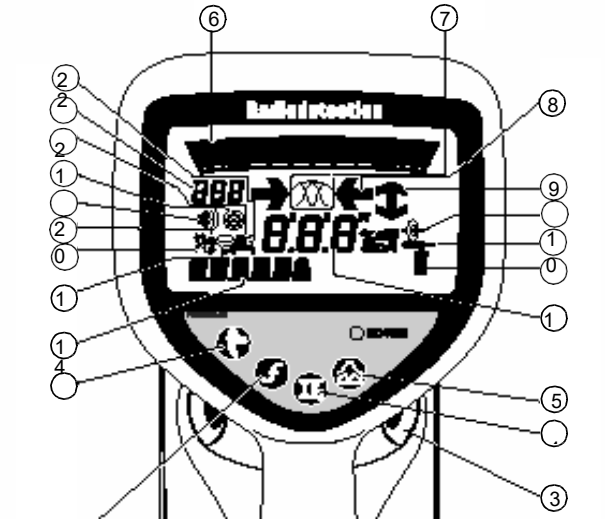

Figure 20: RD4000Rx Receiver.

1. **ON/OFF:** Switches the receiver on and off and is used to select the menu.
2. **FREQUENCY**: Press and release the frequency key to select the next frequency. Press and hold down the frequency key to scroll through the available frequencies in sequence. Release the key when the required frequency is displayed.
3. **GAIN PADDLE**: Increases or decreases the signal strength. To reduce the signal strength, lightly push the paddle anti-clockwise. To increase the signal strength, lightly push the paddle clockwise. A bar graph reading of approximately 50% is suitable for most uses. (The gain paddle has a secondary function of menu scrolling when the menu key is pressed.)
4. **DEPTH AND MEASUREMENT**: When pressed, it displays depth to target line and the current. It is also used for data logging when an external data logger is attached.
5. **ANTENNA SELECT**: Press and release the peak/null/single key to select the required mode.
6. **BAR GRAPH**: Displays signal strength.
7. **ANTENNA DISPLAY**: Wide (single horizontal antenna) peak. Narrow (twin horizontal antenna) peak. Null (single vertical antenna).
8. **LEFT/RIGHT ARROWS**: Indicates if the target line is to the left or right of the receiver when the receiver is in null mode.
9. **CURRENT DIRECTION (CD) ARROWS**: Indicates current direction when an allocated CD frequency is in use and the fault direction when using FaultFind.
10. **LINE SELECTED INDICATION**: Displayed when line measurement is selected.
11. **SONDE INDICATION**: Displayed when sonde measurement is selected.
    - **NOTE:** The sonde option is not available when using some frequencies.
12. **BATTERY LEVEL INDICATION**: Displays receiver battery level.

13. **NUMERIC DISPLAY**: Indicates the receiver response to a signal. Also provides information from other functions.
14. **SELECTED FREQUENCY INDICATION**: Displays selected frequency.
15. **ELECTRONIC MARKER SYSTEM (EMS) MODE SYMBOL**: (RD-4000 MRx option only).
16. **RADIO MODE SYMBOL**: This symbol is displayed when radio mode is selected.
    - **17 Power mode symbol:** This symbol is displayed when power mode is selected.
    - **18 Volume level:** Shows volume level (off, low, mid, high).
17. **Power mode symbol**: This symbol is displayed when power mode is selected.
    - **Volume level**: Shows volume level (off, low, mid, high).
18. **ACCESSORY INDICATION**: The symbol is displayed when an accessory is fitted.
19. **FAULT FIND MODE**: The symbol is displayed when an A-frame is plugged into the accessory socket.
20. **NUMERIC DISPLAY**: Displays gain-setting value.
21. **CD MODE INDICATION**: The arrows are displayed when the CD frequency is selected. The RD-4000 receiver uses 4 D-cell (LR20) batteries. See the owner's manual for operating instructions (p/n 860327).

2. Transmitter controls.

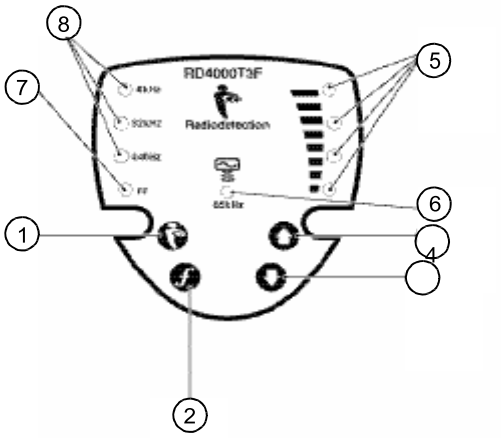

Figure 21: RD4000T3 Transmitter.

1. **ON/OFF**: Used to switch the transmitter on and off. The on/off key is also used to select one of two volume levels, which are only selectable when switching the transmitter on. To select the higher volume when switching on, press and release the on/off key. To select the lower volume, when switching on, press the on/off key for approximately two seconds. To change to the higher volume, switch the transmitter off and then on.
2. **FREQUENCY**: Press to select required frequency.
3. **DOWN ARROW**: Press to reduce power output level.
4. **UP ARROW**: Press to increase output power level.
5. **POWER OUTPUT INDICATION LEDs**: When the up or down arrows are pressed, the four LEDs illuminate or extinguish in turn to indicate the selected output power level. If the demanded output level can be achieved, the LEDs up to and including the one representing the demanded output level will illuminate and will remain on. If the demanded output level cannot be achieved, the LED representing the achieved output will illuminate and remain on. The LEDs between the achieved level and the required level will flash on and off.

6. **INDUCTION INDICATION LED**: Indicates that induction mode is selected. The induction frequency is indicated by one of the three frequency LEDs. The illuminated LED represents the induction frequency. Induction mode is automatically selected if there is not an accessory plugged into the transmitter.
7. **FAULTFIND (FF) INDICATION**: (RD4000T3F only). Indicates that FF mode is selected.
8. **FREQUENCY INDICATORS**: Indicates selected frequency. Please see the owner's manual (p/n 860327) for transmitter operating instructions. The RD4000T3 transmitter uses 12 D-cell (LR20) batteries.