Locate Theory and Equipment Operations

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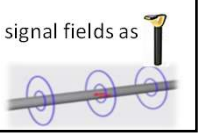
Presentation Overview

- Science of Locating
- Frequency
- Types of Signals & Application
- Search, Pinpoint & Tracing Signals

1

Science of Locating

- A locatable signal field is created when current flows back and forth along a conductive circuit at a known frequency
- The signal field takes the shape of the conductor
- For current to exist it needs a source and a conductive pathway to flow
- If no current flows on a conductor, no signal is produced on the conductor
- Locating receivers detect & measure signal fields as they broadcast away from the line



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Electrical Circuit or Medium

- A circuit is an electrical pathway of least resistance in which applied current travels the path of least resistance to and from the power source

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A Locatable Circuit

Locatable Circuit Components:

- AC Transmitting Source (transmitter)
- Metallic conductor with electrical continuity (conductive cable or pipe)
- Earth/Soil

Points to ponder

- A good circuit has low resistance to the flow of electrical current through the conductor and through the soil
- Circuit resistance is the combination of the resistance of the soil, underground line and the resistance created at the connection points of the transmitter.

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Good Conductors of Electricity

- Good conductors of electricity means current can flow easily due to low resistance
  - Moist soils
  - Metals
    - Copper (CU)
    - Cast iron (CI)
    - Ductile iron (DI)
    - Aluminum (AL)
    - Steel (STL)
    - Corrugated metal (CMP)
  - Good Connection Points
    - All physical connection point represent a certain amount of resistivity to current flow within a circuit
    - Extra time should be taken to ensure a good metal to metal connection is made between the signal transmitter, the underground facility to be located and an independent grounding stake.

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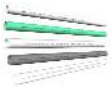
Bad Conductors of Electricity

- Bad conductors of electricity means current cannot flow easily due to <u>high resistance</u>
  - Dry Soils & Bad Connection Points
  - Rubber, plastics, cement, wood, clay
    - Poly vinyl chloride (PVC)
    - Polyethylene (PE or HDPE)
    - Transite – asbestos / cement (ACP)
    - Cement, mortar, or concrete (CMC)
    - Clay (VCP)
    - Fiberglass

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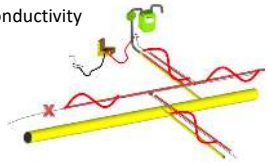
Good Conductors with poor continuity

Insulators, gaskets and breaks in continuity can greatly reduce or block the flow of electrical current

Resistors to current flow:

- Pipe insulators or insulated flanges
- Poor connections points within circuit
- Bad test wire or poorly connected lead
- Dry soils or soils with low conductivity
- Broken connection lead

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Frequency

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Choosing the Best Frequency

- Selecting the best frequency for the job is critical to success. You should always use the lowest frequency that will produce a traceable signal over the distance you need to cover.
- The ideal frequency for one scenario may be the worst frequency choice for another scenario.

Circuit Resistance	Optimum Frequency
0-2K Ohms	477Hz - 8kHz
2K-6K Ohms	Low, 8kHz-20kHz
7K - 10K Ohms	20kHz-83kHz
10K Ohms +	83kHz +

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Tips for frequency choice

- Use lowest possible power and frequency settings to achieve a clean traceable signal throughout the entire area you need to locate. Higher frequencies tend to bleed off to nearby lines
- Increase power output before increasing frequency. The higher the frequency ranges have greater chance for bleed-off onto other nearby conductors in the ground, choose wisely.
- Very high frequencies should be used as last resort or if there is a need to "light everything up" in the ground through direct connection or induction
- Start with mid to high range frequency for signal induction

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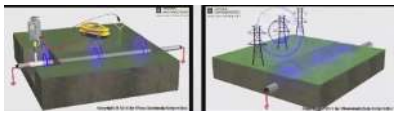
2 Types of Detectable EM Signals



- Active Signal – produced and applied by transmitter
- Passive Signal – signal already present and produced by external forces

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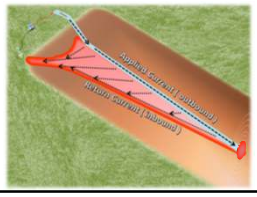
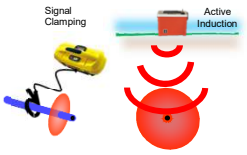
Active Signals

