

## What is a Locating Circuit?

The art of locating is based upon detecting electrical current on a target conductor, usually a pipe, cable or tracer wire, underground. A transmitter is used to apply electrical current to the target line and a receiver is used above ground to detect the electromagnetic fields generated by this current. In almost all cases, more current flowing through the target conductor, will provide a stronger signal that is easier to locate accurately.

Electrical current can only flow if a circuit is present. A locating circuit is a closed loop between a transmitter and a conductor. The loop is created when current flows from the transmitter, through the conductor (utility), and then back to the transmitter. The better the circuit, (less resistance) the more efficiently the current can flow, and the stronger the locatable signal. In this article we will explore what makes a good locating circuit for locating underground utilities and how to increase current flow to make locating easier and more accurate.



Basic locating circuit. Click image to play video clip.

### Circuit Essentials

#### 1. Connection Point

Solid metal-to-metal contact between the transmitter's clip lead and the connection point is essential for the efficient transfer of signal energy (current). Scrape away any paint, dirt, or corrosion, and work the clip's teeth into the connection point to get good metal-to-metal contact. The better the contact the less resistance there will be to current flow.



Good contact at the connection point aids current flow.

#### 2. Achieving current flow on the **target utility**

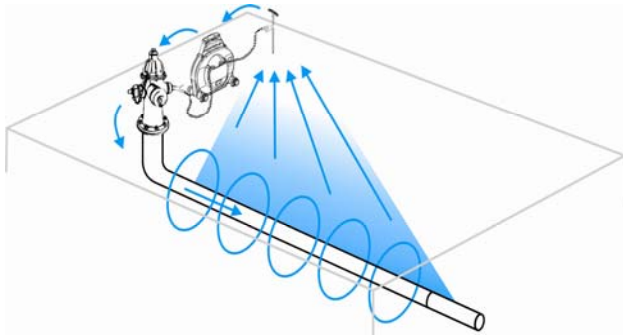
For current to flow, and signal to be generated, the target utility must be continuously metallic down it's entire length. PVC, XLPE, AFC and clay are non-metallic, and therefore not conductive. Also, insulated joints or gaskets can stop or impede the current's flow, depending on the frequency being transmitted. (See the article on Frequency for more information on this topic.)

Like water flowing downhill, the locating signal (current) will follow the circuit that offers the lowest resistance path to ground. If an alternate conductor offers a lower resistance path than your target utility, the majority of the signal will flow down the alternate conductor instead of the one you want to locate. A common example for this is when the target utility shares a common bond (ground) with another metallic conductor that has an easier path to ground.

If the target conductor is insulated, the insulation must be intact. Broken insulation can allow the signal to leak off the line at that spot. This can limit your ability to locate past that point, and in some cases the signal may jump onto an adjacent non-insulated metallic conductor. If this happens, you could mark the wrong utility.

Insulated conductors must be grounded at the far end. Otherwise, current will have more resistance because it is contained within the insulation barrier. (higher frequencies can overcome this limitation to some extent; see the article on Frequencies for more information).

If the conductor is not insulated, the signal will transfer its energy into the surrounding soil as it travels down the line. Higher frequencies "bleed off" to ground faster, limiting the line's locatable distance.



Non-insulated conductors achieve ground by transferring energy directly into the surrounding soil.

### 3. The path back to the transmitter’s ground stake

The soil is the signal’s return path back to the transmitter so the type and condition of the soil can greatly affect your circuit. Moist, compactable soil is highly conductive and offers less resistance than dry, sandy soil. In poor soil conditions, a great deal of the signal can be lost as it “fights” its way back to the transmitter. Extremely poor soil conditions may prevent any signal (current) from flowing.

### 4. The transmitter’s ground

Connecting the transmitter’s remaining lead to ground “closes the loop” and completes the circuit. A low-resistance ground is an essential part of your circuit because it helps transfer energy efficiently from the soil to the transmitter with minimal signal loss. See the article on Grounding for tips on getting the best ground possible.



A good ground transfers energy efficiently from the soil to the transmitter, “closing the loop” to create a circuit.

### Things to remember

- **A good circuit** – Has low resistance to the flow of electrical current through the target

utility. The utility, the earth, the ground rod and all of their connection points contribute to the resistance to overall current flow. Actions taken to lower any resistance will help increase current flow.



Click image to play video clip.

- **Grounding** – Make sure that both your transmitter and the far end of insulated lines are well grounded. These connection points “close the loop” to complete your circuit.
- **Type of Soil/Moisture Content of Soil** – Moist, clay soil is highly conductive; dry, sandy soil is not.
- **Conductivity of Target line** – Continuously metallic lines are good conductors, non-metallic utilities do not conduct.
- **Continuity of Target Line** – Insulators or gaskets between sections can impede or block current flow, especially at lower frequencies.
- **Common Bonding of multiple utilities** – This creates many paths for current to flow. It confuses the locate and robs current flow from the target line.
- **Presence of other lines** – Adjacent conductors can draw current off target line even if they are not directly bonded.
- **More current makes locating easier and more accurate** – The downside to using the maximum power setting is shorter battery life. To maximize both accuracy and battery life, a good rule of thumb is to set the transmitter’s output to the point where you have a strong, steady and clear signal over the distance you need to locate.