

## Practice, Practice, Practice

### Using Prototek Analog 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.

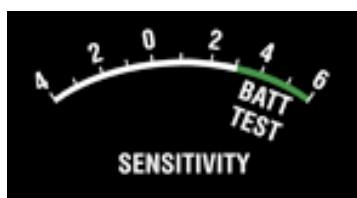
The AR-1 "Ardy" receiver (the one that is yellow or orange around the meter) can perform line tracing in addition to the sonde locating that all of our analog receivers can do. This first section will cover sonde locating; line tracing using the AR-1 and the Orange BuzzBox will be covered later in this document.

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!

### Sonde Locating

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. Turn on a transmitter and toss it on the ground. Walk away from it further than its range and turn on the receiver. Set the switch to "Far" and turn the sensitivity up all the way clockwise. You may hear some noise but the meter should sit at the far left with no distinct signal.

Please note: If you're using a "beeping" transmitter, such as an AT-12, the meter will "bounce" with each beep. You will still be able to detect the difference between strong and weak signals by paying attention to the highest point the meter needle reaches on each bounce.



A good battery is indicated by the needle being in the green area when the red button on the handle is pressed.

First let's take a look at the meter. As with any signal strength meter, when the needle is at the far left it means little or no signal, and as it goes to the right it means the signal is stronger. But why is zero near the middle? It's marked this way to encourage you to "ride" the sensitivity controls to keep the needle in the center of the range (between 0 and +4). That way you will be able to detect any change in the signal: *nulls* when the needle suddenly drops to zero, and stronger signals that will push the needle to the right. (Nulls are described in detail below.)

Now walk around randomly, **holding the receiver level**, at waist height, toward the general direction of the transmitter, slowly sweeping the receiver back and forth. As you point toward the direction of the transmitter, the signal will get louder and the meter will begin to rise. Try to maintain a meter reading in the center of the scale. Turn the sensitivity down as needed to keep it in this range as you get closer. When you're unable to keep the meter below full scale, flip the switch to "Near". Keep moving in the direction that makes the signal stronger.



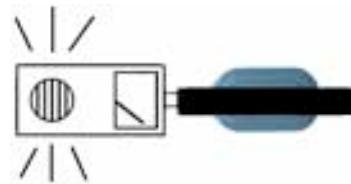
When you have reached the point that the signal seems to be strongest, and any direction you move makes it weaker, mark that spot. Move to another place and seek this peak signal again and see if you always come back to the same spot. You should find yourself right over the transmitter each time. If you don't, keep practicing until you get consistent results.

### I keep finding "dead" spots!

Good news! And if you haven't noticed any "dead spots", let's go look for some. These dead spots are known as "nulls", and they are the key to accurate, precise locating.

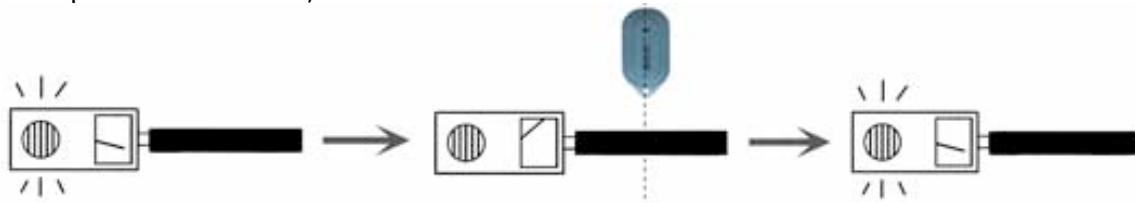
As we find nulls, notice that they happen at very sharp and precise places, unlike "peak signals" which are much more generalized. Let's look at a clear demonstration of a "peak" and a "null". *Be sure to do all these tests with the receiver held level, at waist height.*

Hold the receiver directly above the transmitter, parallel to the long axis of the transmitter. The speaker is loud and the needle goes all the way to the right. *This is a peak signal.*