- Actively applied and produced by an EM signal transmitter
- Active Signal Application Methods
  - Direct Connection: (metal to metal contact) is made between the transmitter's wire leads attached to the conductor and the ground stake
  - Inductive (non-metal to metal broadcast) is applied with induction clamp or inductive signal broadcast from transmitter to conductor

Direct Connection



Signal Induction



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Direct Connection Signal Broadcast

- "Locating Best Practice" should be first choice for applying an active signal if possible to directly connect to your target line
- Applied current will flow along the path of least resistance along a conductive circuit

- When attaching transmitter clips, insure good metal to metal connection between clip and conductor.
- Place ground stake at 90-degree angle from the expected path of the line
- Better grounding = better signal
  (add water if necessary, to improve signal)

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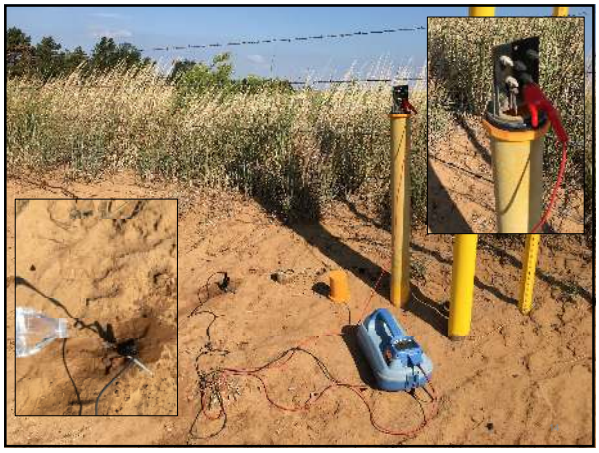

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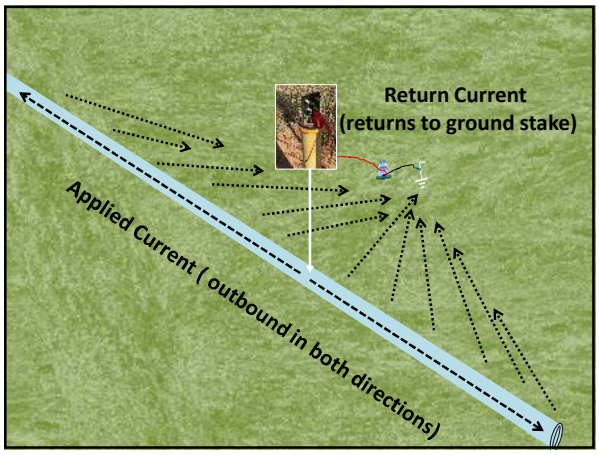

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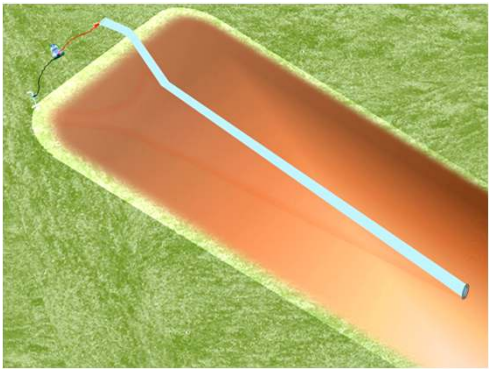
Placing the temporary ground



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A few tips on grounding

- Do not place ground over or towards adjacent buried lines
- Do not place ground on the other side of adjacent lines
- Do not place ground close to metallic fences that run parallel with target line
- A shovel or probe usually provides a better grounding point
- Add water to ground stake to improve grounding potential

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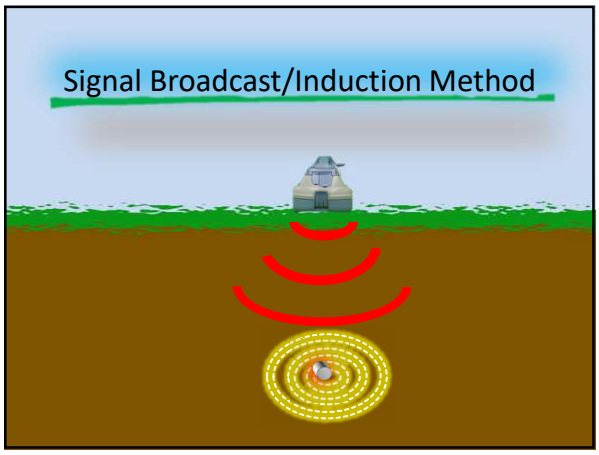

