



LineTrac User Guide

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Geophysical Survey Systems, Inc.

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Table of Contents

- Section 1: Introduction 1
 - About this Guide..... 1
 - LineTrac Physicals..... 1
- Section 2: Electromagnetic Theory and LineTrac.....2
- Section 3: Installation3
- Section 4: Software Setup and Use with the UtilityScan Pro4
 - Configuring the SIR 4000 4
 - Power Mode 4
 - Frequency Mode..... 5
 - Data Examples: Power Mode..... 5
 - Data Examples: Frequency Mode 8
- Section 5: Software Setup with the UtilityScan DF/HS 11
 - Configuring the UtilityScan Tablet 11
 - Power Mode 11
 - Frequency Mode..... 12
 - Data Examples: Power Mode..... 12
 - Data Examples: Frequency Mode 15
- Section 6: Software Setup with the UtilityScan with Built-in LineTrac..... 18
 - Configuring the UtilityScan..... 18
 - Power Mode 18
 - Frequency Mode..... 19
 - Data Examples: Power Mode..... 19
 - Data Examples: Frequency Mode 21

Section 1: Introduction

Thank you for purchasing the LineTrac, an optional accessory for GSSI's UtilityScan® systems utilizing digital antennas. LineTrac integrates traditional utility line locator technology with GSSI's renowned ground penetrating radar (GPR) expertise. LineTrac data is seamlessly overlaid on GPR data to combine two of the most important tools used for detecting underground utilities. This guide is meant to familiarize the user with installation, setup, use and data interpretation of the LineTrac.

LineTrac is a one-piece accessory employing a three-axis magnetometer that, by itself, can detect the 50/60 Hz magnetic signal created by live, loaded alternating current (AC) electrical power lines. When paired with a third-party signal transmitter directly coupled or inductively clamped to a utility, LineTrac can detect these active signals.

About this Guide

This document discusses tips about how to collect and interpret data using LineTrac and refers to use of third-party signal transmitters. There are numerous AC signal transmitter manufacturers and products on the market and GSSI can only speak in generalities about the use of these transmitters. It is incumbent on the user to read and consult the operator's manual of any AC signal transmitter that is to be paired with LineTrac.

LineTrac Physicals

- 1 Rugged, IP 65 rated enclosure
- 2 Push-pull LEMO Connector to digital GSSI antenna
- 3 Secure four-point mounting to antenna



Section 2: Electromagnetic Theory and LineTrac

While GPR and electromagnetic line location are both termed electromagnetic techniques, the principles behind how each work are quite different. LineTrac works because of the principle of electromagnetic induction. A current flowing through a linear conductor generates a circular, magnetic field perpendicular to the conductor. This magnetic field can induce a voltage in a second conductor if this second conductor is placed in close proximity AND at the correct orientation to the magnetic field. Inside LineTrac are three such conductors, the magnetometers, in horizontal, vertical, and transverse orientations. When LineTrac moves through a magnetic field a weak current is induced in the preferentially aligned magnetometer.

A current flowing through a buried utility occurs in two general ways. The first is termed “Passive”: the utility is naturally carrying a current along its length. Examples of this are AC power lines. The second is termed “Active”: an AC signal transmitter is actively creating a current on the utility. LineTrac can detect the first in Power Mode and the second in Frequency Mode.

All currents are not created equally and detectable by LineTrac. An Alternating Current (AC) regularly changes its direction and polarity. How often this change occurs in a given time determines the frequency of the current, measured in cycles/second or Hertz (Hz). For most electrical power grids, this frequency is either 50 Hz or 60 Hz, with 60 Hz being the main frequency generated in the United States. Direct Current (DC) maintains a constant direction and magnitude and has no frequency to be detected by LineTrac. An energized AC line that is not under load (for example, an electrical wall outlet with no appliance plugged into it) has a voltage but no current. Without an AC current moving through the line there will be no magnetic field to be detected by LineTrac. The stronger the current flowing through a line the more identifiable the line will be to LineTrac. Note voltage has no effect on detectability.

AC signal transmitters have a selection of different frequencies they can generate. The exact selections will be manufacturer dependent but in general they will span from low (example 29 Hz) to high frequencies (example 33 kHz). There are advantages and disadvantages to each frequency and the proper selection of frequency will depend on many factors, including but not limited to:

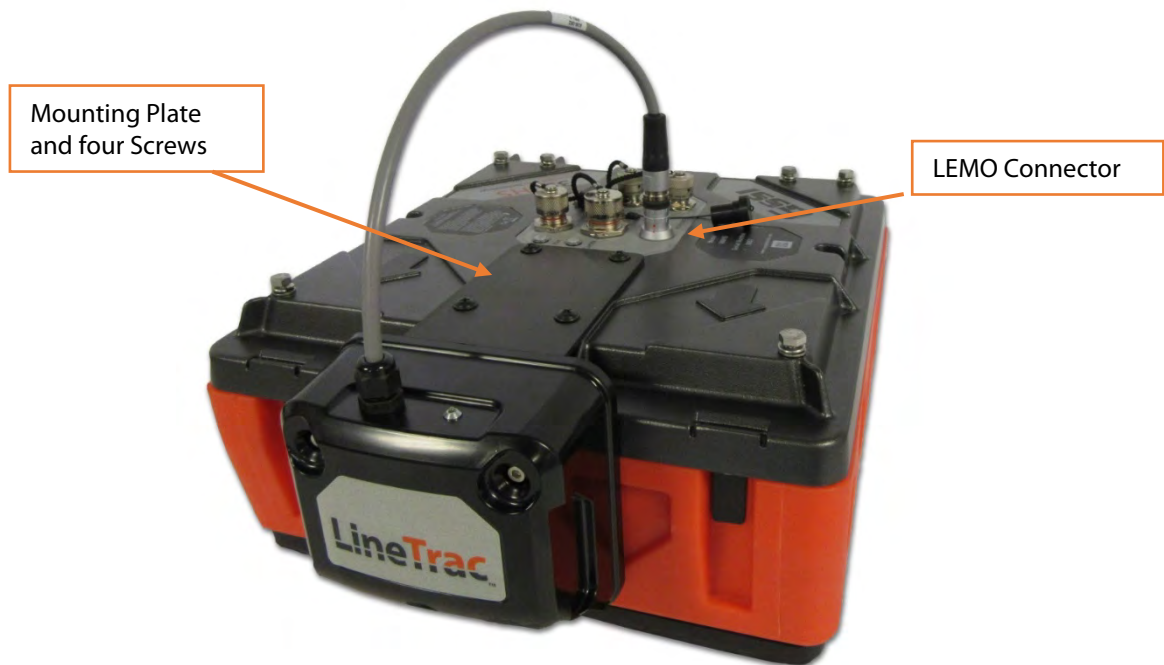
- Soil Conductivity
- Number and proximity of conductive, buried utilities in an area.
- Length/distance of the utility to be located.

The higher the frequency the better the signal can conduct along a utility. The tradeoff of this superior signal conductance is the signal can be induced (“bleed”) on neighboring conductive utilities and lead to incorrect locates. The lower the frequency the more difficult for the signal to conduct along a utility but, once established, the longer distance the signal can be detected over.

Section 3: Installation

LineTrac is simple to install on GSSI's digital antennas, the 350 Hyperstack (HS) and the 300/800 Dual Frequency (DF).

- 1** Unscrew the 4 machine screws from the top, front of the digital antenna. Align the mounting plate of the LineTrac over the holes and reinstall the 4 machine screws to secure the LineTrac.
- 2** **Note:** If using the digital antenna battery bracket or the antenna handle mount (AKA shark fin) in conjunction with the LineTrac, the two are installed as a stack with the LineTrac on the bottom and the other accessory on top.
- 3** Push the LEMO connector on the end of the cable into the Accessory port of the digital antenna, making note line up the red dot on the connector with the red hash mark on the accessory port. Assemble the rest of the UtilityScan system.
- 4** **Note:** There is only one proper alignment to plug the LineTrac connector into the antenna port. Forcing the connector into the port using an incorrect alignment may result in damage to the connector and/or the port.
- 5** It isn't necessary to install and remove LineTrac for each use but to unplug the LEMO connector from the digital antenna, firmly grasp the connector below the black, rubber gasket and pull up. Grasping and pulling from the top of the connector or the cable may result in damage to the LineTrac.
- 6** When LineTrac is properly attached and the UtilityScan system is powered ON, a green light on top of the LineTrac will illuminate. If the light doesn't illuminate unplug the LEMO connector and inspect for damage. LineTrac can be plugged/unplugged to a powered antenna with no damage to LineTrac or the antenna.