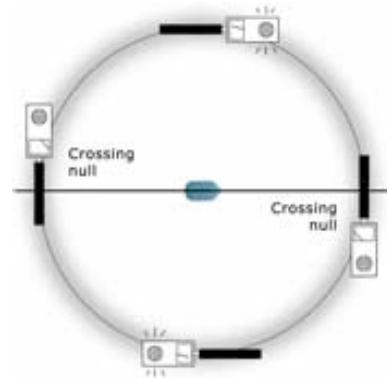
Now turn the receiver to be perpendicular to the transmitter. The signal suddenly drops to almost nothing! *This is a null.* Move the receiver around a little to see how sharp and precise this null point is, and how dependent it is on being exactly perpendicular.

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 null just as you crossed the axis of the transmitter, just like above! 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.

Now for the real beauty of crossing nulls. Walk in a 5 foot circle around the transmitter with the receiver rod held straight in front of you and notice that you get a crossing null at two points of the circle, directly across from each other and on a line that runs right through the center of the transmitter, parallel with its long dimension.



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, almost always that 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 step in precision locating: determining depth.

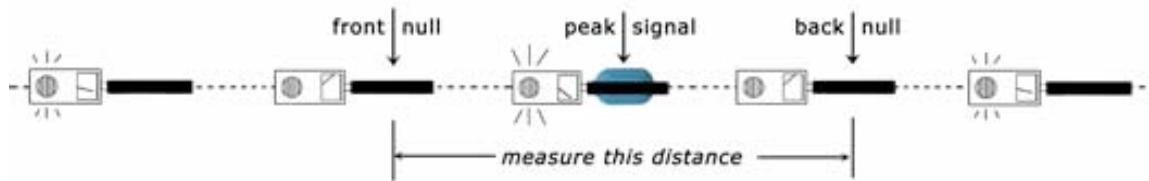
## Determining Depth

**Note:** When you're actually locating a transmitter underground, you will do the front and back null determinations described below *with the receiver at ground level*, and the calculated depth will then be the distance between the top of the ground to the transmitter, which is its true depth. In this exercise, you will hold the receiver at waist level because the transmitter is actually on top of the ground.

When you have found the crossing nulls on your circle walk, mark them on the ground with something like a stick or a rock. A straight line drawn between these markers will run right through the middle of the transmitter. Step away a bit and begin walking the line slowly, from outside the circle toward the middle, again holding the receiver level at waist height

Watch carefully, and you will find a null again several feet before you reach the center of the circle. Mark this spot as precisely as you can, by putting another rock marker directly below the center of the receiver's antenna rod, then continue to walk toward the center. At the center, you will encounter the peak signal when you are right over the transmitter. Mark this spot. Continue to walk the line, now away from

the transmitter, until you encounter another null about the same distance away from the center as the first one was. Mark it also. You have just discovered the *front and back nulls*.



Measure the distance between the front and back nulls and multiply by 0.7. That is the depth of the transmitter, directly below the peak signal mark, which is halfway between the front and back nulls. *It's that simple!*

Now you may be saying, "That's not the depth! The transmitter is lying on top of the ground." OK, let me modify that. You have calculated the distance from the center of the transmitter to the center of the receiver rod, at the peak signal point. Your "depth" here should be the height of your belt above the ground. Remember, when you're locating an actual transmitter underground, you will do these determinations with the receiver held at ground level.

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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 practical considerations when doing actual field locating. Good luck!

## Line Tracing with the AR-1 and Orange BuzzBox

The technique for handling the AR-1 receiver when doing line tracing is a little different than how it is used for sonde locating. Turn on the Orange BuzzBox by turning the knob to the "Lo" position. 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 on the AR-1, set the switch at "Near" with the Sensitivity turned up high enough to hear the tone from the BuzzBox. Unlike when locating a transmitter, hold the receiver pointing **straight down**. Move the receiver in an arc back and forth across the imaginary line extending out from the "track" lines on the BuzzBox, as shown.



