

Practice, Practice, Practice

Using Prototek Digital Receivers

You have purchased some of the finest locating tools in the business, but they don't do magic. Your skill at handling these tools and recognizing their strengths and weaknesses is what makes a locating job successful. Before taking them out on their first job, make sure you understand how the system works.

The LF2000 and LF2200 receivers both locate sondes the same way, using a series of screens that guide you through the steps necessary for an accurate locate. The LF2200 additionally does line tracing, where buried lines are energized by an external line exciter. Line tracing will be covered later in this document. *Note to owners of the LF2100: The instructions here for the LF2200 apply to the LF2100 as well. The LF2100 has fewer features, but the basics of locating are the same.*

The best place to start is above ground where you can see how the receiver responds to the location and position of the transmitter. You may be surprised at what you see. Better to be surprised when you have plenty of time to learn and nothing is at stake!

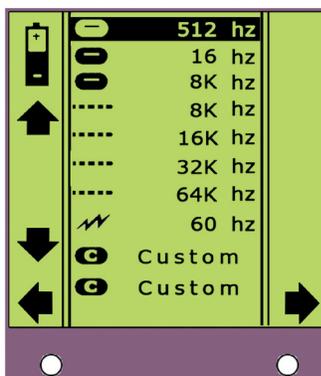
Do your practicing in a place where you have plenty of room to move around - inside in a large room, or outside on the ground.

Locating a Sonde

Turn on the receiver by clicking the rocker switch in any direction and holding it for a second. The handle briefly vibrates, and the friendly Prototek logo screen greets you, with our phone number, which you should not hesitate to call if you're having problems. The unit goes through a brief self-test, and the information on this screen can sometimes help us solve a problem. Notice the arrows - the one pointing down shows where to push to turn the unit OFF, the one pointing right indicates that a push on the right side of the switch will take you to the next screen.



You must return to this screen to turn the unit off



This screen will only be seen on the LF2200

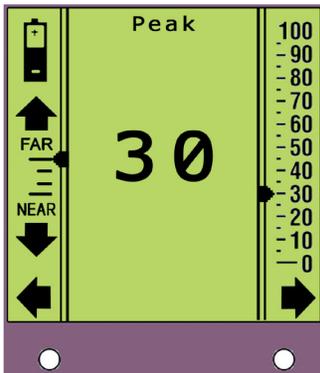
If you're using the LF2200, the next screen will look like this one. This Menu screen gives you choices of the type of locating you want to do. The top 3 choices are for sonde locating at 3 different preset frequencies, the next 4 are presets for line locating. You will be working with a 512 Hz transmitter for this exercise, so be sure it is selected by moving the highlight bar to it by pushing the thumb switch up or down as necessary. When you have selected 512 Hz, you are ready to get started.

Please note: this is only part of the LF2200 Menu screen. There are more choices further down, but they are not important for this practice session. The Digital Underground Locating manual covers all of the LF2200 operations in detail.

No matter which receiver you are using, now turn on a 512 Hz transmitter (also called a "sonde") and toss it on the ground. Walk away from it further than its range.

Step 1: The Peak Screen

Go ahead and push the switch to the Right to get to the Peak Screen. You may hear some noise but the digital display should read under 10, and possibly say "no signal". Let's look at the features on this screen that are typical of all the locating screens.



The "30" in the middle in this example duplicates what is currently shown on the sliding scale, and is only seen on the Peak Screen.

- Battery symbol - shows battery strength, with all black meaning full. The battery shown here is down to half strength. When it is all white, they should be replaced.
- "FAR ... NEAR" with up and down arrows - this shows you the current sensitivity setting; FAR is the most sensitive, NEAR is the least, with two intermediate steps. When you first turn the unit on, it is set to FAR. This setting is controlled by pushing the switch away from you or toward you, as the arrows show.
- The sliding scale on the right side of the screen shows the current signal level, at the current sensitivity setting. It will never be higher than "99"; whenever it reaches this level, automatic circuitry will lower the sensitivity.