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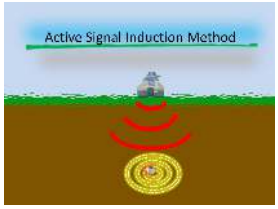
Active Signal Inductive Broadcast

- Used when access point is unavailable or not close enough
- Can be used to verify locate markings
- High risk method but often the only choice for locators to apply current indirectly to the conductor



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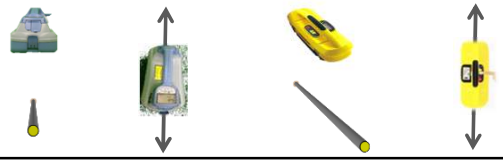
Transmitter Placement

Conductor Direction Indicator shows you how to position the transmitter over the expected path of a buried pipe or cable

If conductor direction indicator is not printed on your transmitter, line the handle up with the expected path of the buried pipe or cable



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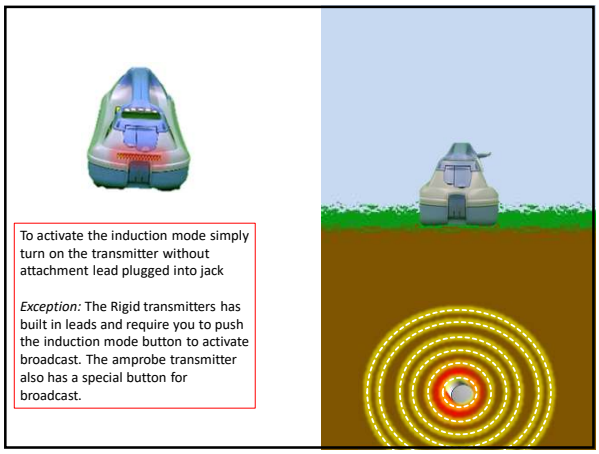
To activate the induction mode simply turn on the transmitter without attachment lead plugged into jack
Exception: The Rigid transmitters has built in leads and require you to push the induction mode button to activate broadcast. The amprobe transmitter also has a special button for broadcast.

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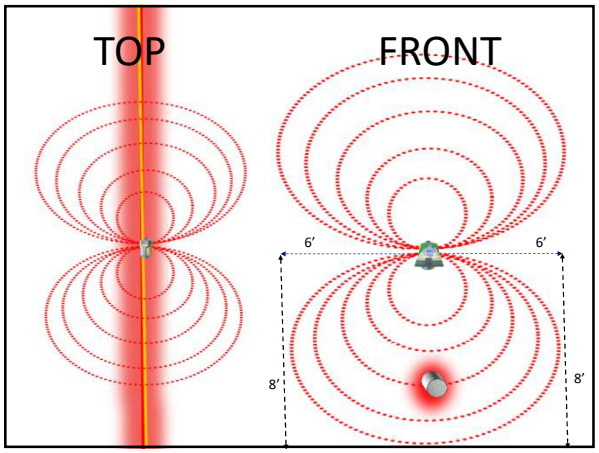
TOP
FRONT
6'
6'
8'
8'

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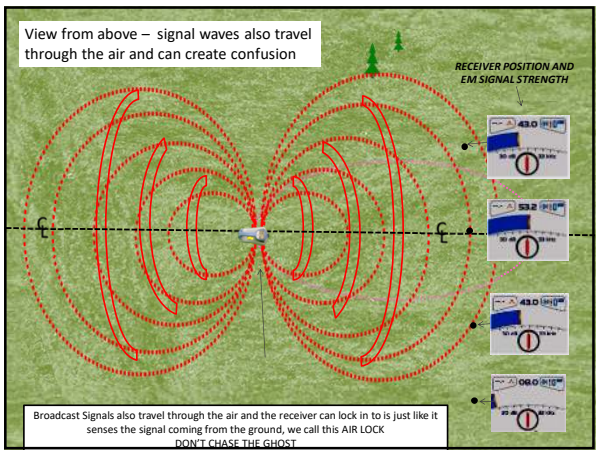
View from above – signal waves also travel through the air and can create confusion
RECEIVER POSITION AND EM SIGNAL STRENGTH
Broadcast Signals also travel through the air and the receiver can lock in to is just like it senses the signal coming from the ground, we call this AIR LOCK
DON'T CHASE THE GHOST

