DigiTrak® LT2™

Directional Drilling Locating System

Operator's Manual

Digital Control Incorporated

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This equipment complies with Part 15 of the Rules of the FCC and with Industry Canada license-exempt RSS standards and with Australia Class License 2000 for LIPD (low interference potential devices). Operation is subject to the following two conditions: (1) this equipment may not cause harmful interference, and (2) this equipment must accept any interference received, including interference that may cause undesired operation. DCI is responsible for FCC compliance in the United States: Digital Control Incorporated, 19625 62nd Ave S, Suite B103, Kent WA 98032; phone 425-251-0559 or 800-288-3610.

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DigiTrak receivers are classified as Class 2 radio equipment per the R&TTE Directive and may not be legal to operate or require a user license to operate in some countries. The list of restrictions and the required declarations of conformity are available on DCI's website, www.digitrak.com, under the Service & Support tab. Click on DOWNLOADS and select from the CE Documents pull-down menu to download, view, or print the documents.

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Dear Customer,

Thank you for choosing a DigiTrak locating system. We are extremely proud of the equipment we have been designing and building in Washington State since 1990. We believe in providing a unique, high-quality product and standing behind it with superior customer service and training.

Please take the time to read this entire manual, especially the section on safety. Also, please fill in the product registration card provided with this equipment and either mail it to DCI headquarters, fax it to us at 253-395-2800, or complete and submit the form online at our website, www.digitrak.com. We will put you on the Digital Control mailing list and send you product upgrade information and our *FasTrak* newsletter.

Feel free to contact us if you have any problems or questions. Our Customer Service department is available 24 hours a day, 7 days a week. International contact information is available on our website.

As the horizontal directional drilling industry grows, we're keeping our eye on the future to develop equipment that will make your job faster and easier. Visit us online any time to see what we're up to.

We welcome your questions, comments, and ideas.

Digital Control Incorporated
Kent, Washington
2013

See our DigiTrak Training Videos on YouTube at www.youtube.com/dcikent.

Table of Contents

Safety Precautions and Warnings

Carefully review this manual and be sure you always operate your DigiTrak locating system properly to obtain accurate depth, pitch, roll, and locate points. If you have any questions about the operation of the system, please contact DCI Customer Service for assistance.

General

Warning All operators must read and understand the following safety precautions and warnings and must review this operator's manual before using the DigiTrak F5 Locating System.

Serious injury and death can result if underground drilling equipment makes contact with an underground utility such as a high-voltage electrical cable or a natural gas line.

Substantial property damage and liability can result if underground drilling equipment makes contact with an underground utility such as a telephone, cable TV, fiber-optic, water, or sewer line.

Work slowdowns and cost overruns can occur if drilling operators do not use the drilling or locating equipment correctly to obtain proper performance.

DCI equipment is not explosion-proof and should never be used near flammable or explosive substances.

In the event of electrostatic shock, the display screen may go blank. No data loss will occur. Click the trigger to reset the receiver, or toggle down to reset the remote display.

Hot surfaces can occur on cable transmitters if housing requirements are not met. Always ensure the transmitter is installed properly in the housing during use.

Directional drilling operators MUST at all times:

- Understand the safe and proper operation of drilling and locating equipment, including the use of ground mats and proper grounding procedures.
- Ensure that all underground utilities have been located, exposed, and accurately marked prior to drilling.
- Wear protective safety clothing such as dielectric boots, gloves, hard hats, high-visibility vests, and safety glasses.
- Locate and track the transmitter in the drill head accurately and correctly during drilling.
- Maintain a minimum distance of 8 in. (20 cm) from the front of the receiver to the user's torso to ensure compliance with FCC requirements.
- Comply with federal, state, and local governmental regulations (such as OSHA).

- Follow all other safety procedures.

DigiTrak locating systems cannot be used to locate utilities.

Continued exposure of the transmitter to heat due to frictional heating of the drill head can cause inaccurate information to be displayed and may permanently damage the transmitter.

Remove the batteries from all system components during shipping and prolonged storage; damage caused by leakage may occur.

Equipment and Battery Disposal

This symbol on equipment indicates that the equipment must not be disposed of with your other household waste. Instead, it is your responsibility to dispose of such equipment at a designated collection point for the recycling of batteries or electrical and electronic equipment. If the equipment contains a banned substance, the label will show the pollutant (Cd = Cadmium; Hg = Mercury; Pb = Lead) near this symbol. Before recycling, ensure batteries are discharged or the terminals are covered with adhesive tape to prevent shorting. The separate collection and recycling of your waste equipment at the time of disposal will help conserve natural resources and ensure it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste equipment for recycling, please contact your local city office, your household waste disposal service, or the shop where you purchased the equipment.

The battery charger provided with your DigiTrak locating system is designed with adequate safeguards to protect you from shock and other hazards when used as specified within this document. If you use the battery charger in a manner not specified by this document, the protection provided may be impaired. Do not attempt to disassemble the battery charger, it contains no user-serviceable parts. The battery charger shall not be installed into caravans, recreational vehicles, or similar vehicles.

Pre-Drilling Testing

Before each drilling run, test your DigiTrak locating system with the transmitter inside the drill head to confirm it is operating properly and providing accurate drill head location and heading information.

During drilling, the depth will not be accurate unless:

- The receiver has been properly calibrated and the calibration has been checked for accuracy so the receiver shows the correct depth.
- The transmitter has been located correctly and accurately and the receiver is directly above the transmitter in the drill head underground or at the front locate point.
- The receiver is placed on the ground or held at the correct height-above-ground distance, which has been set correctly.

Always test calibration after you have stopped drilling for any length of time.

Interference

Interference can cause inaccuracies in the measurement of depth and loss of the transmitter's pitch, roll, or heading. Always perform a background noise check prior to drilling.

- Sources of interference include, but are not limited to, traffic signal loops, invisible dog fences, cable TV, power lines, fiber-trace lines, metal structures, cathodic protection, telephone lines, cell phones, transmission towers, conductive earth, salt, salt water, rebar, and radio frequencies.
- Interference at the remote display may also occur from other sources operating nearby on the same frequency, such as car rental agencies using their remote check-in modules or other directional drilling locating equipment.
- Background noise must be minimal and signal strength must be at least 150 points above the background noise during all locating operations.
- Because this equipment may generate, use, and radiate radio frequency energy, there is no guarantee that interference will not occur at a particular location. If this equipment does interfere with radio or television reception, which can be determined by powering the equipment off and on, try to correct the interference using one or more of the following measures:
  - Reorient or relocate the receiving antenna.
  - Increase the separation between the receiver and affected equipment.
  - Consult the dealer, DCI, or an experienced radio/TV technician for help.
  - Connect the DCI equipment to an outlet on a different circuit.