Turn the sensitivity up to FAR, and walk around with the receiver held so that it hangs straight down. Turn to the left and right as you walk, keeping the receiver directly in front of you. You will hear the receiver click at a faster rate as you get closer to the transmitter, which will be accompanied by a higher number in the display. When the signal gets too strong for the current sensitivity setting, it will automatically be lowered. The clicking will slow down at this point, but will speed up again as you continue to approach the transmitter. You already know where the transmitter is, but try to approach this exercise as though you didn't.

Note that the receiver circuitry will automatically lower the sensitivity when the signal gets too strong, but it will not raise it when the signal gets weak. You would never be able to find your way if it did that! If you get too far away from the signal, raise the sensitivity with the rocker switch and start over.

When you have reached the point that the signal gets no stronger, mark that spot. Move to another place and seek this peak signal again and see if you come back to the same spot. You should find yourself right over the transmitter each time. If you don't, keep practicing until you get consistent results.

Recognizing "Nulls"

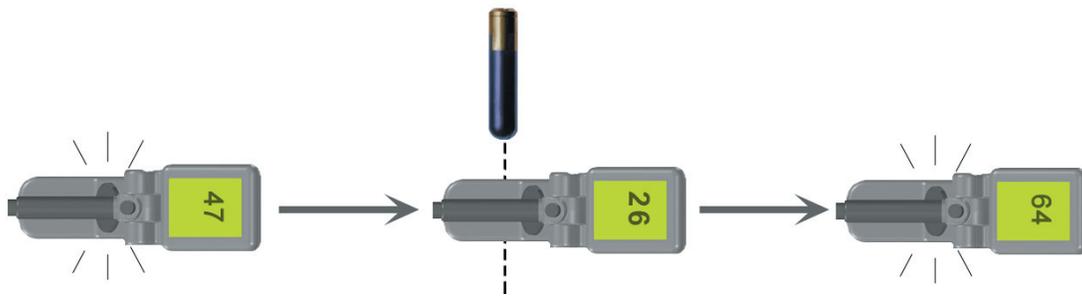
Depending on the orientation of the transmitter with respect to the receiver, you may encounter "dead spots" where the signal suddenly drops off. These are called "nulls", and rather than being an annoyance they actually provide the means for very precise locating. These nulls happen at very specific spots, and it's good to recognize these. So let's find a few nulls.

Hold the receiver directly above the transmitter, parallel to the long axis of the transmitter. The clicking is fast and the Peak screen indicates a strong signal. This is a peak signal.



Now turn the receiver to be perpendicular to the transmitter. The click slows way down and the Peak screen indicates almost no signal at all. This is a null. Move the receiver around a little to see how sharp and precise this null point is, and how dependent it is on being exactly perpendicular.

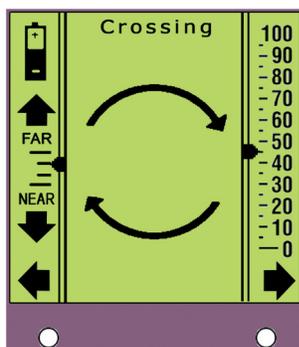
Now let's look at some other places to find nulls. Back away from the transmitter and walk past it off the end, like this:



There was a signal drop-off (and the clicking slowed way down) just as you crossed the axis of the transmitter. This is called a "crossing null" and it is a very good thing to know about. Walk around and see that the crossing null is detected any time you cross either end of the transmitter, no matter how far away you are as long as you are within range.

We've done all this in the Peak screen to show you where nulls are, but the Digital receivers will do the job of figuring out nulls and what they mean for you, depending on which locating step, or screen, you are on. Step away from the transmitter several feet and then push the switch to the right to go to the Line screen.