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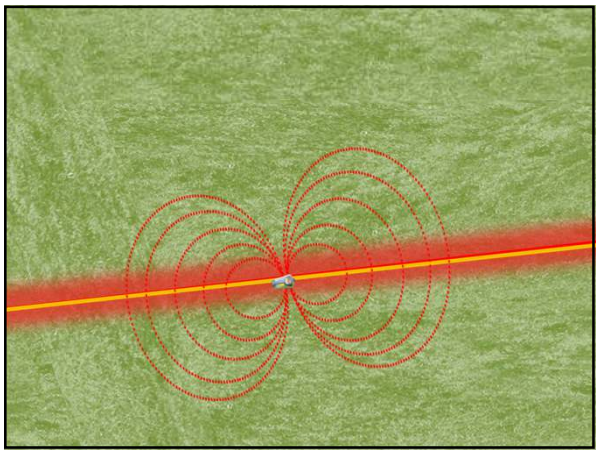

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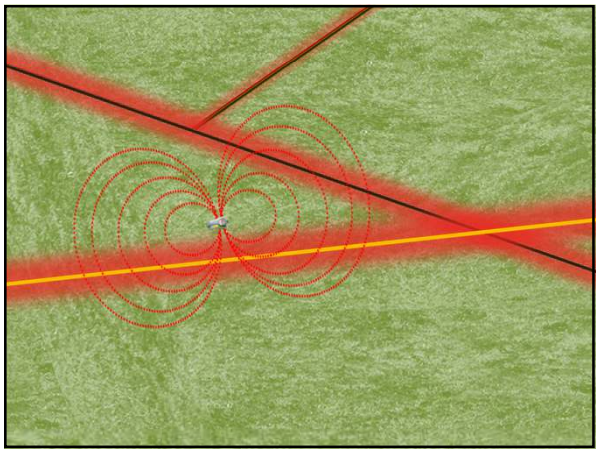

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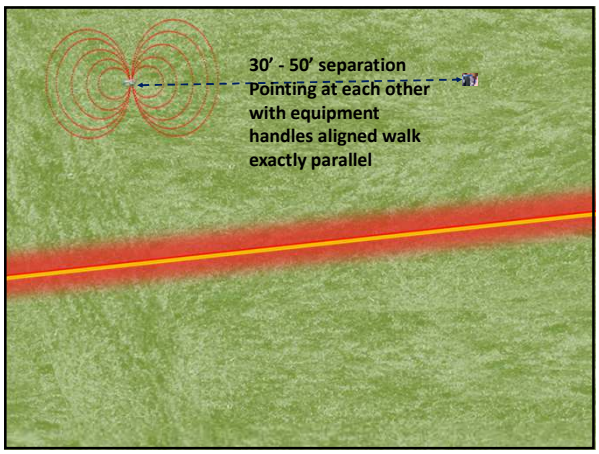
30’ - 50’ separation
Pointing at each other
with equipment
handles aligned walk
exactly parallel

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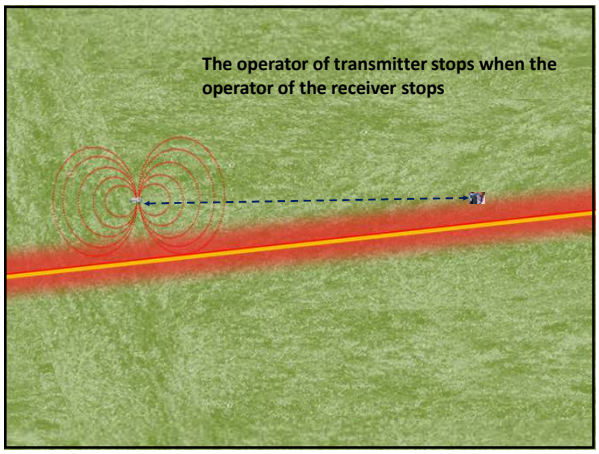
The operator of transmitter stops when the operator of the receiver stops