Equipment Maintenance

Turn off all equipment when not in use.

Store the equipment in cases, away from heat, cold, and moisture. Test to confirm proper operation prior to use.

Clean the screens on the receiver and remote display using a damp soft cloth without chemicals or cleaning agents.

Clean the receiver, remote, and battery charger case using only a soft moist cloth and mild detergent.

Do not use chemicals to clean the transmitter.

Inspect the equipment daily and contact DCI if you see any damage or problems. Do not disassemble or attempt to repair the equipment.

Do not store or ship this equipment with batteries inside. Always remove the batteries from the equipment before shipping or periods of non-use.

Introduction

DigiTrak LT2 Locating System

The DigiTrak LT2 Locating System is used to locate and track the transmitter in the drill head during horizontal directional drilling (HDD) operations. The system consists of a handheld receiver, a transmitter that is placed in the drill head, and a remote display that is located at the drill rig. The receiver and remote are powered by a rechargeable battery pack, and a battery charger is also included with the system.

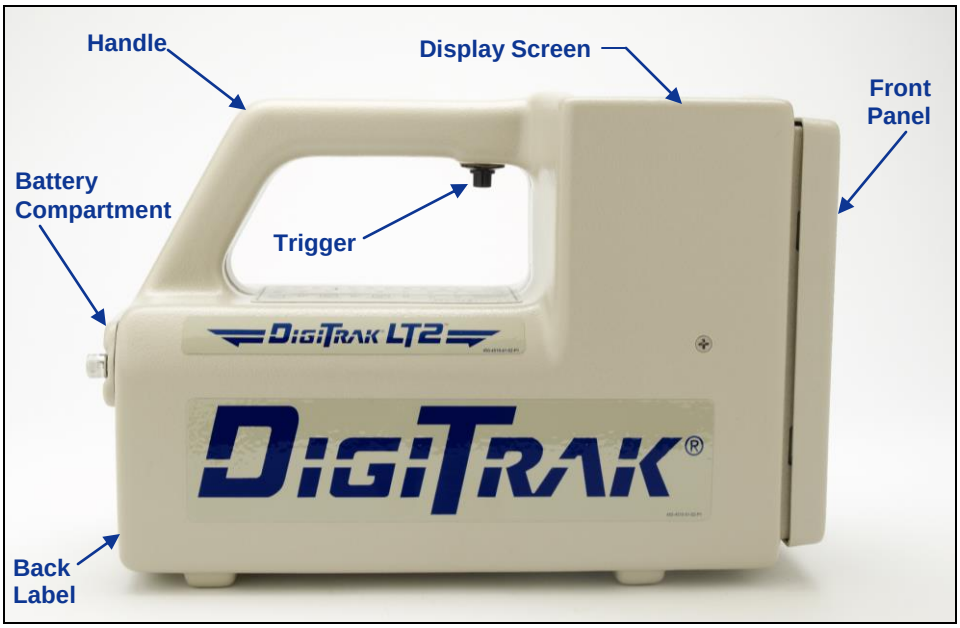
Locating is streamlined using the LT2 receiver's graphic display and menu system. The real-time graphic display guides you in positioning a target (or a line) in a box on the display window to locate the transmitter. You can also locate using the plus/minus signs, as on earlier DigiTrak models produced by Digital Control Incorporated (DCI).

This manual provides information on each LT2 system component—the receiver, transmitter, remote display, and battery charger—in separate sections following this introduction. These sections are followed by the *Locating Instructions* section, which explains important locating terms and gives step-by-step locating instructions.

Supplemental information is provided in appendices. Appendix A presents the LT2 system's power requirements, environmental requirements, and equipment maintenance requirements. Appendix B provides information regarding how to calculate the actual depth when the transmitter is deep (greater than 15 ft or 4.5 m) and/or at a steep pitch (greater than ±30% or ±17°). Appendix C provides a method to calculate the transmitter depth based on the distance between the front and rear locate points and the pitch of the transmitter.

The LT2 system is programmed to comply with global operating requirements. The receiver's global designation number must match that of the transmitter for proper communication (see figure showing startup screen under "General Description" in the *Receiver* section and "Types of LT2 Transmitters" in the *Transmitter* section). Also, the receiver's telemetry frequency designation must match that of the remote display (see figure showing receiver back label in "General Description" in the *Receiver* section and "General Description" in the *Remote Display* section).

Receiver



DigiTrak LT2 Receiver (side view)

General Description

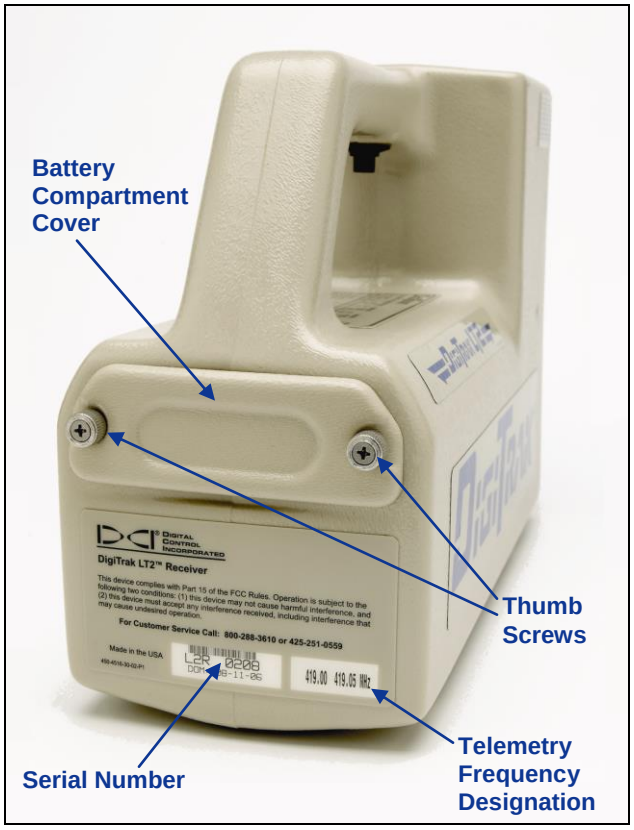
The LT2 receiver is a handheld unit used for locating and tracking an LT2 transmitter emitting a signal at 12 kHz. The receiver converts signals from the transmitter and displays the following information: depth, pitch, roll, and temperature of the transmitter, and battery status of both the transmitter and the receiver. The LT2 receiver also sends signals to the LT2 remote display at the drill rig.

The LT2 system can be used to take depth readings without setting the receiver on the ground. The height-above-ground function allows you to program a comfortable height for holding the receiver for depth readings (see discussion under “Receiver Display Menus” later in this section). Using the height-above-ground feature also allows greater separation, which can decrease the effects of interference.