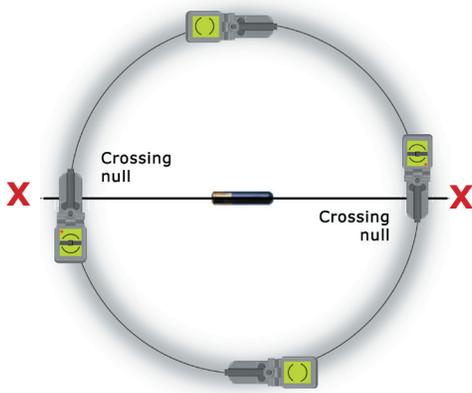
Step 2: The Crossing Screen (*do not skip this step!*)



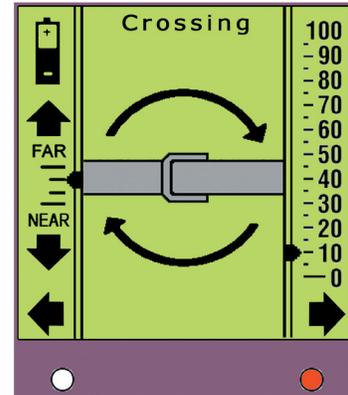
This screen represents the most overlooked step for locating with our Digital receivers. Many people figure that the Peak screen got them to the transmitter and they move straight to the Sonde screen to get the black sonde icon. And then they complain that the transmitter is not where it said it was! Learn what this screen has to tell you and you'll be right on the money every time.

Most of the time this screen is showing, it will look just like this, with a couple of curved arrows around a blank space. You'll hear the clicking go up and down, along with the sliding signal strength indicator, as you move around.

Using the Crossing screen, we are going to find the same nulls we just found with the Peak screen, but in an easier and more useful way. Walk in a 5-7 foot circle around the point you established from step 1 on the Peak screen. Hold the receiver right in front of you, letting it hang naturally. Walk slowly, and notice that the clicking slows down and the screen changes at two distinct points of the circle.



Notice that the pipe image appears and the red LED lights up at the two points where you cross the axis of the transmitter. Mark these spots clearly

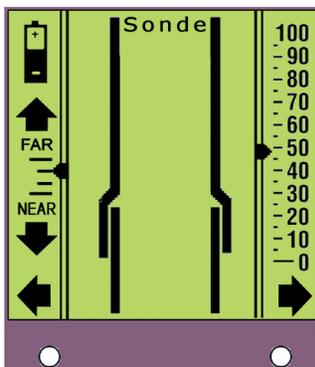


The handle vibrates every time the red LED lights up.

What's so special about this? Well, imagine that you can't see the transmitter, which is just like a real locating situation. In fact, have someone put the transmitter under a box or newspaper and orient it in a way you can't see. Using the circle method, you can quickly determine which way the transmitter is lying. And in a real pipe, that usually means that the pipe lies along that line, too. That can be very useful information when trying to locate in unknown lines, but it has even more usefulness for the next steps in precision locating: zeroing in on the exact location of the transmitter, and determining its depth.

Step 3: Zeroing In - Using the Sonde Screen

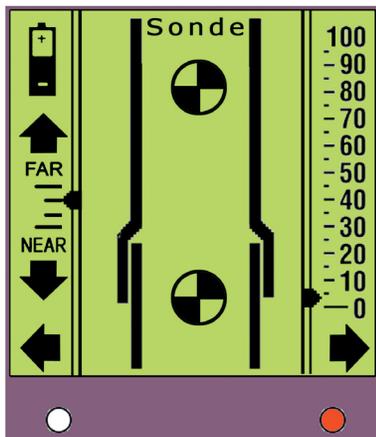
When you have found the crossing nulls on your circle walk, mark them on the ground with something like a stick, a rock, chalk or a paint marker. A straight line drawn between these markers will run right through the middle of the transmitter. Push the switch to the right once more to get to the Sonde screen.



Remember that the Crossing Nulls we just marked indicate the direction the transmitter is lying, and presumably a pipe it is in lies the same way. The Line Screen showed an image of a pipe at right angles as we crossed it. Now we are going to walk in line with the "pipe". Notice that the Sonde Screen shows us a pipe in line with the way we walk with the receiver.