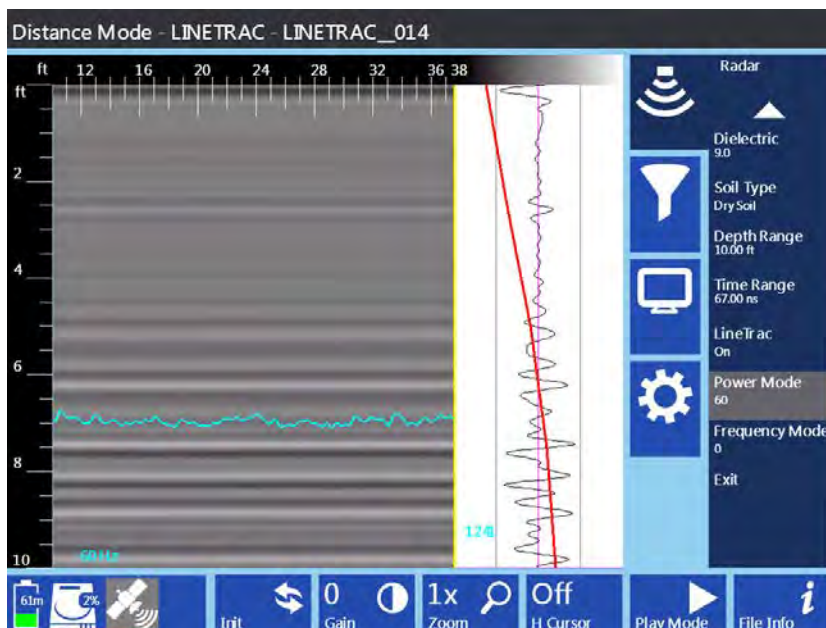
Section 4: Software Setup and Use with the UtilityScan Pro

Configuring the SIR 4000

The SIR 4000 control system is the heart of the UtilityScan Pro system. Using the Digital 2D mode of the SIR 4000 will allow the user to configure the LineTrac settings. Please refer to the SIR 4000 User Manual for a comprehensive discussion of all other SIR 4000 settings and functionality.

Turning on LineTrac: Before changing the collection settings of LineTrac it first must be activated. This is done on the Setup Screen in the Radar Menu, where LineTrac is the last setting and defaults to Off.

- 1 Highlight LineTrac, press Enter to select the menu.
- 2 Change the setting to On, then press enter again. Power Mode and Frequency Mode will now be visible.



Power Mode

This mode is used to detect AC current flowing through energized electric lines. LineTrac can detect AC current with frequencies of 50 Hz or 60 Hz, the two predominant frequencies of electrical power grids worldwide.

- 1 Highlight Power Mode and press Enter to activate the setting.
- 2 Select 50 or 60 from the menu and press Enter.
- 3 The data preview screen will reset and you will see a blue line superimposed on the GPR data. This blue line is the LineTrac data and upon setup will appear quite ragged, with the exception if the UtilityScan system is being setup in very close proximity to a 60 Hz current (not recommended).

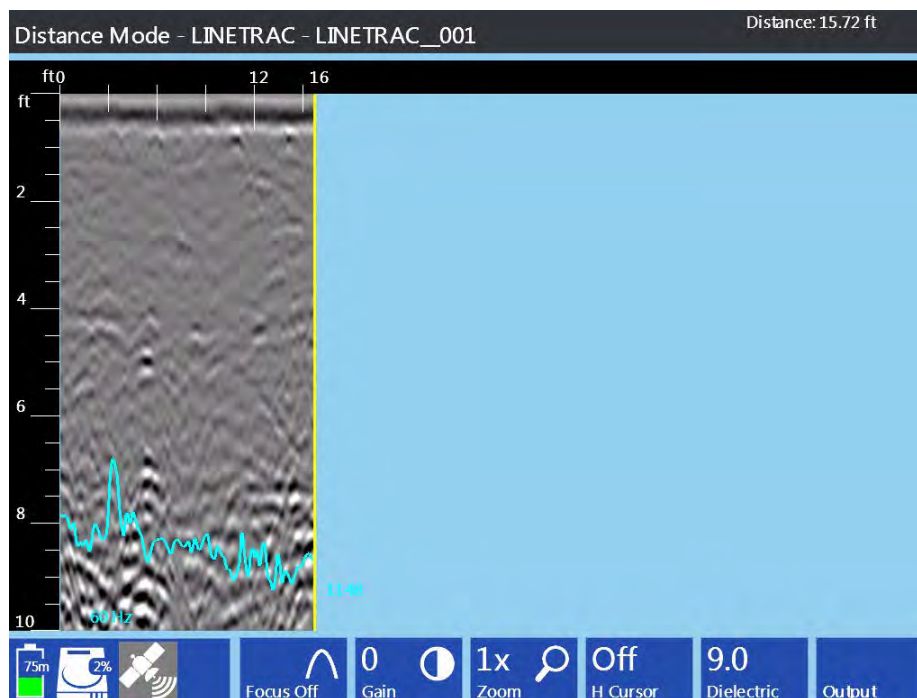
Frequency Mode

This mode is used to detect the AC current flowing along a conductive utility generated by an AC signal transmitter. LineTrac can detect a wide range of AC signals with 12 industry standard frequencies selectable.

- 1** Highlight Frequency Mode and press Enter to activate the setting.
- 2** Select the frequency to match the signal being generated by the signal transmitter from the menu and press Enter.
- 3** The data preview screen will reset and you will see a yellow line superimposed on the GPR data. This yellow line is the LineTrac data and upon setup will appear quite ragged, with the exception if the UtilityScan system is being setup in very close proximity to the AC signal transmitter (not recommended).

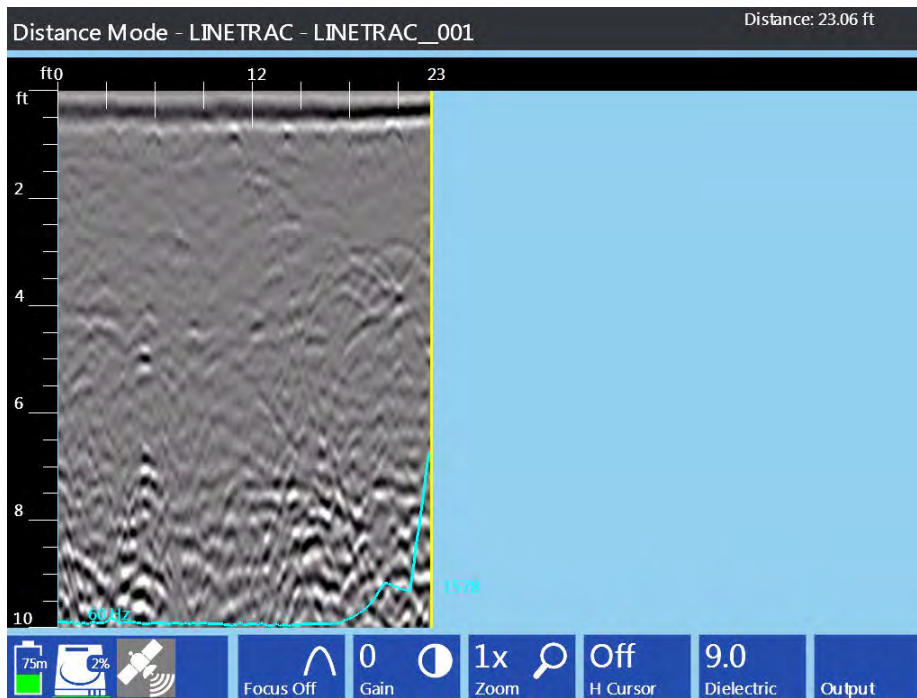
Note: It is possible to collect both Power and Frequency data at the same time, though it can create a cluttered data screen.

Data Examples: Power Mode



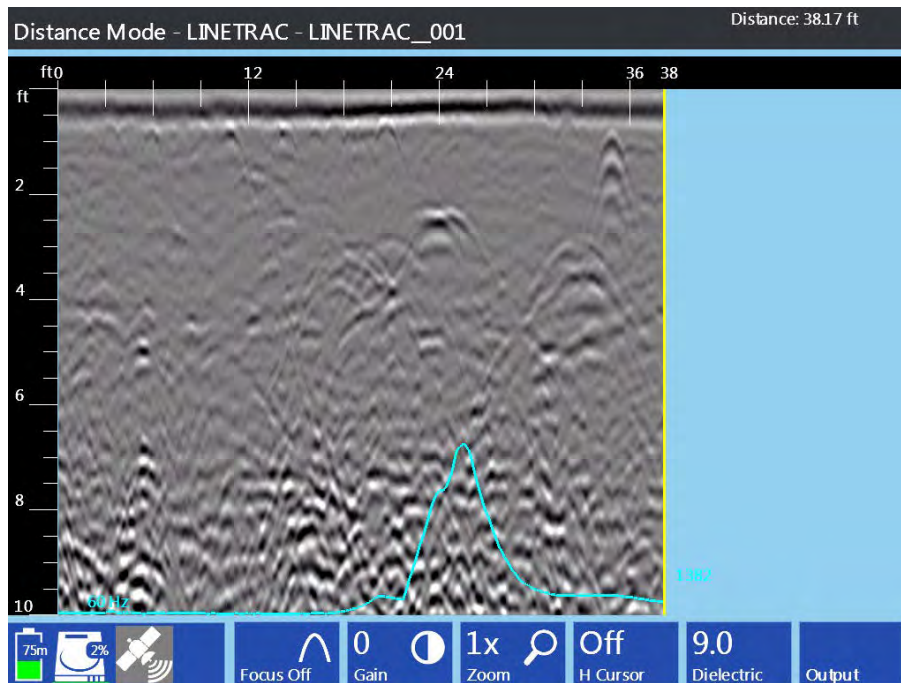
UtilityScan Pro Power Mode: Data Set 1-A

The above image shows the ragged blue LineTrac data characteristic of no detectable flowing current. What the LineTrac is recording and displaying is the ambient AC signal present in the background. Most GPR data collected with LineTrac will initially look like this.