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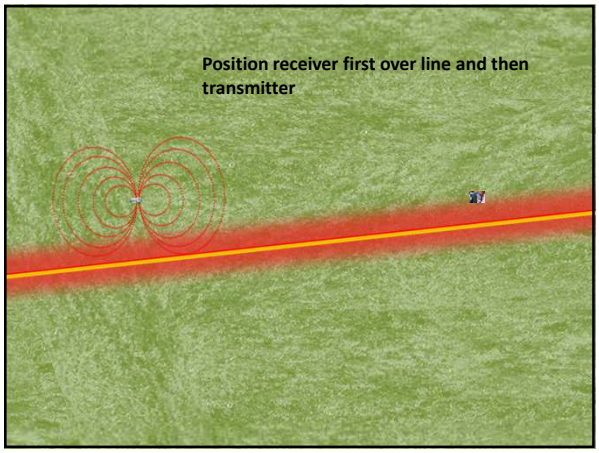
Position receiver first over line and then transmitter

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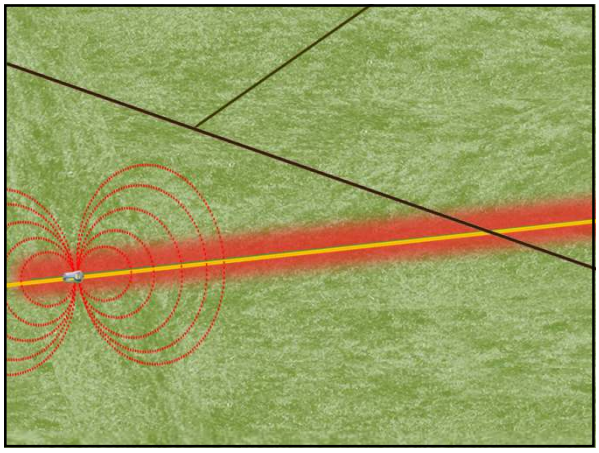

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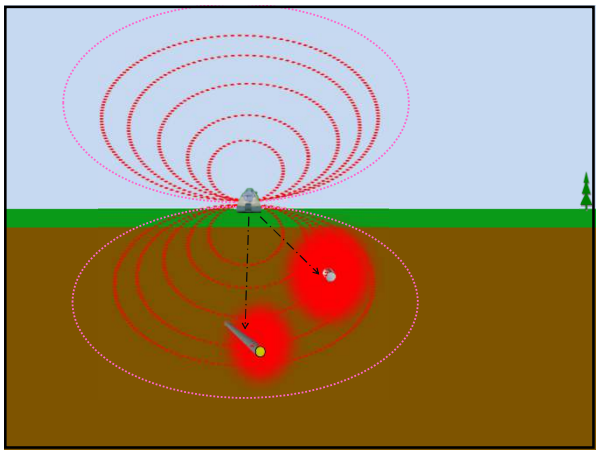

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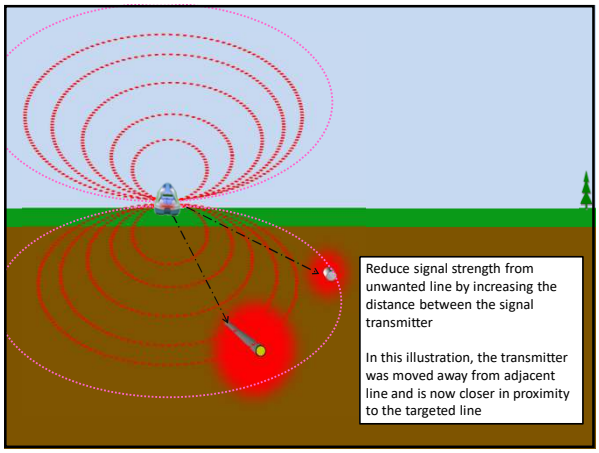
Reduce signal strength from unwanted line by increasing the distance between the signal transmitter
In this illustration, the transmitter was moved away from adjacent line and is now closer in proximity to the targeted line

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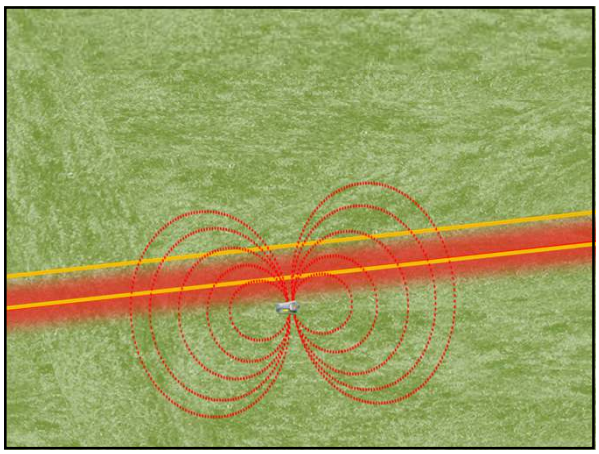