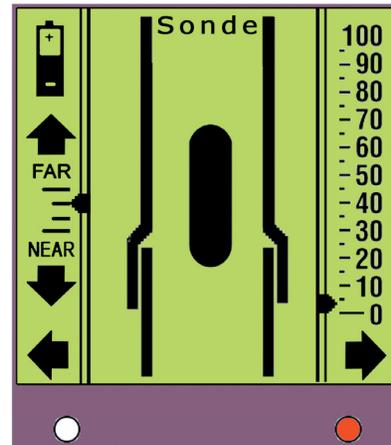
For this exercise, hold the receiver up so that the handle is in front of your chest (and you can still see the screen). We need to have a little distance between the bottom of the receiver and the transmitter as we approach it. (When the transmitter is actually underground, this is not a problem.)

Go to a point about 6 feet or so away from the location of the transmitter, on the line described by your Crossing Null markers. Start with the sensitivity at FAR (set it there if it isn't). Start walking slowly along the line toward the transmitter.



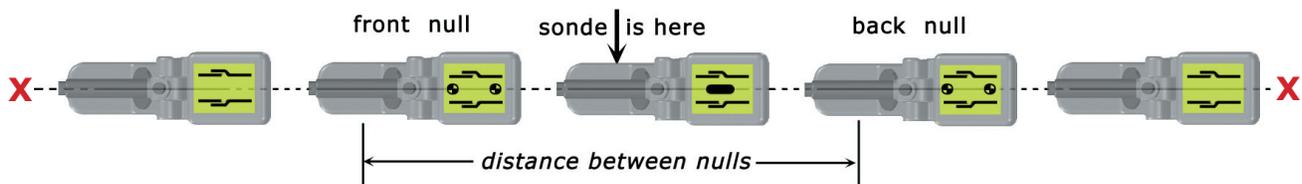
Indicates a front or back null

These images appear at very sharp points. The clicking will slow down and the red LED will light at the same time. When the sonde image shows, the handle will vibrate.



Indicates the sonde is directly below

Watch carefully as you walk, and you should see both of these screens appear at different points as you approach the transmitter and walk beyond it.

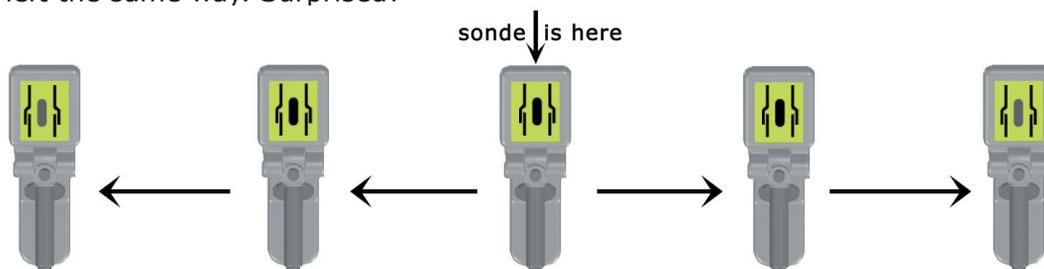


The appearance of the front and back nulls is a good sign that you are proceeding along the correct path (determined by the crossing nulls of the Line screen) but they aren't of particular interest just yet. But the appearance of the sonde in the pipe image is just what you are looking for. That means you are directly over the transmitter (sonde) and you're ready to find out its depth.

Or does it ?

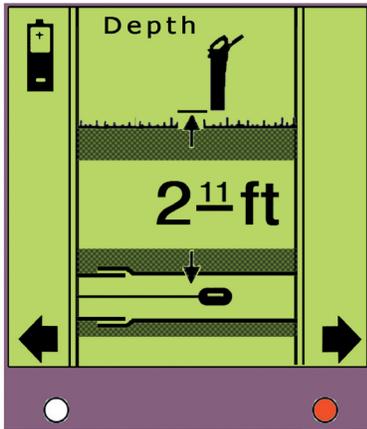
The appearance of the sonde in this screen is a reliable indication that you are directly over the sonde **IF** you have gotten to that point by following the line described by the crossing nulls using the Crossing screen. If you have skipped that step and just looked for the sonde image, you can be way off, and very disappointed. Let's demonstrate why.