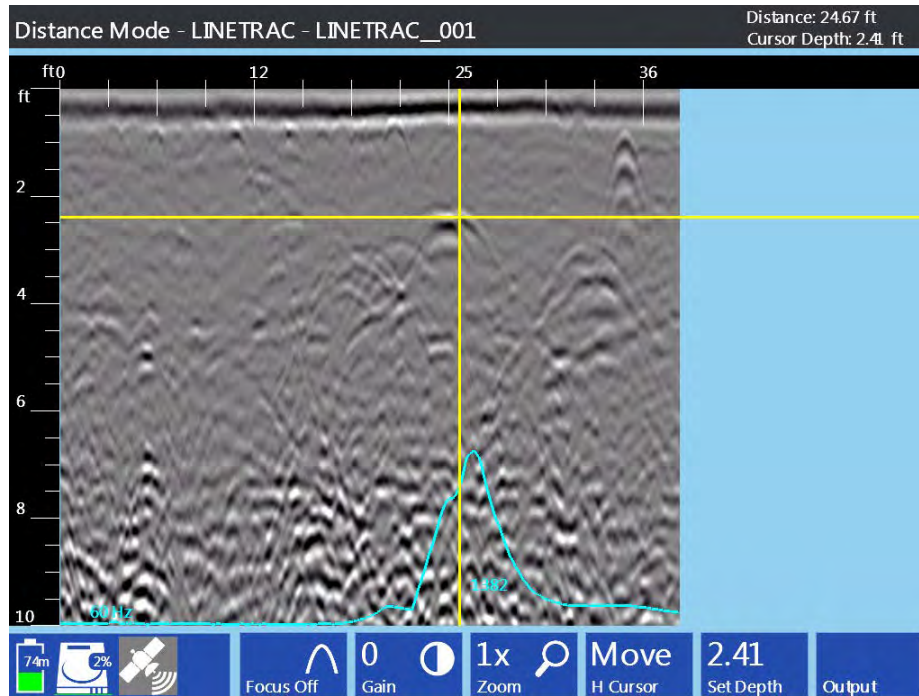
UtilityScan Pro Power Mode: Data Set 1-B

The above image is a continuation of the preceding image, but the UtilityScan system is approaching a buried electric line. The LineTrac data automatically rescaled as a stronger AC current was detected.



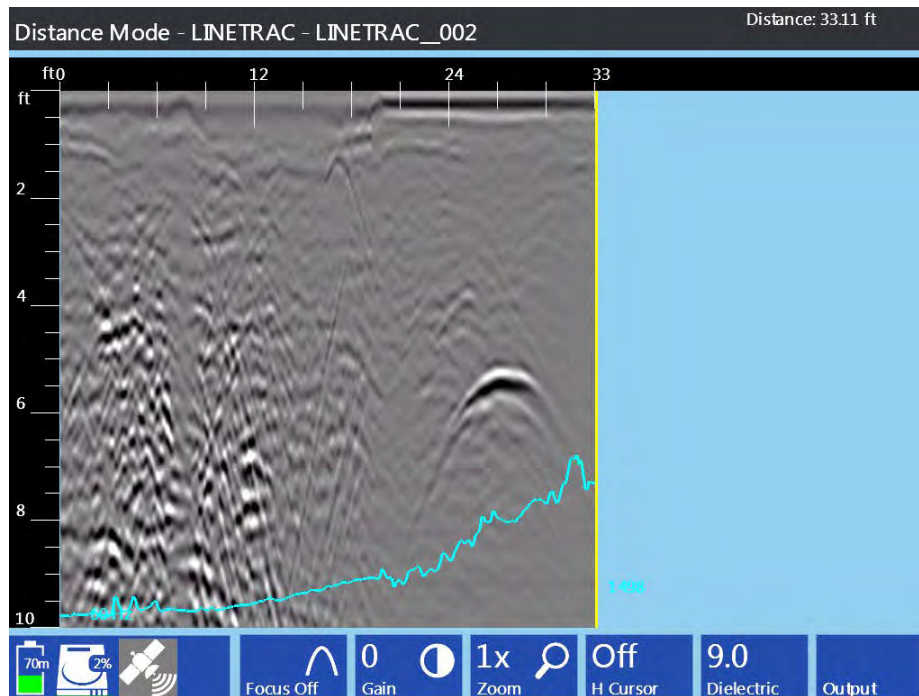
UtilityScan Pro Power Mode: Data Set 1-C

The above image is a continuation of the preceding image and the UtilityScan system has completed traversing the buried electric line. The LineTrac data displays a completed peak with a slight null point at its midpoint and there is a corresponding reflection in the GPR data.



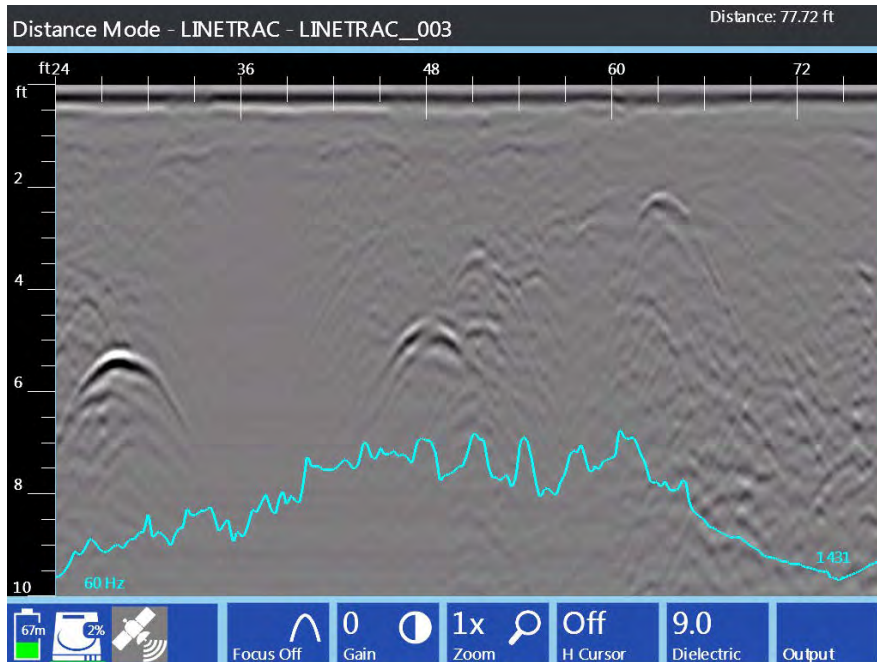
UtilityScan Pro Power Mode: Data Set 1-D

The UtilityScan’s backup cursor function was used to identify the GPR reflector corresponding with the LineTrac data, and the horizontal cursor used to determine the depth of the buried electrical line.



UtilityScan Pro Power Mode: Data Set 2-A

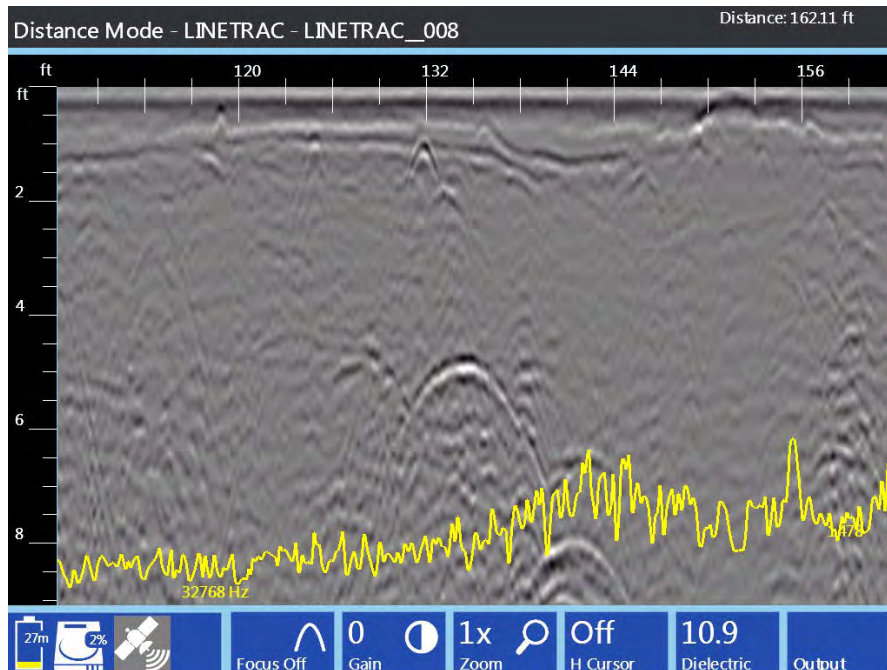
The above image shows data collected crossing a road with overhead power lines on the far side. The LineTrac data has rescaled itself and is beginning to “ramp up” but the UtilityScan system is still approximately 20 feet from being under the power lines.



UtilityScan Pro Power Mode: Data Set 2-B

The above image is a continuation of the preceding image and the UtilityScan system has completed crossing under the overhead lines. A very broad hump is displayed instead of a sharp peak.

Data Examples: Frequency Mode



UtilityScan Pro Frequency Mode: Data Set 1-A

The above image shows the ragged yellow LineTrac data characteristic of no detectable tracing frequency. A 33kHz signal has been coupled to a buried natural gas line but the UtilityScan system is still some distance away. Again, most GPR data collected with LineTrac will initially look like this.