You will immediately notice the change in tone when the receiver is pointed right on the line - it disappears! You will find that this change in tone is very distinct, and you should be able to follow the line while you move the receiver in this arc by just listening to it. Note that the meter also drops suddenly to the left when the audio signal drops out at the nulls. It's important to move the receiver in this arc, rather than just swinging it like a pendulum, because it makes it much easier to detect a line that changes direction.



Keep the receiver vertical as you walk the line and swing in the arc



Doing it this way makes it too easy to miss a turn in the line

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 or tape 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 listening for the nulls. If you're swinging your AR-1 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 swing 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 AR-1 to keep a good strong signal and meter indication. 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 "Med" or "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

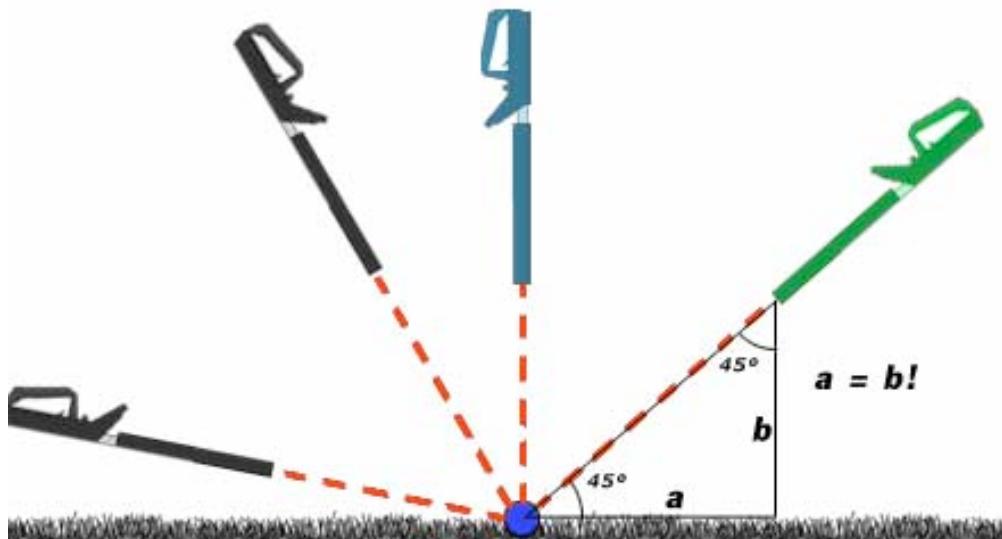
Plug the supplied cable set into the jack on the side of the BuzzBox. Connect the red clamp to the line, that is, the cable or cord you are using for this exercise. It must make a good electrical connection, so clean off any rust or insulation that might compromise this (on an extension cord, just clamp 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. You might want to pour a cup of water around your ground rod if the earth is very dry. 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".



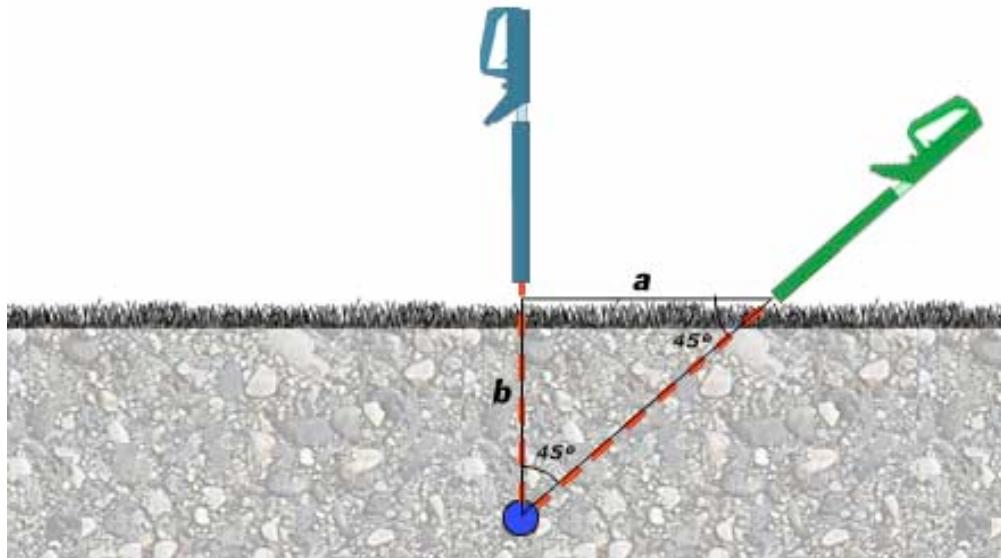
The technique for locating a line energized conductively is the same as for inductively, so go ahead and walk the line again to see how it works. In general, you will find that the signal is stronger and more distinct in the Conductive mode.