The LT2 receiver is equipped with an internal speaker that emits audible tones to accompany menu changes and temperature warnings from the transmitter. Audible tones also accompany the power-on sequence and the manual shutdown sequence. The various warning tones are discussed further where applicable in the following sections.

DigiTrak LT2 Receiver (top view)

To meet global requirements and for proper communication; the frequency designation shown on the receiver's serial number label (see figure below) must match that shown on the remote display. To determine the remote display's frequency designation, see the figure showing the remote's serial number label in the "General Description" discussion in the *Remote Display* section.



Back of Receiver Showing
Serial Number and Telemetry Frequency Designation

Power On/Off

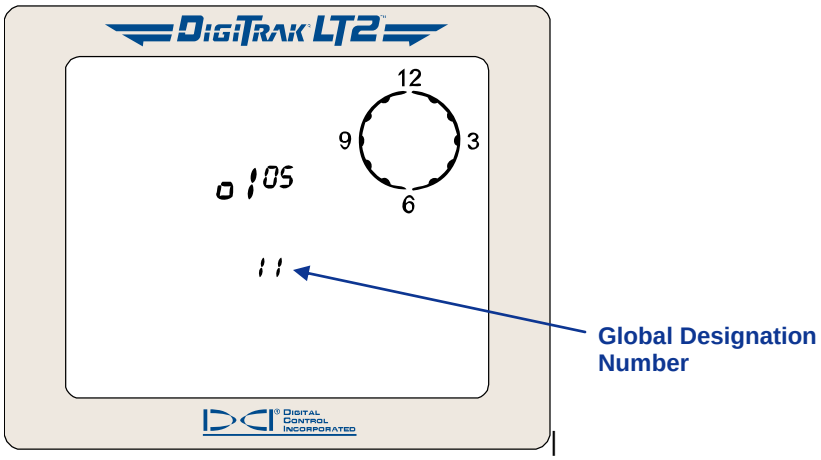
Installing the Battery Pack

1. Remove the battery compartment cover from the back of the receiver by rotating the thumb screws counterclockwise.
2. Insert a fully charged battery pack terminal end first with exposed terminals aligned with springs in battery compartment.
3. Replace the battery compartment cover and tighten the thumb screws by rotating them clockwise.

The serial number label on the back of the receiver shows the telemetry frequency designation (see above photo). This frequency designation must match the frequency designation on the remote display, which is located on the serial number label on the back of the remote display (see "General Description" in the *Remote Display* section).

Turning On the Receiver

To turn the LT2 receiver on, pull and hold the trigger in for 2 seconds and release. When the trigger is engaged at startup, you will hear a short beep followed by a long tone. You will briefly see a series of three screens at startup, before the default locating screen appears. The first startup screen shows all of the display symbols illuminated. The second screen shows the firmware and software versions. The third and final screen (shown in the following figure) displays the global designation number, which must match that of the transmitter (see "Types of LT2 Transmitters" in the *Transmitter* section).



Startup Screen Showing Global Designation Number

Turning Off the Receiver

To turn the unit off, you must first access the menu choices (see "Receiver Display Menus"). Click the trigger until you reach the power menu ⏻, then hold the trigger in during the countdown from 3 to 0 to shut the receiver off; you will hear a beep each time the counter decreases followed by three short confirmation beeps before the unit shuts off.

Note that when the receiver power is turned off, the height-above-ground function is also turned off. If you want to use the height-above-ground function, you must turn it on and reset the value (if needed) after you turn on the receiver.

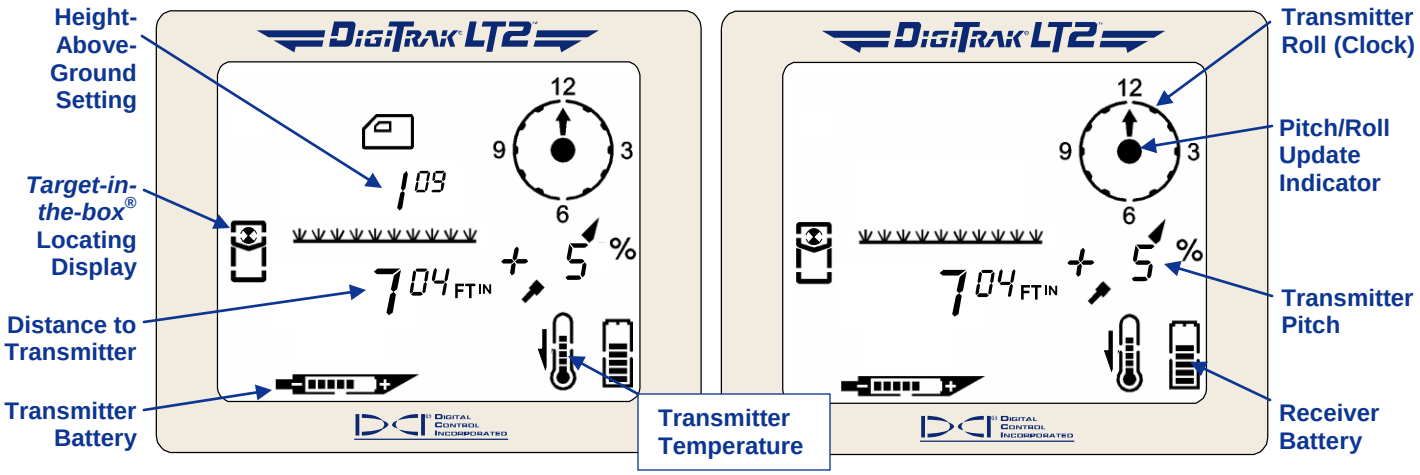
Automatic Shutoff

The receiver will automatically shut itself off if no signal is received for 15 minutes.

As noted above, when the receiver power is turned off, the height-above-ground function is also turned off. If you want to use the height-above-ground function, you must turn it on and reset the value (if needed) after you turn on the receiver.