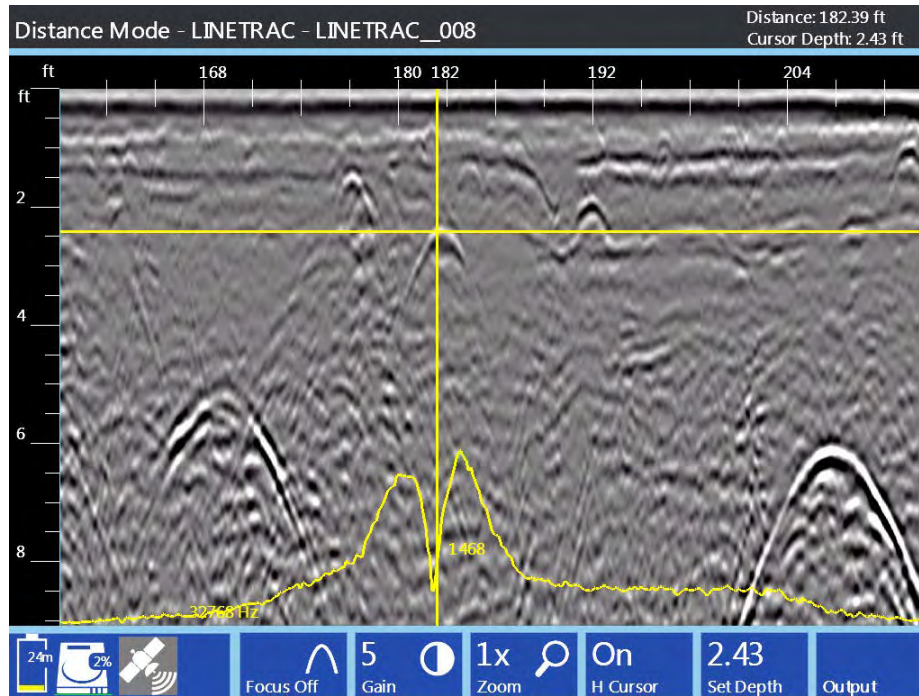
UtilityScan Pro Frequency Mode: Data Set 1-B

The above image is a continuation of the preceding image, but the UtilityScan system is approaching the buried gas line. The LineTrac data automatically rescaled as a stronger 33 kHz signal was detected.



UtilityScan Pro Frequency Mode: Data Set 1-C

The above image is a continuation of the preceding image and the UtilityScan system has completed traversing the buried gas line. The LineTrac data displays a completed peak with a distinct null point at its midpoint and there is a corresponding reflection in the GPR data.



UtilityScan Pro Frequency Mode: Data Set 1-D

The UtilityScan's backup cursor function was used to identify the GPR reflector corresponding with the LineTrac data, and the horizontal cursor used to determine the depth of the buried gas line.

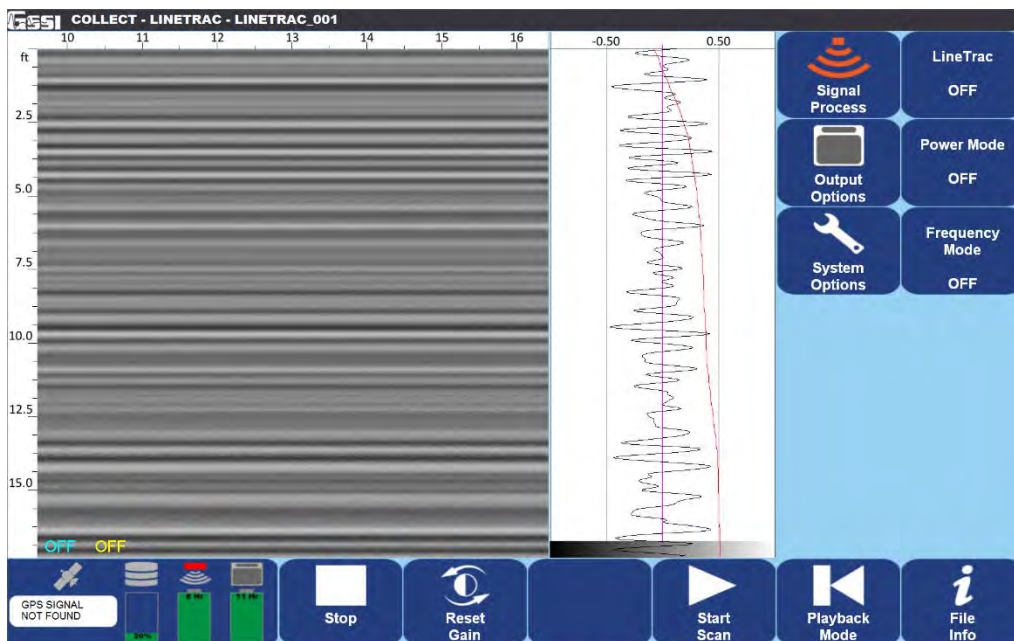
Section 5: Software Setup with the UtilityScan DF/HS

Configuring the UtilityScan Tablet

GSSI's digital antennas are capable of operating with specially prepared Panasonic Toughbook tablet computers. Whether pairing the LineTrac with an UtilityScan DF or UtilityScan HS the operating software is the same. Using the 2D mode of the UtilityScan DF/HS will allow the user to configure the LineTrac settings. Please refer to the UtilityScan DF or HS Quick Start Guide for a comprehensive discussion of all other UtilityScan settings and functionality.

Turning on LineTrac: Before changing the collection settings of LineTrac it first must be activated.

- 1 This is done on the Setup Screen in the Signal Process Menu, where LineTrac is the fourth setting and defaults to Off.
- 2 Press LineTrac and Power Mode and Frequency Mode will be visible.



Power Mode

This mode is used to detect AC current flowing through energized electric lines. LineTrac can detect AC current with frequencies of 50 Hz or 60 Hz, the two predominant frequencies of electrical power grids worldwide.

- 1 Press Power Mode and select 50 or 60 from the menu.
- 2 Press the check mark button to set the power frequency. The data preview screen will reset and you will see a blue line superimposed on the GPR data. This blue line is the LineTrac data and upon setup will appear quite ragged, with the exception if the UtilityScan system is being setup in very close proximity to a 60 Hz current (not recommended).

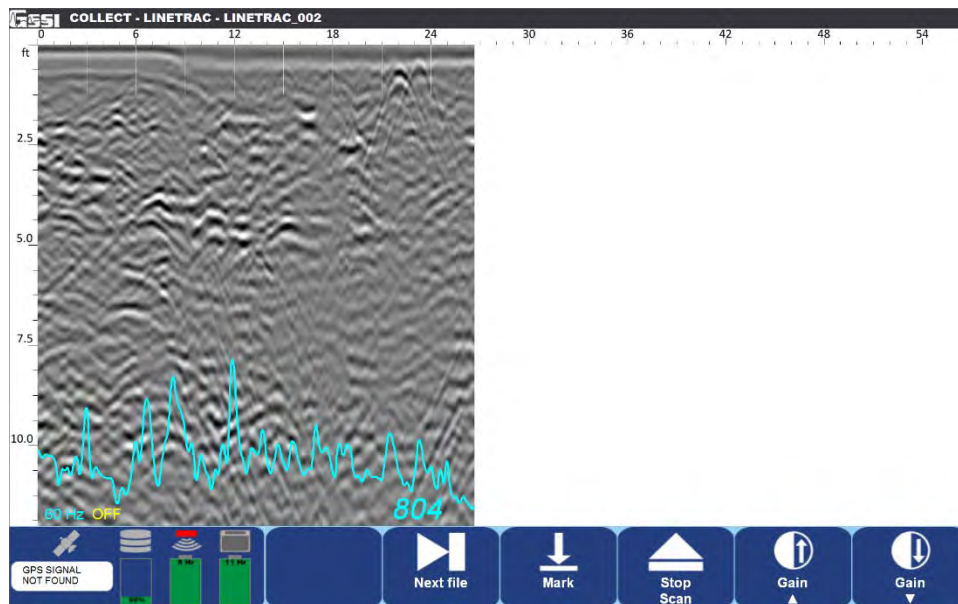
Frequency Mode

This mode is used to detect the AC current flowing along a conductive utility generated by an AC signal transmitter. LineTrac can detect a wide range of AC signals with 12 industry standard frequencies selectable.

- 1 Press Frequency Mode and select the frequency to match the signal being generated by the signal transmitter from the menu.
- 2 Press the check mark button to set the frequency. The data preview screen will reset and you will see a yellow line superimposed on the GPR data. This yellow line is the LineTrac data and upon setup will appear quite ragged, with the exception if the UtilityScan system is being setup in very close proximity to the AC signal transmitter (not recommended).

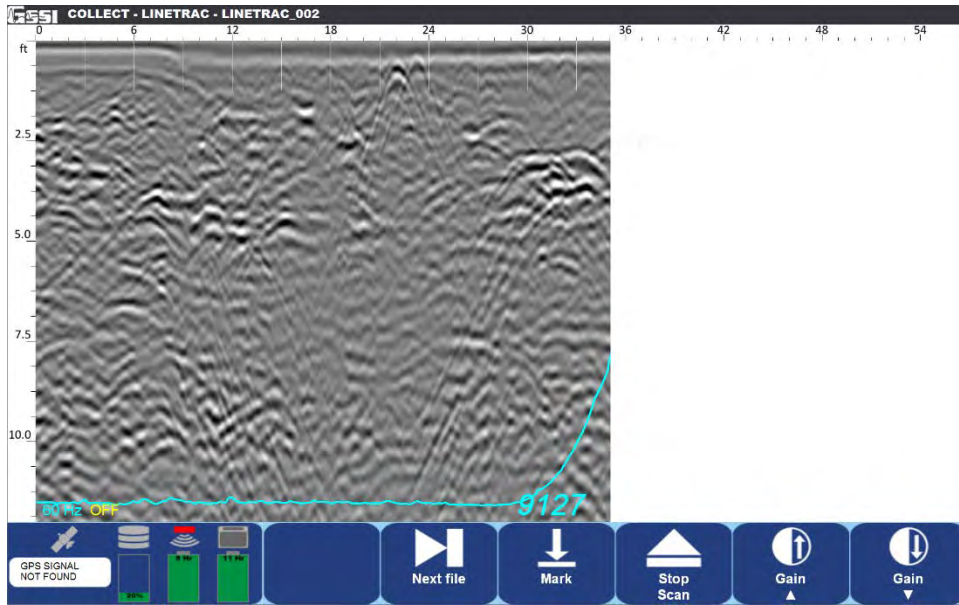
Note: It is possible to collect both Power and Frequency data at the same time, though it can create a cluttered data screen.