## What About Depth?

It is very easy to determine the depth of a line you are tracing with this equipment. First, let's look at some facts of physics. Here's a picture of a receiver (the blue one) getting a null signal when it is pointing straight down at the energized line, just like we've seen so far. But get this - the other receivers in this picture are all picking up the null also. Why? Because they are pointed directly at the line. This is very useful: anytime you encounter a null, it means the antenna is pointing straight at the line, at right angles to its run.



Take a look at the green receiver on the right. It is being held at a  $45^\circ$  angle to the ground, and pointed directly at the line, and getting a null. Look at the triangle that is formed when you hold the receiver at this angle. A  $45^\circ$  right triangle, like we have formed, always has 2 sides of equal length, by definition. That means the length of side **a** is the same as side **b**. It also means that since we can measure how far the end of the receiver's antenna is from the center null point (side **a**) we automatically know that the height of the end of the antenna above ground, or the "depth", is the same distance (side **b**).

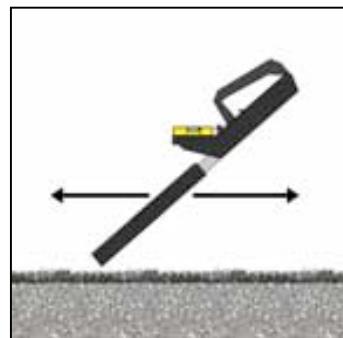


When you visualize this as working with a hidden underground line, it is even clearer. Measure distance **a**, from the end of the antenna to the center of the line as you have determined from the earlier steps of walking the line. The depth of the line (**b**) is the same distance!

How do you be sure you're holding the receiver at exactly 45°, and how do you find this magic spot? It's made easy by the fact that the AR-1 receiver's meter panel forms an angle of exactly 45° with the base of the receiver. So the application of a simple bubble level to this surface solves the first problem.



A bubble level on the meter panel will tell you when you are holding it at 45°



Hold the receiver at this angle as you move back and forth until you find the null point.

Mark the position of the line with the receiver held vertically, then move away from the mark at right angles to the line you have been walking. Turn the receiver to 45° and move it slowly toward and away from the line until you hit the null spot. Measure from the end of the antenna to your mark, and there you have it!

## Finding a Place to Start

Last but not least, how do you start tracing a line when you don't know very well where it runs? In this exercise we can see the whole thing, so there's no mystery. And in actual locating, you had to have found one end of the line to connect your BuzzBox to, so you have a good starting point. But it's possible to lose track of it along the way and you need to pick it up again.

The best way to make initial contact with a line that is energized by the BuzzBox is to do a Peak search. This is simply a process of listening for the tone generated by the box and finding a spot where it is at maximum level. This is done by holding the receiver horizontally, at waist height, just like you do when doing the initial search for a sonde. In this case, the peak spot will be when the antenna is directly above the energized line with the antenna perpendicular to the line. When you have found such a point, visualize the line as running below you left to right, and resume locating it by holding the antenna vertically and swinging it in the familiar arc. Try this with your practice setup and see how easy it is.



The signal is strongest when you cross the line with the antenna at right angles to it

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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!