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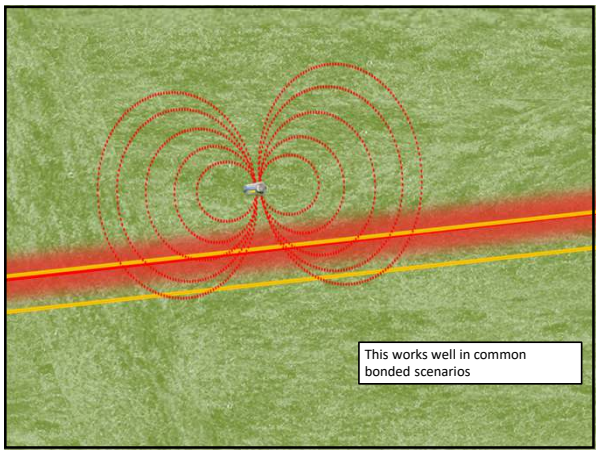

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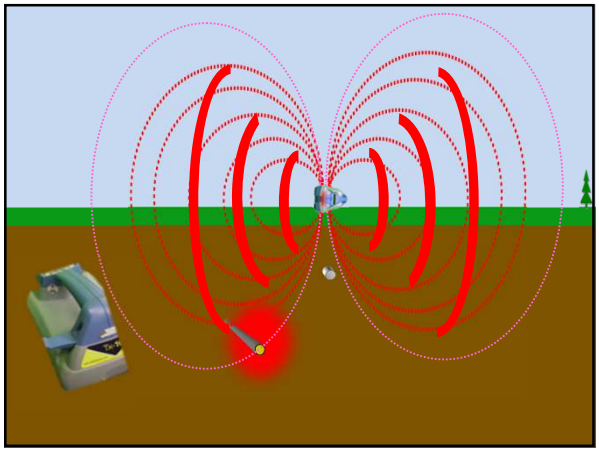

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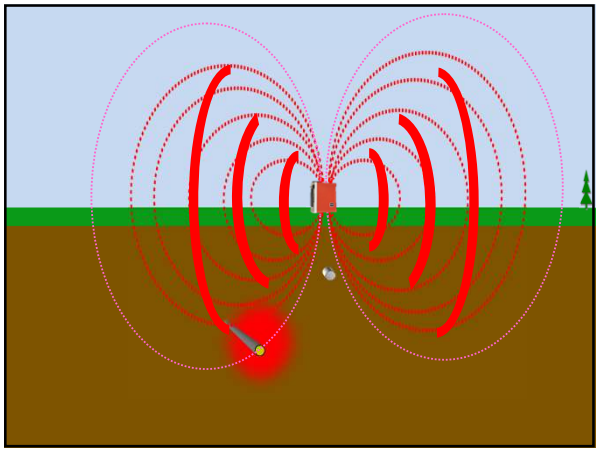

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Active Signal Inductive Broadcast

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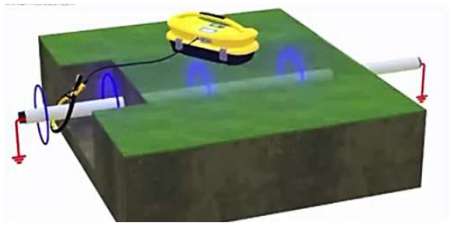
Active Signal Ring Clamp Accessory

- Primarily used for cable locating
- Ring clamp should be placed between two grounding points of the cable



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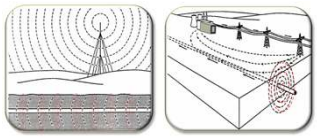
Passive Signals



- Occur “naturally” on underground lines as the result of signal broadcast or radiation from outside sources
- Created by various sources
  - CPS /CP120 (cathodic protection signal)
  - 60Hz Power (Signal created by power systems return currents)
  - Radio (radio signal radiation)
- Underground facilities provide paths of least resistance for passive currents to flow along
- Are almost always present to some level on most metallic underground facilities with electrical continuity including steel gas lines, telephone cables and power cables