Data Examples: Power Mode



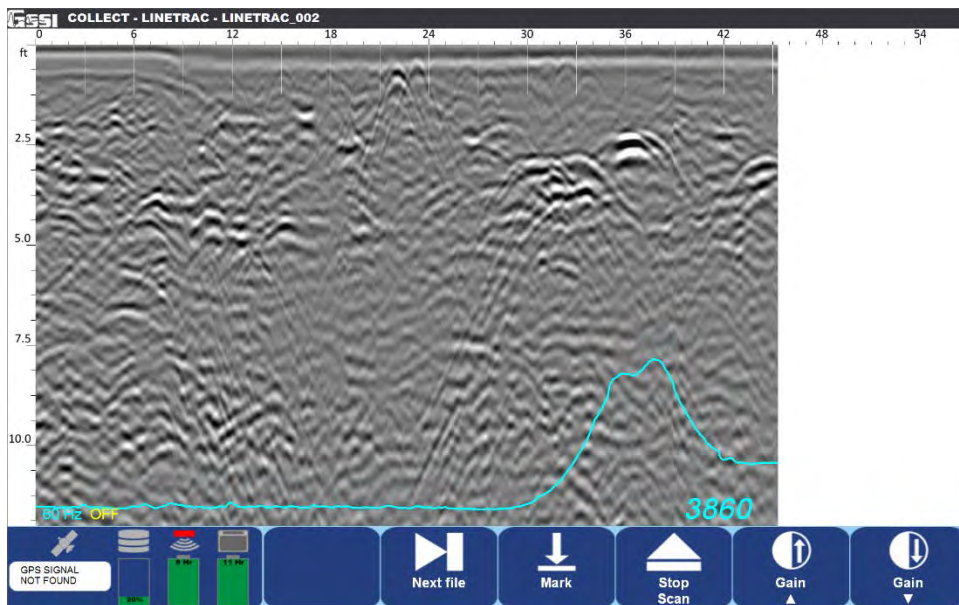
UtilityScan DF/HS Power Mode: Data Set 1-A

The above image shows the ragged blue LineTrac data characteristic of no detectable flowing current. What the LineTrac is recording and displaying is the ambient AC signal present in the background. Most GPR data collected with LineTrac will initially look like this.



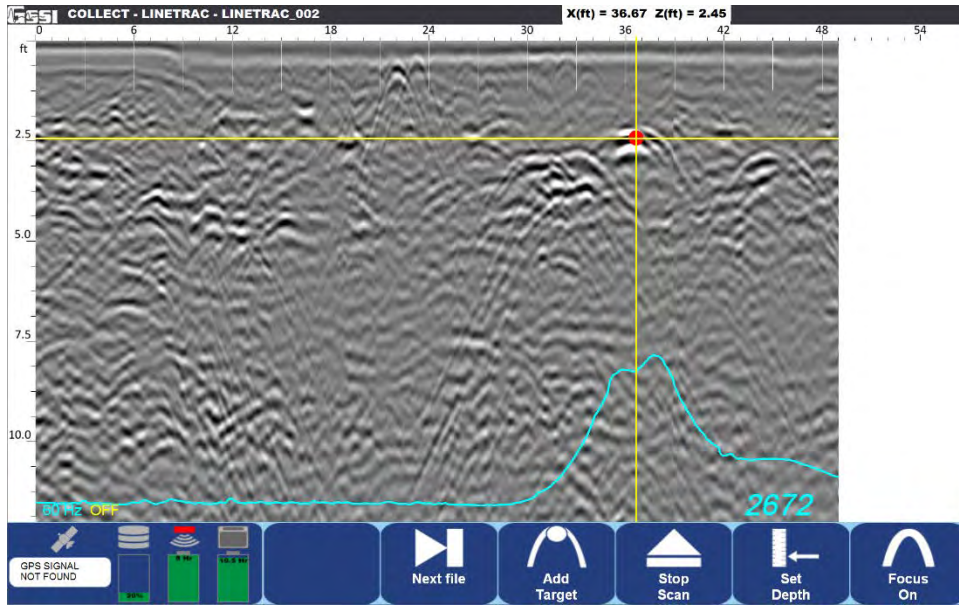
UtilityScan DF/HS Power Mode: Data Set 1-B

The above image is a continuation of the preceding image, but the UtilityScan system is approaching a buried electric line. The LineTrac data automatically rescaled as a stronger AC current was detected.



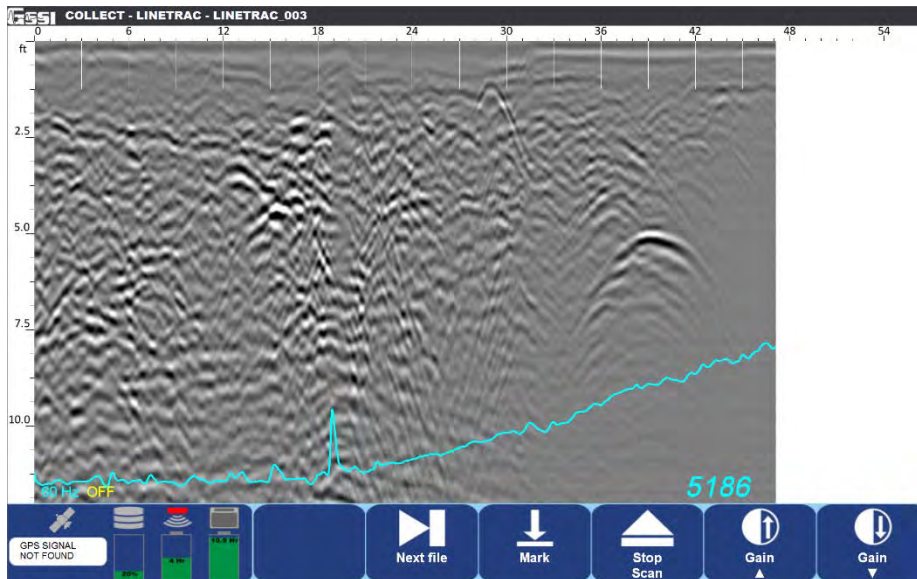
UtilityScan DF/HS Power Mode: Data Set 1-C

The above image is a continuation of the preceding image and the UtilityScan system has completed traversing the buried electric line. The LineTrac data displays a completed peak with a slight null point at its midpoint and there is a corresponding reflection in the GPR data.



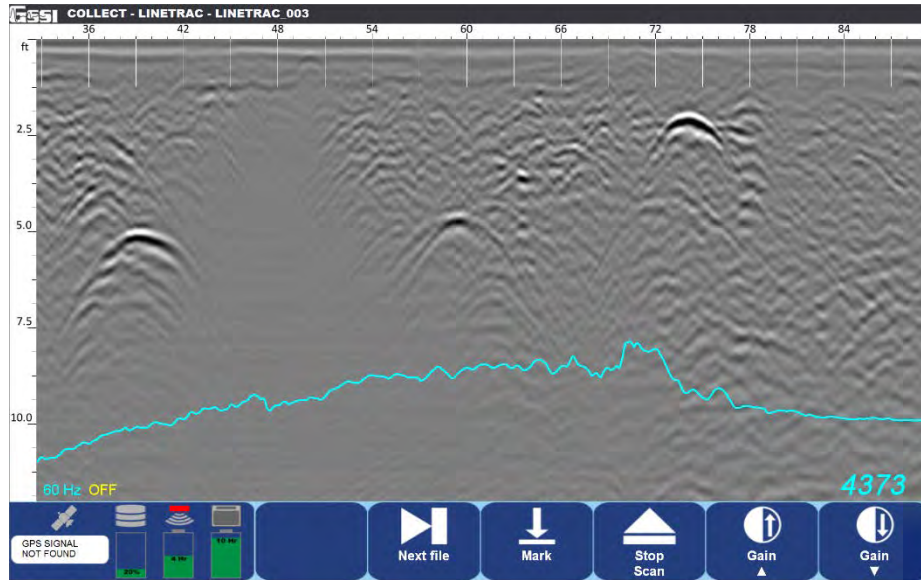
UtilityScan DF/HS Power Mode: Data Set 1-D

The UtilityScan’s backup cursor function was used to identify the GPR reflector corresponding with the LineTrac data, the horizontal cursor used to determine the depth of the buried electrical line, and the Add Target function was used to insert a color-coded target into the data.