Go back to where the receiver is directly over the transmitter, and the sonde image is showing clearly in the screen. Now move the receiver to the right a foot, keeping it parallel to the transmitter. Move it another foot away. Now go back to the original point and move it to the left the same way. Surprised?



The sonde signal can show on the screen for many feet on either side of its actual location. The only way you can be sure which of these spots is the actual location is to have found the crossing nulls with the Crossing screen. *The exact location of the sonde is along the line through the crossing nulls.*

Step 4: The Depth Screen



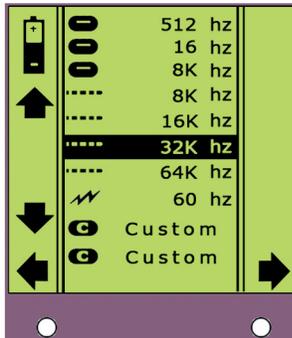
Now that you know for sure where to stand so that the sonde is directly below the receiver, it's time to determine its depth. Click the rocker switch once more to the right with your thumb to get to the Depth screen. Hold the receiver still in this position and wait while it reads the signal and displays the depth in feet and inches. The red LED will blink while it is thinking, then turn solid red when it is finished.

What if you had settled on one of the "ghost" sonde locations we discovered a minute ago, and tried to determine depth on it? Try it and see. The depth will appear to be considerably deeper than actual as you move to the right or left of the actual sonde location. And, of course, it won't be down there when you dig. That's why it's so important to establish your crossing nulls before you proceed to the Sonde screen.

With what you have learned here, you should be able to go out and be successful at locating a transmitter you have sent underground without knowing in advance where it is. Be sure to read *The Sonde Locating Job* for digital receivers for practical considerations when doing actual field locating. Good luck!

Line Tracing with the LF2200 and Blue BuzzBox

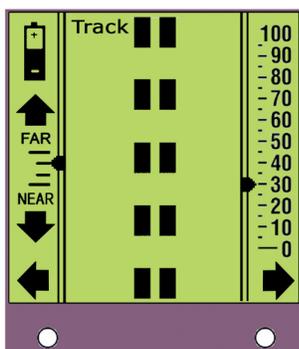
First turn on the Blue BuzzBox, by turning the frequency knob to any of the choices. "Lo" or "Hi" power doesn't matter at this point. See that the red LED flickers but doesn't stay on, and that the meter needle briefly swings and comes to rest toward the left end of the scale. Don't plug in any cables at this point. Set the box on the ground and step away from it about 10 feet in the direction of the "tracks" on the panel.



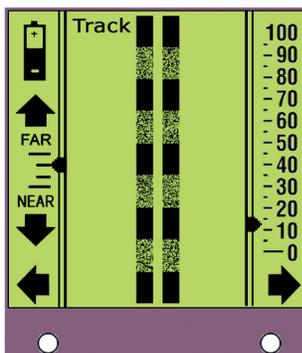
Turn the LF2200 on the usual way, go to the Menu screen and select the frequency that corresponds to the frequency you set on the BuzzBox (in this example, 32 KHz). Click the thumb button to the right to get to the Track Screen.



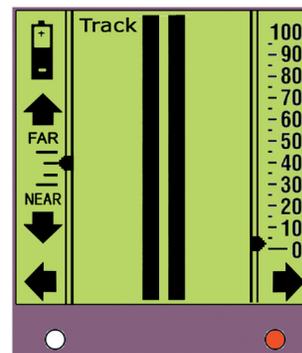
Stand in front of the BuzzBox with the LF2200 hanging down as in the picture (not to scale) and turn the LF2200 back and forth across the imaginary line extending out from the "track" lines on the BuzzBox, as shown. As you do this, you will see the Track Screen change as you cross that line.