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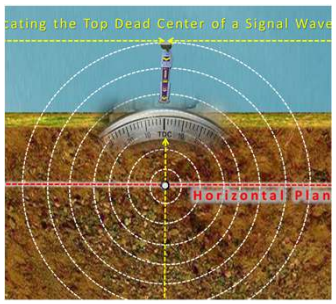
Signal Receivers



- Detect signal fields broadcasting and known frequencies
- Designed to find (TDC) Top-Dead-Center of a perfectly round signal field
- Can determine location, orientation and depth
- Have auto or manual gain to adjust sensitivity

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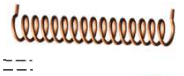
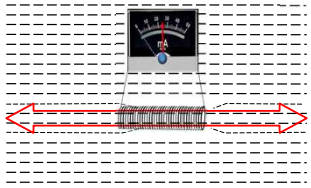
Receiving Antenna





- A receivers sensor or receiving antenna is constructed of a coil of wire normally wrapped around a metal or ferrous rod which channels more magnetic field through the coil
- Magnetic field is channeled through coil in antenna and induces current onto the coil of wire” which is read as signal strength

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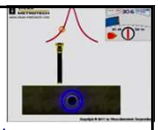
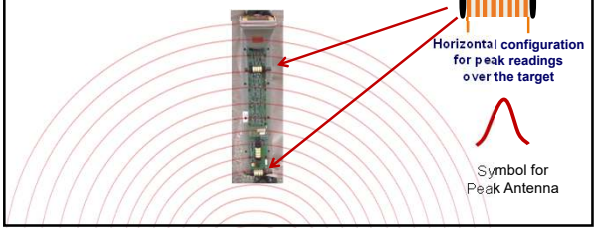
Twin Peak Mode



- Primary antenna for locating and pinpointing signals
- Most accurate mode when dealing with signal distortion
- Strongest response occurs when directly above facility at right angle
- Indicates facility position and orientation by twisting handle



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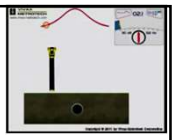
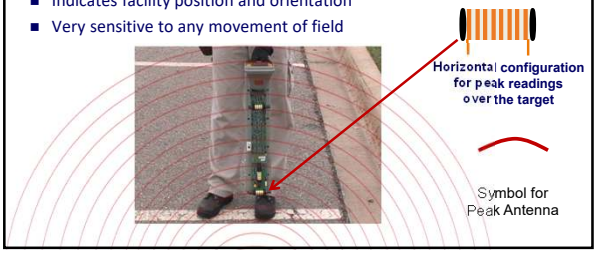
"Single Peak" Mode



- Primarily used to detect deep cables & pipes or weak signals
- Strongest response occurs when directly above facility at right angle
- Indicates facility position and orientation
- Very sensitive to any movement of field



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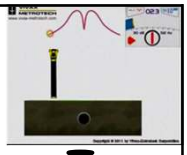
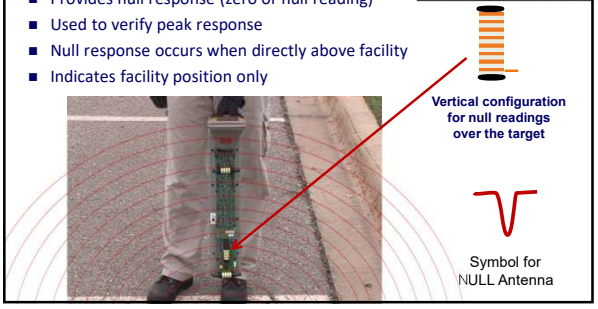
Null



- Provides null response (zero or null reading)
- Used to verify peak response
- Null response occurs when directly above facility
- Indicates facility position only



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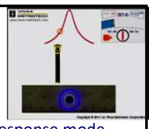
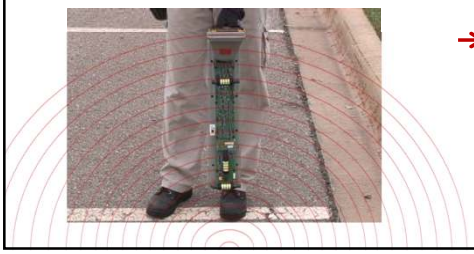
Combination Response Mode



- Both Peak and Null Mode Activated
- Peak response is the numeric readout and the NULL response mode provides the directional arrow guidance to centerline



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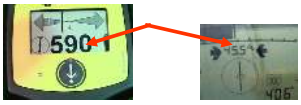
Signal Strength Reading