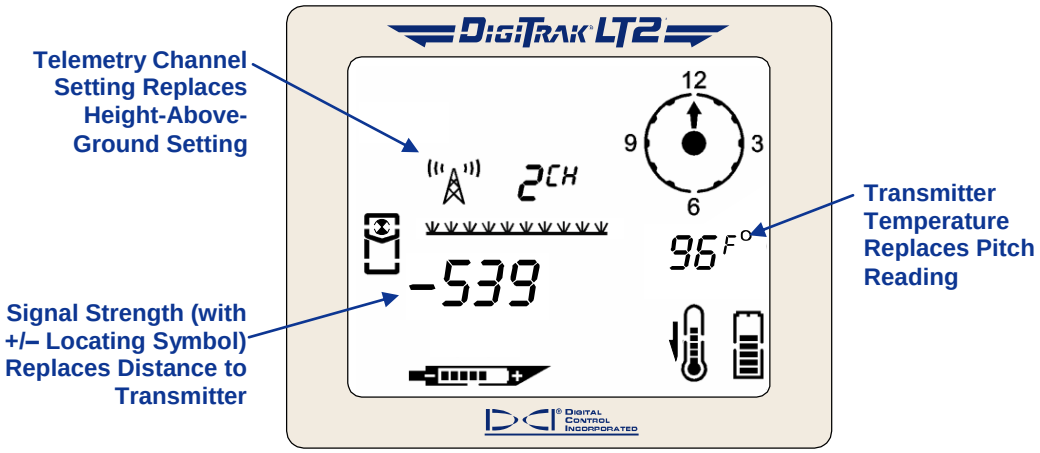
Main Display Screen

When the LT2 receiver is on, the display screen shows the standard locating mode display (see figure below) as the default display. The display symbols that appear on the locating screen are identified in the figure below and described in the “Standard Display Screen Symbols” table on the next page. Note that the height-above-ground setting will only appear if the height-above-ground function is enabled.



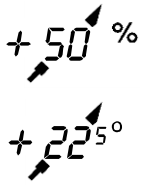
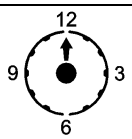
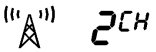
Standard Locating Mode Display with Height-Above-Ground Function Enabled (Left) and Without (Right)

When the operator holds in the trigger, the display changes to show the telemetry channel setting, signal strength, and transmitter temperature (see figure below and table on next page).



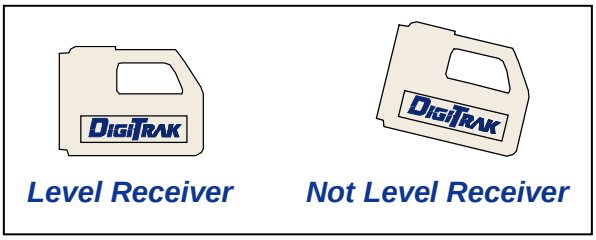
Standard Locating Mode Display with Trigger In

Standard Display Screen Symbols

	**Height-Above-Ground Icon** – Appears above the ground symbol  when the height-above-ground function is on and shows the current height setting.
	**Ground** – Represents the surface of the ground.
	**Locating Icon** – Represents a bird's-eye view of the receiver. This icon is referred to as the "box" when using the *target-in-the-box* and *line-in-the-box* locating techniques.
	**Target** – Represents the front and rear locate points (FLP and RLP). When the receiver is positioned directly above a locate point, the target will be in the box.
	Line – Represents locate line (LL). When the receiver is positioned directly above the LL, the line will be in the box. The LL also allows for off-track locating when access over the drill head is limited.
	**Transmitter Battery –** Depicts the battery status of the transmitter. This case shows five of seven bars, which means there is 71% battery life remaining.
	**Transmitter Temperature** – Shows temperature status of transmitter. An arrow appears next to the thermometer pointing either up to indicate increasing temperature, or down to indicate decreasing temperature. The three curved lines extending from the top of the thermometer appear if the transmitter has reached a dangerous temperature of 118°F or 48°C and requires immediate attention. The thermometer will flash off and on at 140°F (60°C) to further indicate the need for immediate action to cool the transmitter. The actual temperature can be displayed in place of the pitch by holding the trigger in.
	**Receiver Battery** – Depicts the battery status of the receiver. This case shows five of seven bars, which means there is 71% battery life remaining.
	**Transmitter Pitch** – Shows the inclination of the transmitter, displayed in either percent slope or degrees. The pitch value is shown with a drill head indicator behind it that points up for positive pitch and down for negative pitch. When using percent slope for pitch measurements, a value from 0 to 100 will appear; when using degrees, a value from 0 to 45 will appear, followed by a decimal point and a value of 0 or 5. Pitch measurements are given in 0.5-degree increments.
	**Pitch/Roll Update Indicator** - The dot in the center of the clock should blink 2 times per second, indicating that current pitch, roll, battery, and temperature information is being received from the transmitter.
	**Transmitter Roll** – The clock shows the 12 roll positions of the transmitter.
	**Telemetry Channel Setting** – Shows the current channel setting for the receiver. The receiver must be set to the same channel as the remote display. There are four channel settings (1, 2, 3, 4) and an Off setting.
	**Plus/Minus Locating Indicator** – The plus or minus sign in front of the signal strength value can be used to guide the operator in finding the locate points (FLP and RLP) and the locate line (LL).
	**Signal Strength** – Displays the amount of signal from the transmitter when the trigger is held in. The signal strength scale ranges from 0 to 999, where 0 indicates no signal and 999 indicates signal saturation (receiver and transmitter are very close). When the trigger is not held in and the receiver is saturated (too close to transmitter), you will see four dashed lines (— — — —) where the distance/depth number should display.

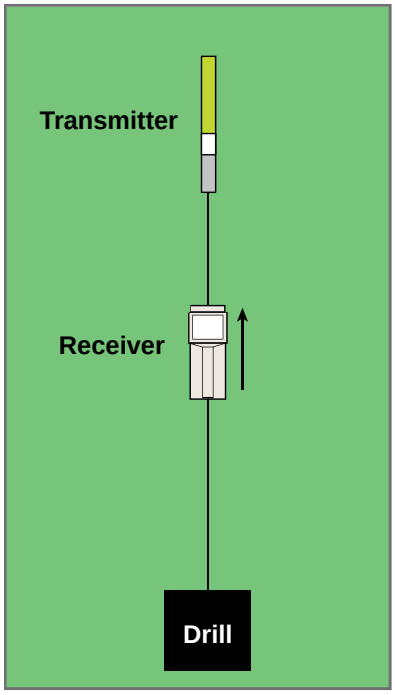
Proper Handling of Receiver

The receiver must always be held correctly to obtain accurate readings. You must hold the receiver **level at all times** and at a **constant height above the ground** (see "Height Above Ground" menu discussion later in this section).