Off the line, no signal.
Track gaps are clear.



Nearing the line, track
begins to fill in



Right on the line, track
solid black, red LED lights,
and handle vibrates.

Walk along the line, turning the receiver as you go, and see how easy it is to follow the path of the signal while keeping your eyes on your surroundings instead of having them glued to the instrument. It's important to turn the receiver in an arc, as shown, instead of letting it swing back and forth like a pendulum, because it makes it much easier to detect a line that changes direction. This will be explained more fully later on.

So far, we've only "located" the BuzzBox by its signal through the air. Not exactly useful. But you have learned how the receiver responds in the presence of a signal generated by the BuzzBox, and it will respond the same way when you're searching for a line that it has energized, which is the one you are looking for.

Let's go outside (if you're not already) and practice a little closer to reality. Why outside? Most buildings are full of metal in one form or another, and metal is going to interfere with the quality of a locate. A concrete floor full of steel rebar is one of the worst places we could practice - the signal gets dissipated everywhere but where you think it should be. Plus, we'll need to work at least 20 feet away from the BuzzBox so we won't pick it up instead of the line.

We will need a metallic line to put our signal into. A sewer cable or metal fishtape will work, or even a plain old extension cord, as long as whatever you are using is at least 50 feet long. First we'll set up for Inductive locating.

using the BuzzBox in Inductive Mode



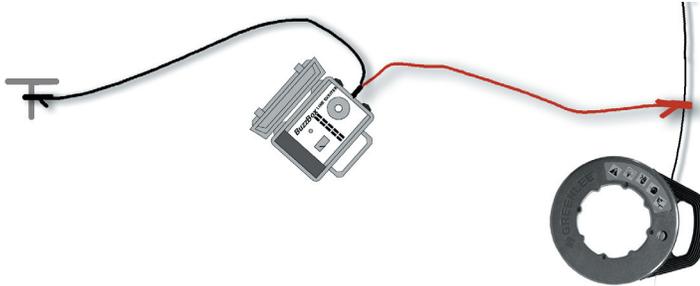
This is the simplest connection of all. Just lay the BuzzBox on top of the cable, tape or cord, with the "tracks" right on top of and parallel to the line. In the picture above, the blue dashed line now represents the cable lying under the box. String the cable out in the yard and give it some bends like you might find in an actual line. Now walk the length and see how easy it is to follow by feeling the handle vibration. If you're turning your LF2200 in an arc, as shown, you will see how easy it is to detect when the line takes a bend and to keep following it. If you don't turn it this way, it is too easy to walk right "off the end" and lose the signal when the line turns.

As you move further away from your BuzzBox signal source, turn up the sensitivity on the LF2200 by clicking the rocker switch forward, raising the sensitivity level on the left side of the screen (toward FAR). The difference between signal and null is much more distinct when the signal is strong. For the same reason, you may need to go back and turn up the BuzzBox's power to "Hi". This will generally be necessary when tracing a long line.

Walk all the way to the end of the line you have energized. Notice that the signal drops off and disappears shortly before you get to the end. This is a fact of life with line tracing, and you need to keep it in mind when you are concerned with exactly where a line ends. Also keep in mind that *this effect is more pronounced the deeper the line is* - that is, a deeper line of a certain length will appear to be somewhat "shorter" than a shallow line of the same length. You'll need to experiment to see how much you should compensate for this. *This effect will be noticed in both Inductive and Conductive modes.*