UtilityScan DF/HS Power Mode: Data Set 2-A

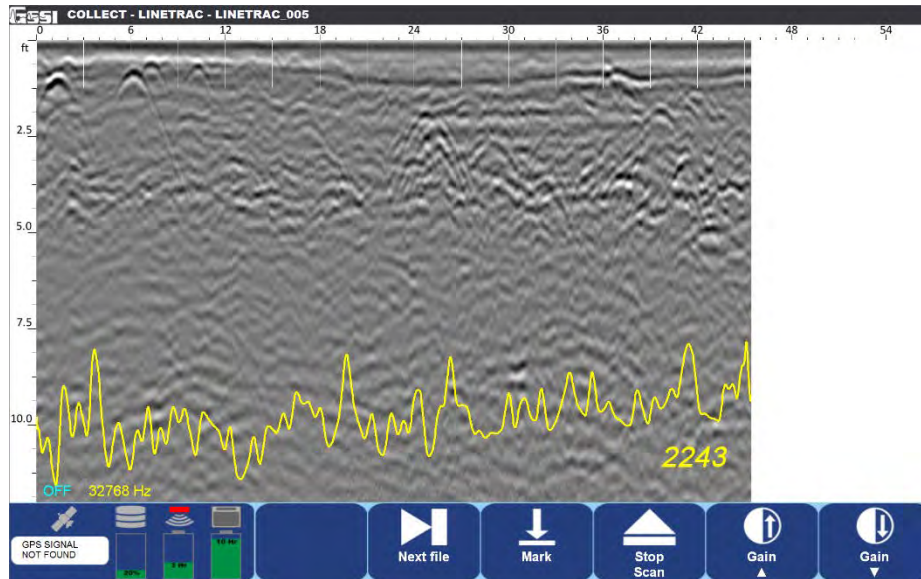
The above image shows data collected crossing a road with overhead power lines on the far side. The LineTrac data has rescaled itself and is beginning to “ramp up” but the UtilityScan system is still approximately 20 feet from being under the power lines.



UtilityScan DF/HS Power Mode: Data Set 2-B

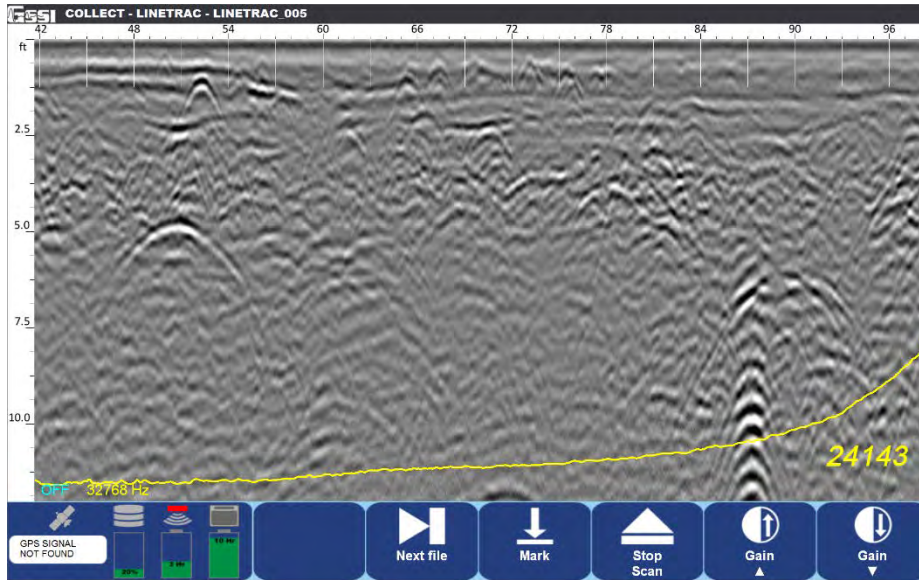
The above image is a continuation of the preceding image and the UtilityScan system has completed crossing under the overhead lines. A very broad hump is displayed instead of a sharp peak.

Data Examples: Frequency Mode



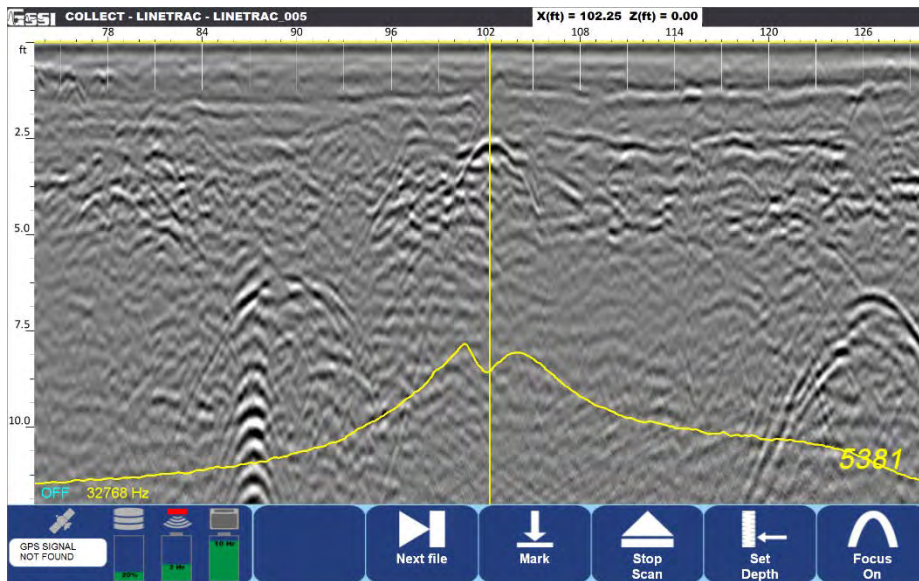
UtilityScan DF/HS Frequency Mode: Data Set 1-A

The above image shows the ragged yellow LineTrac data characteristic of no detectable tracing frequency. A 33kHz signal has been coupled to a buried natural gas line but the UtilityScan system is still some distance away. Again, most GPR data collected with LineTrac will initially look like this.



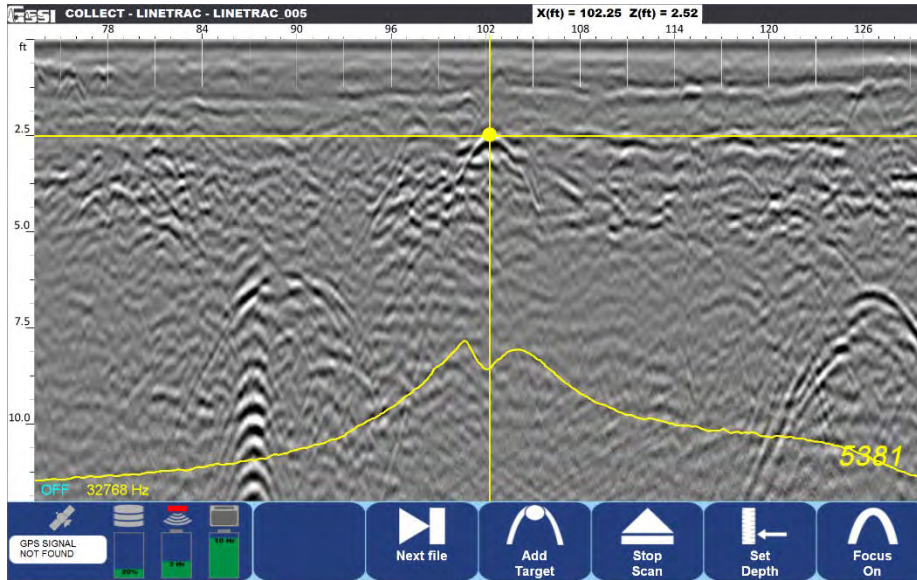
UtilityScan DF/HS Frequency Mode: Data Set 1-B

The above image is a continuation of the preceding image, but the UtilityScan system is approaching the buried gas line. The LineTrac data automatically rescaled as a stronger 33 kHz signal was detected.



UtilityScan DF/HS Frequency Mode: Data Set 1-C

The above image is a continuation of the preceding image and the UtilityScan system has completed traversing the buried gas line. The LineTrac data displays a completed peak with a distinct null point at its midpoint and there is a corresponding reflection in the GPR data.



UtilityScan DF/HS Frequency Mode: Data Set 1-D

The UtilityScan's backup cursor function was used to identify the GPR reflector corresponding with the LineTrac data, the horizontal cursor used to determine the depth of the buried gas line, and the Add Target function was used to insert a color-coded target into the data.

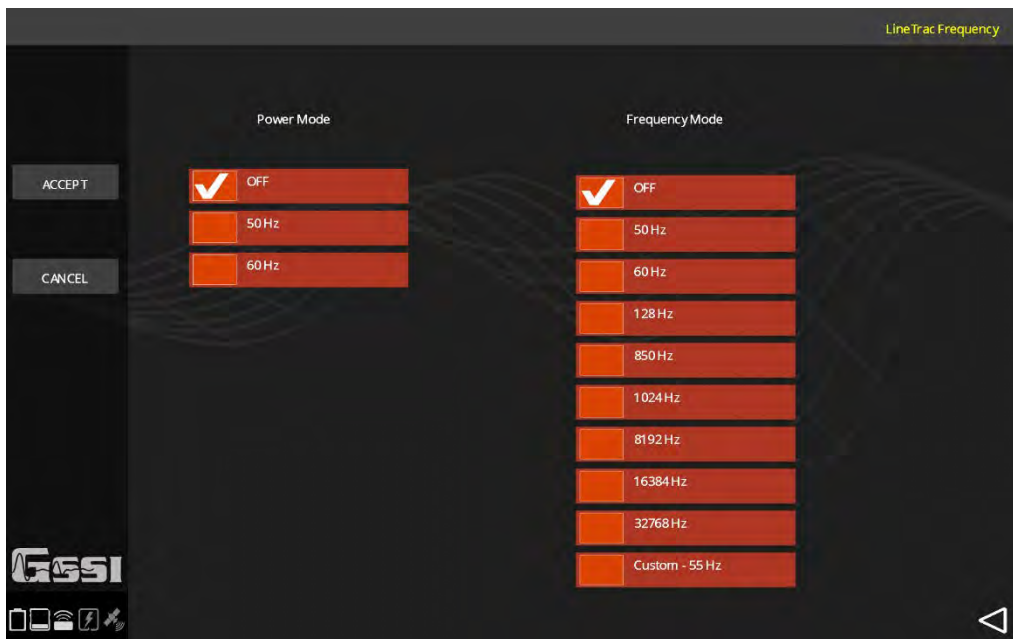
Section 6: Software Setup with the UtilityScan with Built-in LineTrac

Configuring the UtilityScan

GSSI's UtilityScan is capable of operating with consumer grade and ruggedized tablet computers running the Android operating system. Whichever tablet computer is paired with the UtilityScan, the UtilityScan App software is the same. Using the ScanMax mode of the UtilityScan will allow the user to configure the LineTrac settings. Please refer to the UtilityScan Quick Start Guide for a comprehensive discussion of all other UtilityScan settings and functionality.