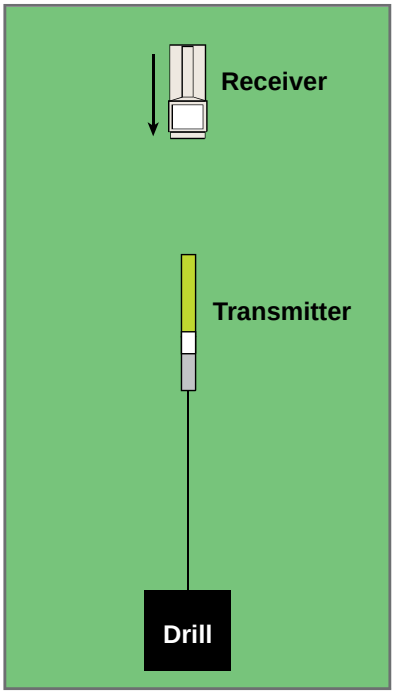


Level Receiver *Not Level Receiver*

You can track the transmitter by holding the receiver while facing the drill or while facing away from the drill (see figures below). Either way, the information on the receiver display will be the same when at the same location. For an accurate depth reading, you must hold the receiver level and have it aligned with and directly above the transmitter.



Receiver Facing Away from Drill



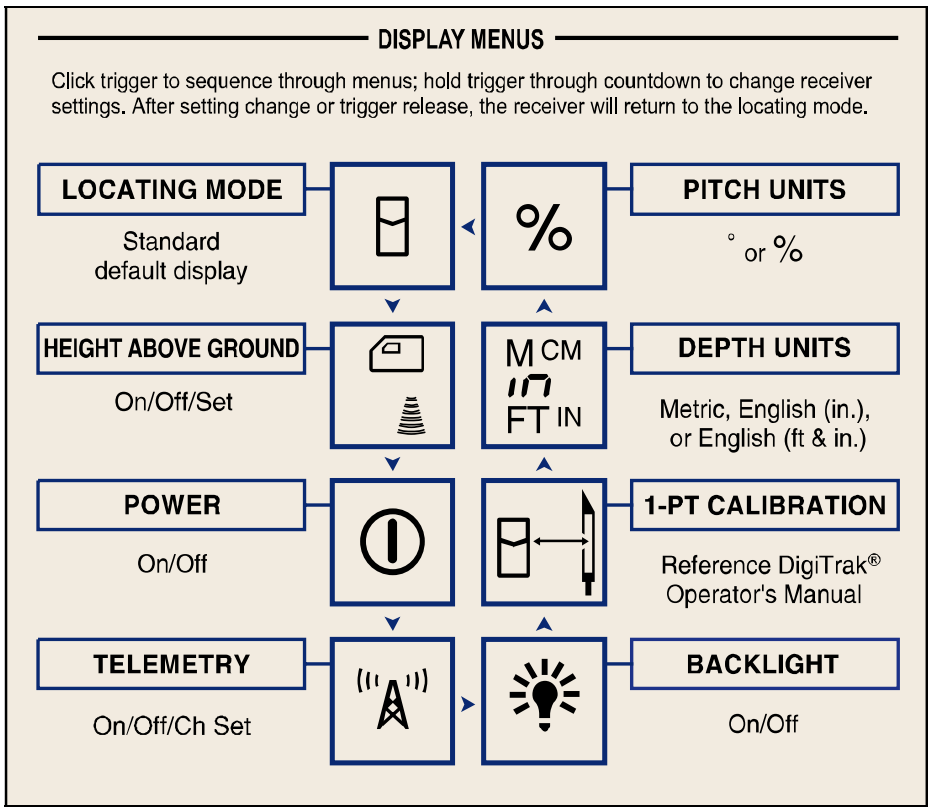
Receiver Facing Toward Drill

Accessing and Changing Menu Settings

To access the LT2 menu functions, you simply **click the trigger**. Each trigger click advances you to the next menu item. When you stop at a menu, you will see a number that indicates a countdown sequence. To change a menu setting, **hold the trigger in** while the counter goes down to 0; you will hear a beep each time the counter decreases. Once the counter reaches 0, release the trigger and the menu setting will be changed, which is indicated by a checkmark at the bottom of the screen (✓) and a few short confirmation beeps. If no trigger action is detected within 3 seconds, the display will return to the locating mode screen.

Receiver Display Menus

The front label on the LT2 receiver shows the display menus (see figure below). This section describes each menu function and gives instructions for how to change the menu settings. The menus are listed in the order that they appear on the front label of the receiver, starting with the height-above-ground menu. The locating mode is the standard default display that you will see when you turn on the receiver.



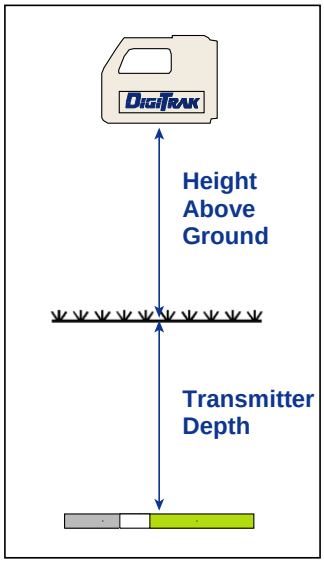
Receiver Display Menus as Shown on Front Label

HEIGHT ABOVE GROUND 

This display menu allows you to enter a height-above-ground measurement so that you can measure the transmitter depth without having to place the LT2 receiver on the ground. If the height-above-ground function is not on, then you must place the receiver on the ground to take depth measurements.

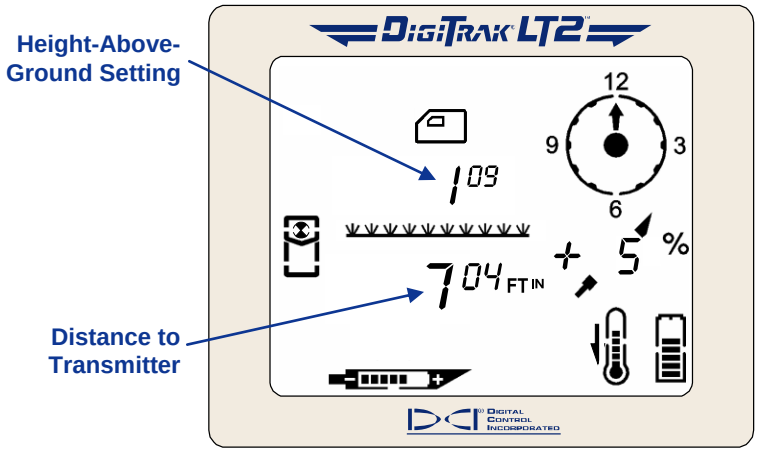
The height-above-ground value can be set from a distance of 1^{00} up to 3^{00} using FT^{IN} depth units (feet and inches); from 12 up to 36 using “in” depth units (or inches only); or from 0^{30} up to 0^{90} using M^{CM} depth units (meters and centimeters)—see discussion of depth units menu later in this section.

The default height-above-ground distances for the three depth options are 1^{00} for 1 ft 0 in.; “12 in” for 12 inches; or 0^{30} for 0 m 30 cm. When using the “Set” option described below, the units of measure will increase by 1-in. increments if you are using English units and by 2-cm increments if using metric units.