Using the BuzzBox in Conductive Mode

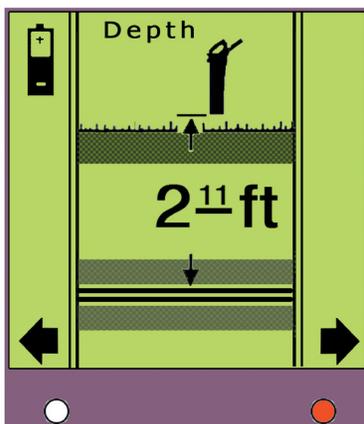
Plug the cable set into the jack on the side of the BuzzBox. Connect the red clamp to the line, that is, the cable or cord you are using for this exercise. It must make a good electrical connection, so clean off any rust or insulation that might compromise this (on an extension cord, just clamp it to the prongs on the male end of the cord). Shove the ground rod into the ground and connect the black clamp to it. The ground rod also needs to make a good electrical connection with the earth; deeper is better and wetter is better. When you have a good ground, the meter needle will lie in the right half of the scale. In practice, it is best to maximize the distance between the ground rod and where you attach to the "line", keeping it at a 90° angle to the run of the line.



The technique for locating a line energized conductively is the same as for inductively, so go ahead and walk the line again to see how it works. In general, you will find that the signal is stronger and more distinct in the Conductive mode.

Determining Depth

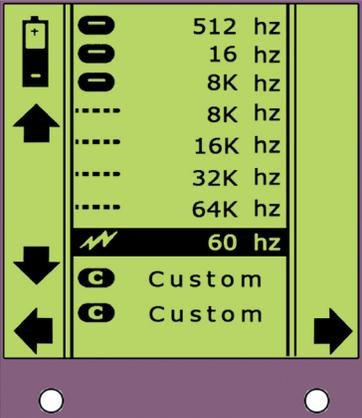
The LF2200 uses the same method to determine the depth of a line as it does for determining the depth of a sonde.



The screen looks the same too. When you are directly over the line (indicated by solid tracks and vibrating handle), hold the LF2200 up by your chest, where you can still see the screen. We do this when practicing because the line is on top of the ground and we want to establish a distance we can measure. When doing actual tracing, you will set the bottom of the LF2200 on the ground when determining depth. When ready, click the rocker switch to the right to get to the Depth Screen. The red LED will flash while it calculates, then will stay on steady when the depth is established.

Power Mode

If you select the bottom choice on the Index screen, labeled "60 Hz", you can locate in "Power" mode. This is also known as a "passive" locating mode, since you will be detecting a signal that already exists instead of one you are causing. The signal you are seeking is the one produced by an energized underground power line.



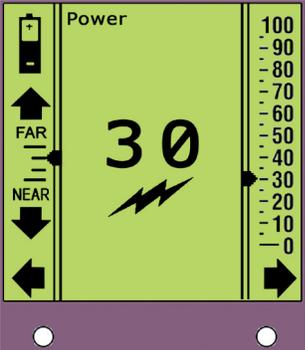
Note: *The fact that an underground power line is energized is not enough to guarantee you will be able to detect it. It must be carrying a certain minimum electrical current before the electromagnetic field will be strong enough to detect. A main line supplying an entire neighborhood will certainly be detectable, but one serving a single house may not be unless a fairly large appliance like an electric clothes dryer or oven is operating.*

For this reason your success at tracing power lines will generally be better if you use Inductive mode as described above. However, if you can't find one end of the line to set the BuzzBox next to, this method may be your only choice in determining whether there are buried electrical lines in the area.

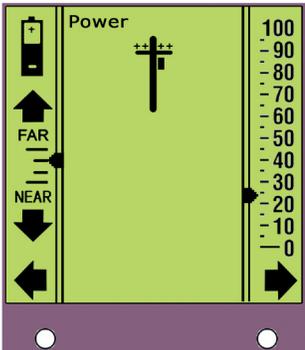
The principle of tracing electrical lines with the LF2200 in Power Mode is very similar to using it in the other modes. The screen, LED and handle vibration will guide you through the process. Power tracing in the LF2200 uses two different techniques to detect and trace power.

The "Peak" Power Screen

This first screen is used for the initial survey to find out if there is power in the area. If you don't have a good idea of where power lines are running, it gets you "in the neighborhood."