Turning on LineTrac: Before changing the collection settings of LineTrac it first must be activated. This is done on the Menu Carousel where LineTrac defaults to Off.

- 1 Press the LineTrac softkey and Power Mode and Frequency Mode will be visible.



Power Mode

This mode is used to detect AC current flowing through energized electric lines. LineTrac can detect AC current with frequencies of 50 Hz or 60 Hz, the two predominant frequencies of electrical power grids worldwide.

- 1 Press Power Mode, select 50 or 60 from the menu. Press the check mark button to set the power frequency.
- 2 The data preview screen will reset, and you will see a green line superimposed on the GPR data. This green line is the LineTrac data and upon setup will appear quite ragged, with the exception if the UtilityScan system is being setup in very close proximity to a 60 Hz current (not recommended).

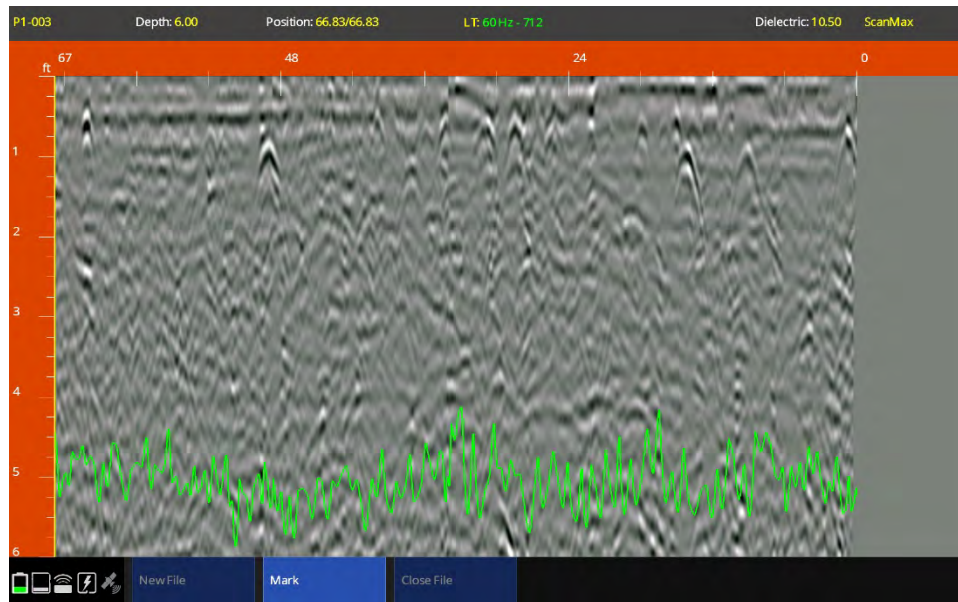
Frequency Mode

This mode is used to detect the AC current flowing along a conductive utility generated by an AC signal transmitter. LineTrac can detect a wide range of AC signals with 9 industry standard frequencies readily selectable or a custom frequency can be entered.

- 1** Press Frequency Mode, select the frequency to match the signal being generated by the signal transmitter from the menu.
- 2** Press the check mark button to set the frequency. The data preview screen will reset, and you will see a blue line superimposed on the GPR data. This blue line is the LineTrac data and upon setup will appear quite ragged, with the exception if the UtilityScan system is being setup in very close proximity to the AC signal transmitter (not recommended).

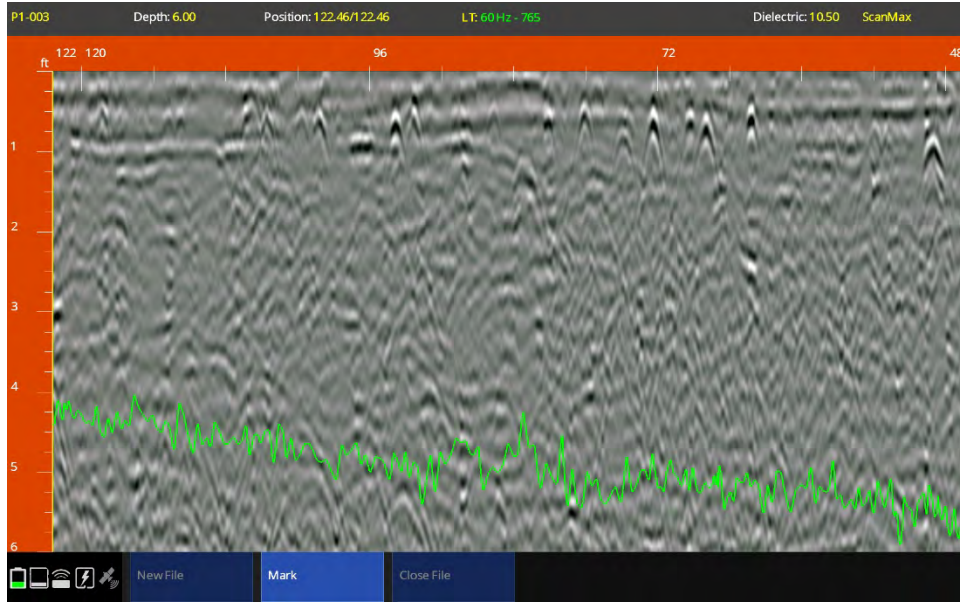
Note: It is possible to collect both Power and Frequency data at the same time, though it can create a cluttered data screen.

Data Examples: Power Mode



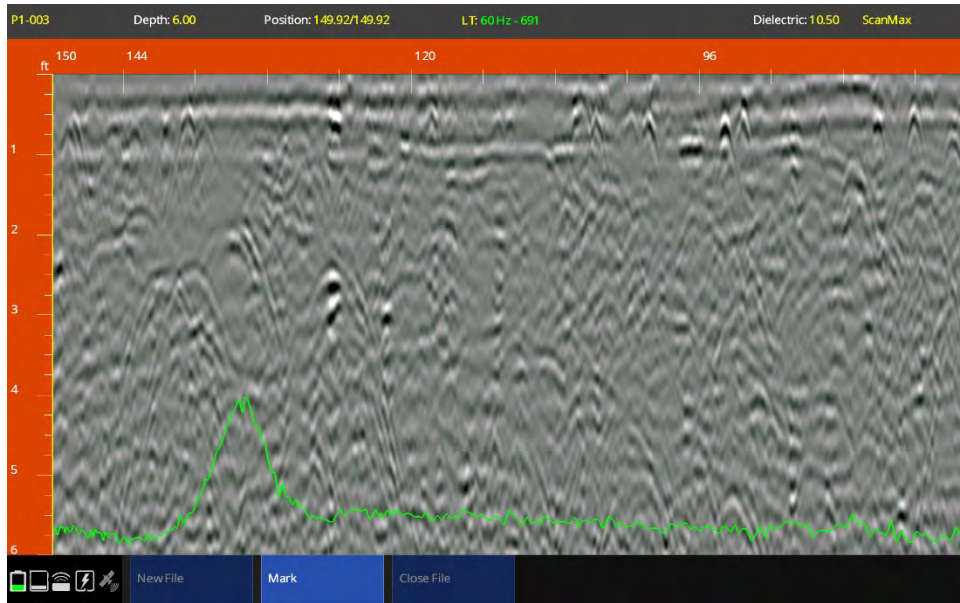
UtilityScan Power Mode: Data Set 1-A

The above image shows the ragged green LineTrac data characteristic of no detectable flowing current. What the LineTrac is recording and displaying is the ambient AC signal present in the background. Most GPR data collected with LineTrac will initially look like this.



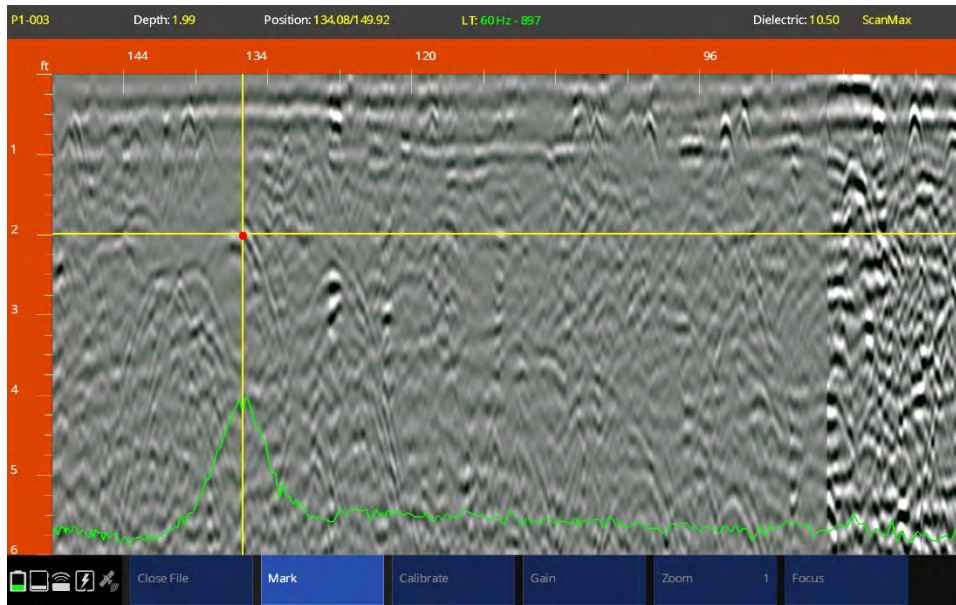
UtilityScan Power Mode: Data Set 1-B

The above image is a continuation of the preceding image, but the UtilityScan system is approaching a buried electric line. The LineTrac data automatically rescaled as a stronger AC current was detected.