The height-above-ground function can also be helpful when the depth of the transmitter is shallower than 24 in. (61 cm). If the receiver is placed on the ground in this situation, it will be saturated with signal and you will not see a depth number. Instead you will see four dashed lines (— — — —) where the distance/depth number should display. In cases like this, you can use the height-above-ground function to increase the distance between the receiver and the transmitter so that the signal does not saturate the receiver.

When the height-above-ground function is enabled, you will see the height-above-ground value on your locating screen, as shown in the following figure. You must hold the receiver at this height to get accurate depth measurements.



Locating Mode Display with 1-ft 9-in. Height Above Ground

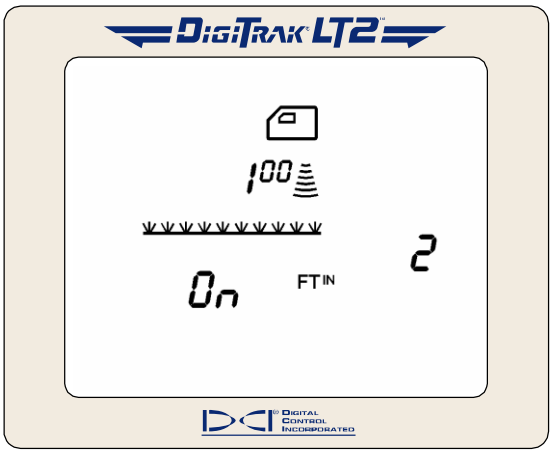
NOTE: When you turn off the receiver, calibrate, or change the depth units, the height-above-ground function automatically turns off. The current height-above-ground setting reverts to the default value if you change the depth units between English and metric.

There are three options in the height-above-ground menu:

- “On” turns on the height-above-ground function.
- “Off” turns off the height-above-ground function.
- “Set” allows you to set (change) the height-above-ground value.

To turn on the height-above-ground function:

1. From the locating screen, click the trigger once to advance to the height-above-ground menu. You will see the “On” option displayed as the first setting option. You will also see the last height-above-ground number that was entered or the default value. If you want that number to remain the same, follow these instructions to turn on the height-above-ground function. If you want to change this number, you must follow the instructions to set (change) the height-above-ground value, described later in this section.

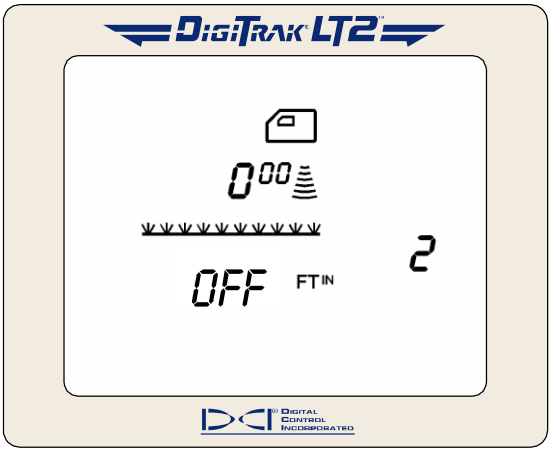


Height-Above-Ground “On” Screen

2. Hold the trigger in through the countdown/beep sequence from 2 to 0.
3. Release the trigger when the 0 is displayed, and a checkmark will briefly appear at the bottom of the display accompanied by three short confirmation beeps indicating this option has been selected. You have now turned on the height-above-ground function to the value displayed.
4. Release the trigger, and the display will return to the locating screen.

To turn off the height-above-ground function:

1. From the locating screen, click the trigger to advance to the height-above-ground menu. You will see the “On” option displayed.
2. Continue to hold the trigger in through the countdown/beep sequence from 2 to 0, and you will then see the “Off” option displayed.

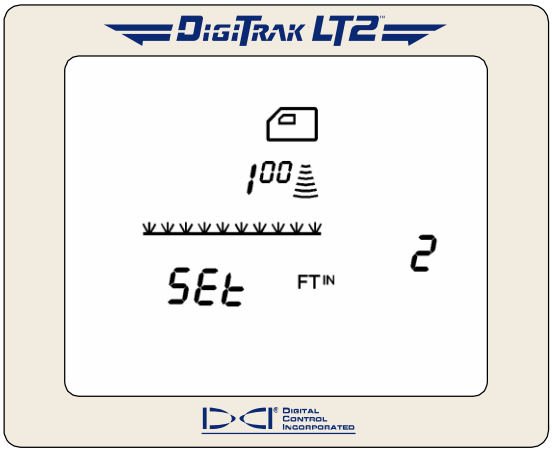


Height-Above-Ground “Off” Screen

3. Continue to hold the trigger in through the countdown/beep sequence from 2 to 0.
4. Release the trigger when the 0 is displayed, and a checkmark will briefly appear at the bottom of the display accompanied by three short confirmation beeps indicating this option has been selected. The height-above-ground function has now been turned off, and the display will return to the locating screen. With the height-above-ground function off, you must place the receiver on the ground for accurate depth readings.

To set or change the height-above-ground measurement:

1. Hold the LT2 receiver at the height which you intend to hold the receiver.
2. Using a measuring tape, measure the distance from the bottom of the receiver to the ground. This is your desired height-above-ground measurement.
3. From the locating screen, click the trigger to advance to the height-above-ground menu. You will see the “On” option displayed.
4. Continue to hold the trigger in through the countdown/beep sequence from 2 to 0, and you will then see the “Off” option displayed.
5. Continue to hold the trigger in through the countdown/beep sequence from 2 to 0, and you will see the “Set” option displayed.



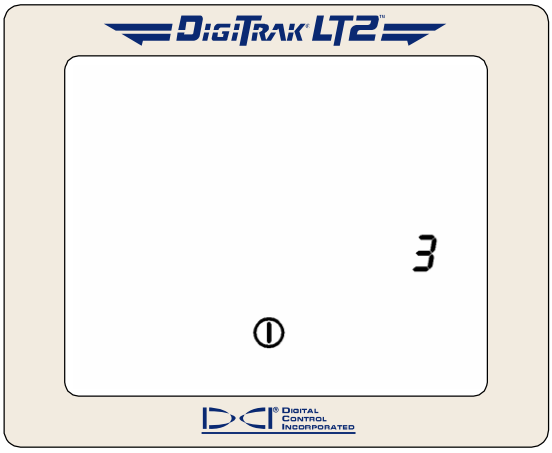
Height-Above-Ground “Set” Screen

6. Continue to hold the trigger in through the countdown/beep sequence from 2 to 0.
7. Continue to hold the trigger in, and the height-above-ground measurement will display starting at 12 in. (30 cm) and then counting up in 1-inch (2-cm) increments.
8. Once you see the desired height, according to the measurement you made in step 2, release the trigger, and a checkmark will appear at the bottom of the display accompanied by three short confirmation beeps indicating you have reset the height-above-ground value. The display will then automatically return to the locating screen with the height-above-ground function on.