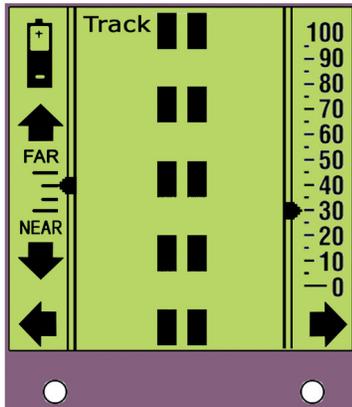


Note the symbols that appear on the Peak screen. When a "zap" symbol is below the number, it shows that the source of signal is underground. Be alert for the "telephone pole" to appear on the screen - in this case the source of signal is overhead, which is not the signal you are looking for. In Peak mode, the LF2200 picks up the strongest signal as you cross the power line, at right angles to the way it runs.

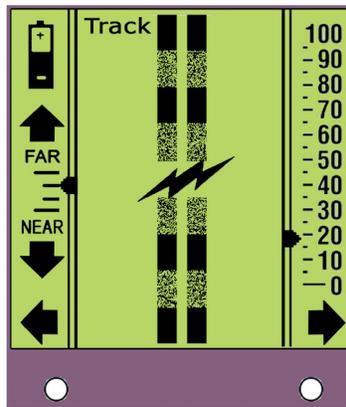


The "Null" Power Screen

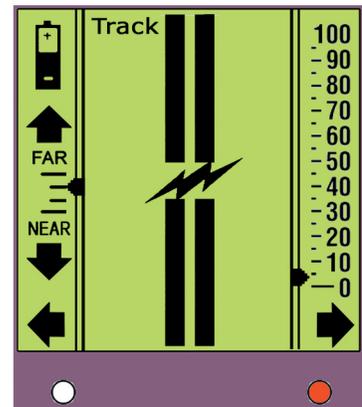
Click again to the right to get the Track screen ("Null Power" mode). This mode shows you the power line the same as when you use the BuzzBox to trace lines.



Off the line, no signal.
Track gaps are clear.



Nearing the line, track and
"zap" begin to fill in

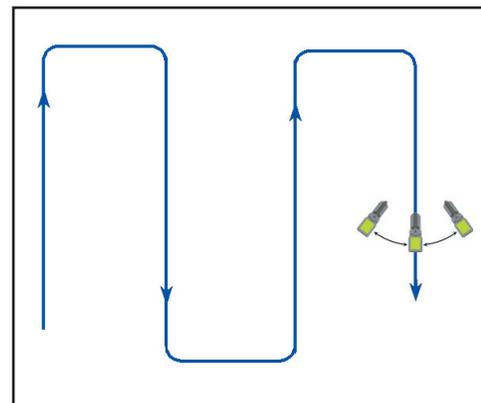


Right on the line, track solid
black, red LED lights,
handle vibrates

To practice in Power mode, find a place where underground power lines are known to run and try to ensure that there is sufficient load to produce a strong enough electric field to work with, using the guidelines described above. If you can detect the line at any point, you should be able to follow it for its entire length. Its signal will not "drop off" as you go further, since the entire line is the source of signal, not a BuzzBox at one end of it. However, be prepared for the signal to suddenly disappear if the load on the line is decreased.

The LF2200 does not have a Depth screen for power. As we have said, locating power using passive methods is at best an approximation, and the lack of accuracy extends to the determination of depth to the point that we don't want to mislead you by suggesting unwarranted precision. Use the Power features only for an initial survey of an area; use with your BuzzBox inductively for precision locating of power lines..

Practice detecting the presence of underground power by walking over the area of interest in a systematic grid pattern, feeling for the vibration in the handle when you near the line. Remember to swing the LF2200 in an arc while you walk, the same way you search for a sonde. The aim is to cover all of the area with the LF2200 held at all possible angles.



With what you have learned here, you should be able to go out and be successful at tracing a line you can connect to inductively or conductively without knowing in advance where it is. Be sure to read "The Line Locating Job" for practical considerations when doing actual field locating with this equipment. Good luck!