UtilityScan Power Mode: Data Set 1-C

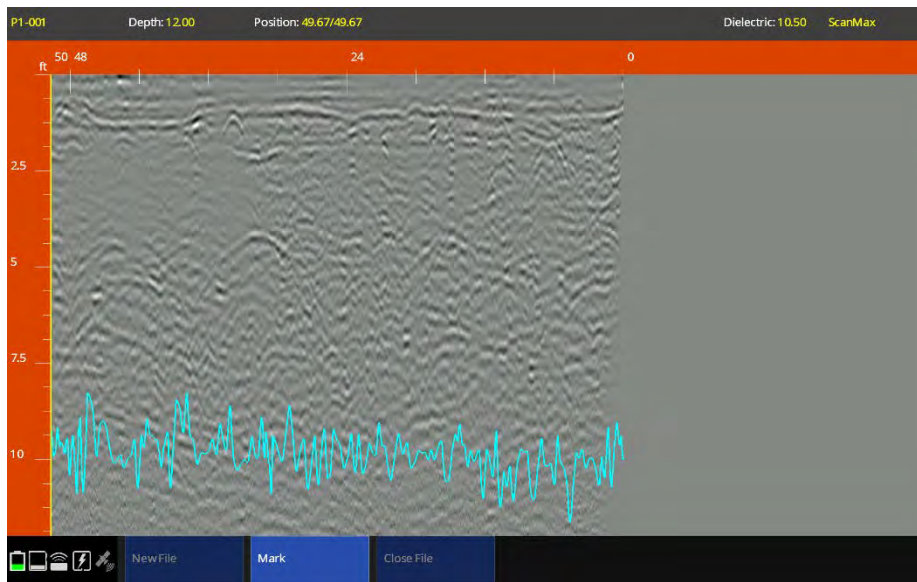
The above image is a continuation of the preceding image and the UtilityScan system has completed traversing the buried electric line. The LineTrac data displays a completed peak with a slight null point at its midpoint and there is a corresponding reflection in the GPR data.



UtilityScan Power Mode: Data Set 1-D

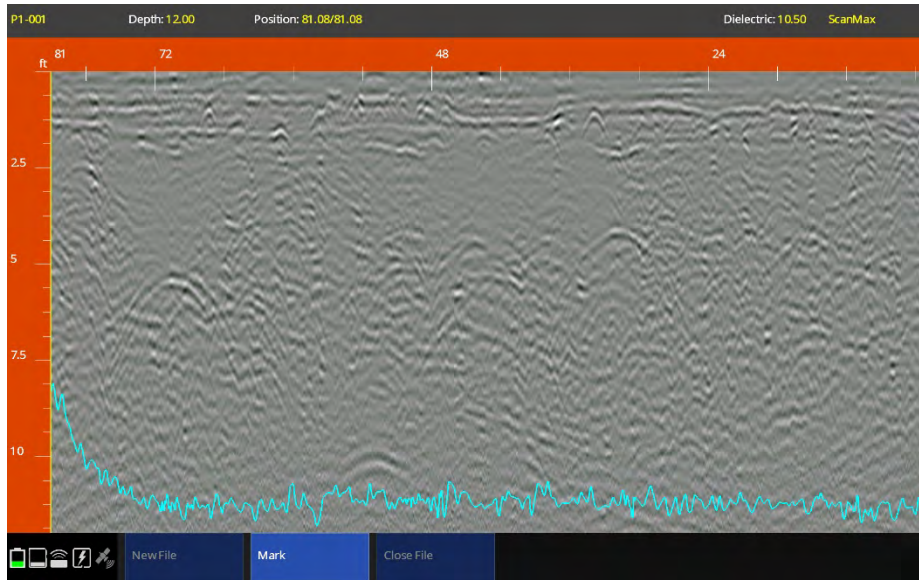
The UtilityScan’s backup cursor function was used to identify the GPR reflector corresponding with the LineTrac data, the horizontal cursor used to determine the depth of the buried electrical line, and the Add Target function was used to insert a color-coded target into the data.

Data Examples: Frequency Mode



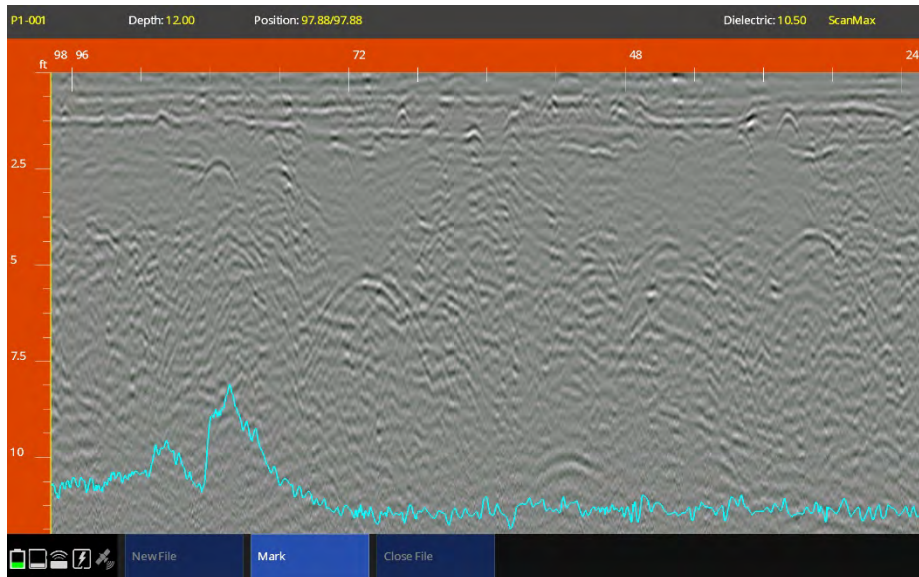
UtilityScan Frequency Mode: Data Set 1-A

The above image shows the ragged blue LineTrac data characteristic of no detectable tracing frequency. A 33kHz signal has been coupled to a buried natural gas line but the UtilityScan system is still some distance away. Again, most GPR data collected with LineTrac will initially look like this.



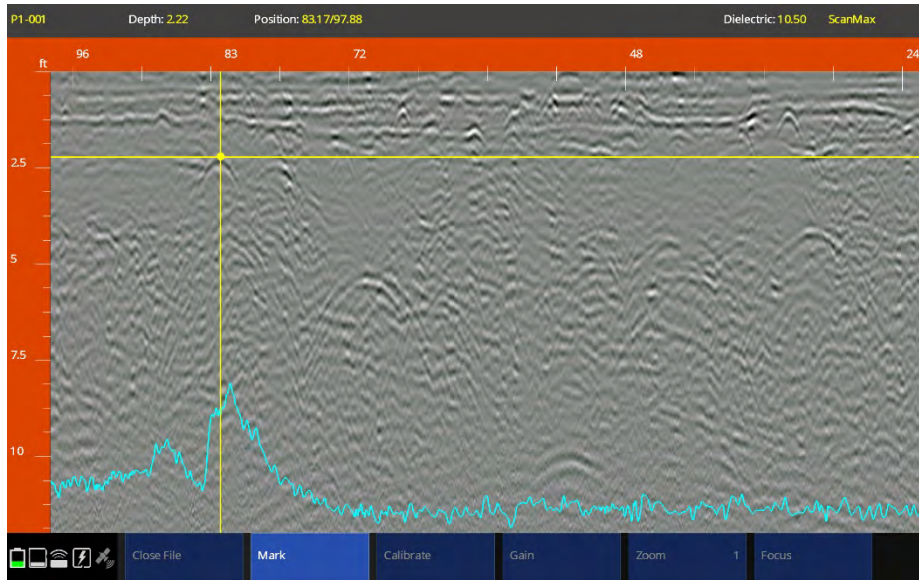
UtilityScan Frequency Mode: Data Set 1-B

The above image is a continuation of the preceding image, but the UtilityScan system is approaching the buried gas line. The LineTrac data automatically rescaled as a stronger 33 kHz signal was detected.



UtilityScan Frequency Mode: Data Set 1-C

The above image is a continuation of the preceding image and the UtilityScan system has completed traversing the buried gas line. The LineTrac data displays a completed peak with a distinct null point at its midpoint and there is a corresponding reflection in the GPR data.



UtilityScan Frequency Mode: Data Set 1-D

The UtilityScan’s backup cursor function was used to identify the GPR reflector corresponding with the LineTrac data, the horizontal cursor used to determine the depth of the buried gas line, the Add Target function was used to insert a color-coded target into the data.