- Is a measurement of overall signal strength being detected by the signal receiver
- Signal strength level depends on the orientation of the receivers antennas detecting the signal, the distance between the signal receiver and target/source
- The overall signal strength or intensity level of the signal at ground level and the sensitivity/gain setting of the signal receiver



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Sensitivity Gain Control

The Gain setting controls sensitivity of receiving antenna

- **Manual Gain *controlled by user (up and down adjustment)**
  - **Adjust gain/sensitivity to match the intensity of the signal**
  - **You are in control of the volume level heard by the receiver gain control amplifies or pads down the amount of signal field traveling through the receiver coils.**
- **Auto Gain *controlled by receiver**
  - **Smart Sound – Automatic volume increase to weak signal or auto volume pad down to over/strong high level signal/sound reception**
  - **Built in sensitivity control of the sensitivity of antenna coils**
  - **Receiver is in control of the level of sensitivity it chooses for any given signal.**

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A few reasons to adjust gain control

- Adjustment is needed to keep signal reading “on scale” or within meters signal range
- Adjustments are needed when walking away from or toward transmitter
- Depth changes of utility or cover
- Drop in signal due to signal energy reduction at (signal splits) example: tee in pipe”

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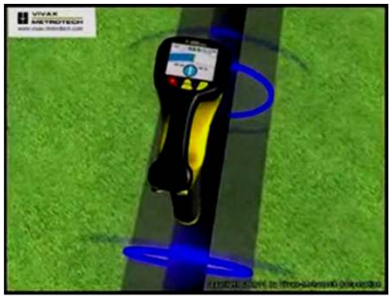
Signal Orientation (using compass antenna)



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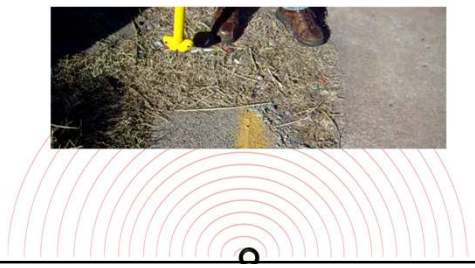
Determining the Line Orientation (without compass antenna)



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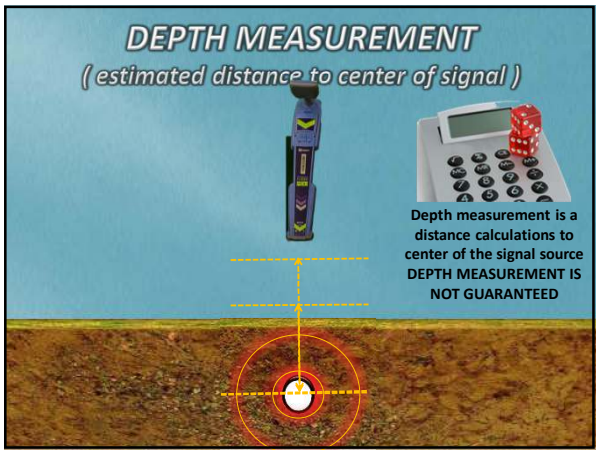

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Estimating Depth

- A few ways to estimate the line depth
  - Push button depth
  - Triangulation
- A sure way to determine depth
  - Safely expose the line and see it with your own eyes….
- Depth Reading is an estimation
  - Reading is not guaranteed
  - Prediction of the distance to the core of the signal from the bottom antenna

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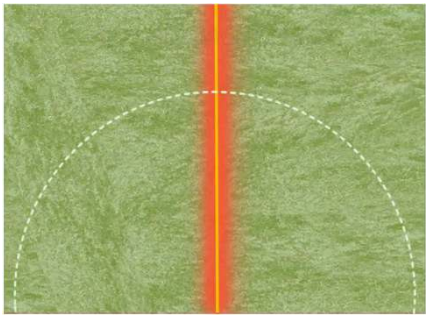
Performing a Signal Search



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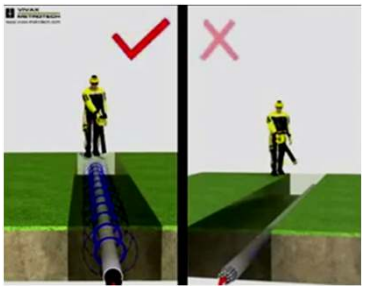
Keep Receiver Level

- Avoid swinging receiver and keep it level



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Questions

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