POWER

This display menu allows you to turn off the receiver.

1. Click the trigger to advance to the power menu.
2. Hold the trigger in through the countdown/beep sequence from 3 to 0.



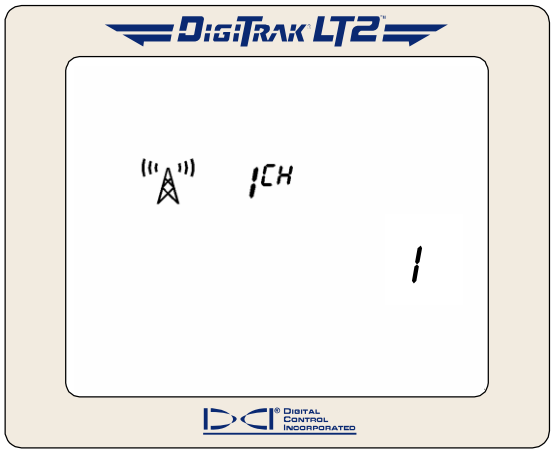
Power Off Screen

3. When the counter reaches 0, you will see a checkmark at the bottom of the display accompanied by four short confirmation beeps.
4. Release the trigger and the unit will shut off.

TELEMETRY

This display menu allows you to change the telemetry channel setting. This is the channel that the receiver uses to communicate with the remote display. The receiver and the remote display must be set to the same channel. There are four different telemetry channels (1, 2, 3, 4).

1. Click the trigger to advance to the telemetry menu, where the current channel setting is displayed.
2. Hold the trigger in through the countdown/beep sequence from 1 to 0.



Telemetry Channel Setting

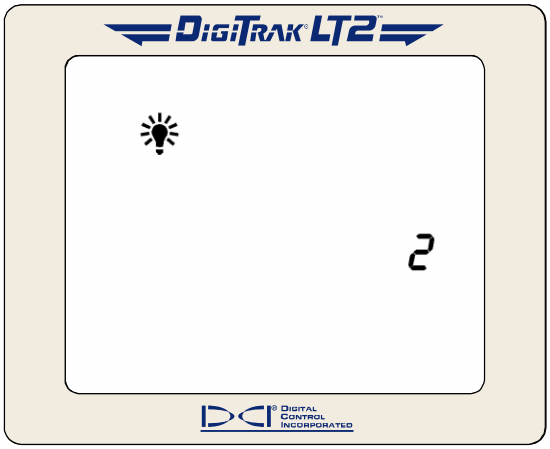
3. When the counter reaches 0, you will see a checkmark at the bottom of the display accompanied by four short confirmation beeps.
4. While still holding the trigger in, the channel setting will cycle through all five settings—Off, 1, 2, 3, 4. You will hear four short beeps each time the setting changes.
5. Release the trigger when the correct setting is displayed, and the display will then automatically return to the locating screen. To confirm, hold in the trigger for 2 seconds or more to display the channel setting.

BACKLIGHT

This display menu allows you to turn on or off the display backlight.

1. Click the trigger to advance to the backlight menu; a light bulb will appear on the display. If the backlight is on, the bulb will be lit up; if it is off, the bulb will appear unlit.
2. Hold the trigger in through the countdown/beep sequence from 2 to 0.

Backlight Is Turned Off



Backlight Is Turned On

3. Release the trigger when the counter reaches 0. The light bulb will either light up as the backlight comes on or become unlit as the backlight turns off, and you will hear four short confirmation beeps before the display automatically returns to the locating screen.

NOTE: The backlight automatically comes on for a few seconds at startup, and then it defaults to the off setting, even if you have set it previously.

1-PT CALIBRATION

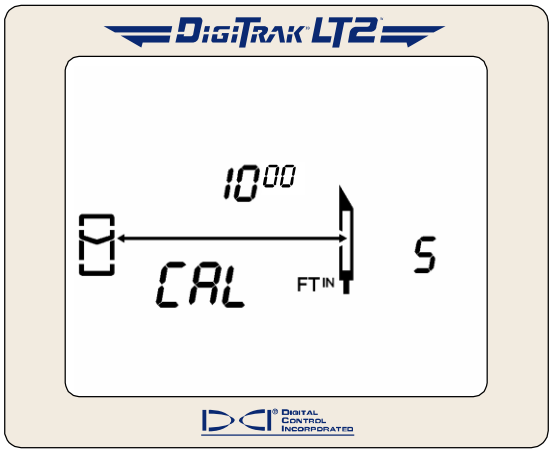
This display menu allows you to calibrate the receiver using the 1-point calibration procedure. The 1-point calibration procedure is performed with the transmitter in the housing, as described later in this section. DCI recommends that you verify that the receiver's depth readings are accurate at several locations using a tape measure before you drill. Calibration is necessary prior to first-time use and whenever a different transmitter, receiver, or housing is going to be used.

Do not calibrate if:

- You are within 10 ft (3 m) of metal structures, such as steel pipe, chain-link fence, metal siding, construction equipment, or automobiles.
- The receiver is over rebar or underground utilities.
- The receiver is in the vicinity of excessive electrical interference.
- The transmitter is not installed in the housing.
- The transmitter is not turned on.

NOTE:	Calibration is necessary prior to first-time use and whenever a different transmitter, receiver, or housing is going to be used.

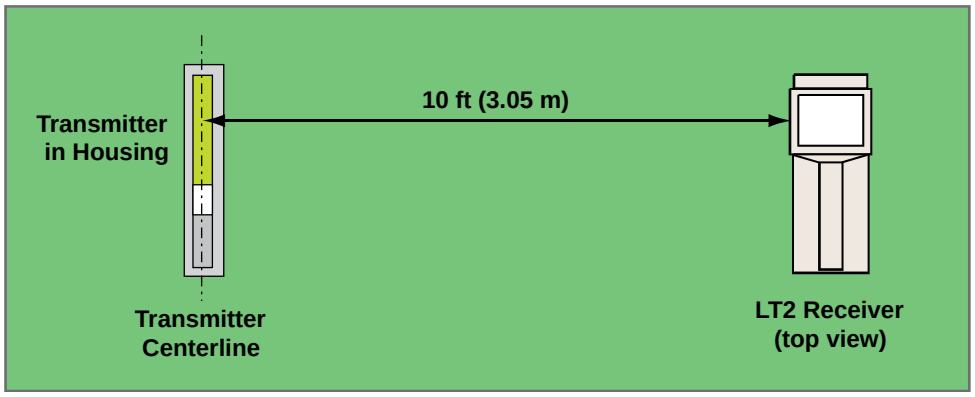
The 1-point calibration menu display appears as follows:



1-Point Calibration Screen

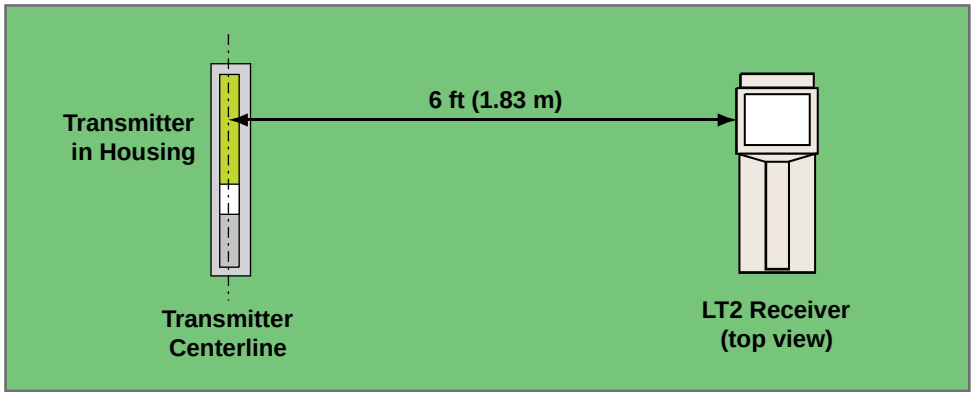
To calibrate the receiver:

1. Using a tape measure, place the receiver on the ground parallel to and level with the transmitter (powered on and in housing) so that the distance from the centerline of the transmitter to the inside edge of the receiver is 10 ft (3.05 m), as shown in the figure given below.



Setup for 1-Point Calibration

2. Hold the trigger in on the receiver, and verify that roll and pitch readings are present and that the signal strength is stable. Then, click the trigger to advance to the 1-point calibration screen.
3. Hold the trigger in while holding the receiver steady through the countdown/beep sequence from 5 to 0.
4. Release the trigger when the counter reaches 0. You will see a checkmark at the bottom of the display accompanied by three confirmation beeps indicating a successful calibration. If you see a checkmark with a slash through it (✓) and hear a short beep followed by two long tones, then the calibration has failed, and you must repeat steps 2 through 4. The error screen will display for approximately 30 seconds before returning to the locating screen.
5. After you have successfully calibrated the receiver, the display will automatically return to the locating screen. You must now verify the calibration by checking depth readings at three locations.
6. To verify calibration, place the receiver on the ground parallel to and level with the transmitter so that the distance from the centerline of the transmitter to the inside edge of the receiver measures a given amount on the tape measure; in the example shown in the figure below, a distance of 6 ft (1.83 m) is used.



Verifying Calibration

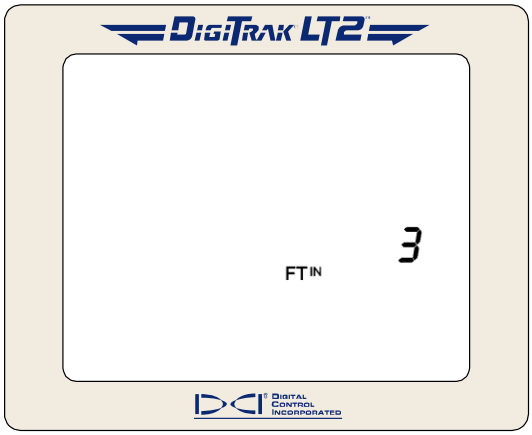
7. You should see a depth reading that matches this measured distance, which in our example would be 6 ft (1.83 m).*
8. Repeat the above two steps in at least two more locations.

*Depth tolerance is 5%; thus, at a distance of 6 ft (1.83 m), the error tolerance is 3.6 in. (9 cm).

DEPTH UNITS

This display menu allows you to set the LT2 system to display values (depth and temperature) in either English units (FT^{IN} or “in” and °F) or metric units (M^{CM} and °C).

1. Click the trigger to advance to the depth units menu. The display will indicate the current setting.
2. Hold the trigger in through the countdown/beep sequence from 3 to 0.



Depth Units Display Menu

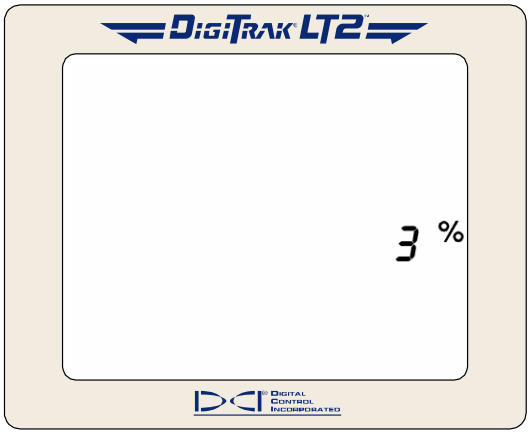
3. When the counter reaches 0, you will see the unit setting change and a checkmark appear at the bottom of the display accompanied by four confirmation beeps. If the desired units are not displayed after the check mark appears, continue to hold the trigger in through the next count down sequence.
4. Release the trigger when the desired units are displayed. The display will then automatically return to the locating screen.

NOTE:	If you change the depth units between English and metric, the height-above-ground setting will revert to the default value.

PITCH UNITS %

This display menu allows you to set the LT2 system to display pitch values in either degrees or percent of slope.

1. Click the trigger to advance to the pitch units menu. The display will indicate the current setting.
2. Hold the trigger in through the countdown/beep sequence from 3 to 0.



Pitch Units Display Menu

3. When the counter reaches 0, you will see the unit setting change and a checkmark appear at the bottom of the display accompanied by four confirmation beeps.
4. Release the trigger, and the display will automatically return to the locating screen.

Transmitter

Types of LT2 Transmitters

DCI manufactures two different battery-operated transmitters for use with the LT2 system—the standard-range LT transmitter (bright-green tube) and the short-range LS2 transmitter (brown tube). The transmitter fits inside the drill housing and transmits information regarding the drill head location, position, and heading. An index slot at the front end assists in properly aligning the transmitter in the housing. The transmitter emits electromagnetic signals at a frequency of 12 kHz that the LT2 receiver "hears" and converts into the information shown on the receiver and remote display screens.

The transmitter and receiver must both have matching global designation numbers to ensure that they comply with regional operating requirements. The global designation number is located near the serial number on the transmitter's battery compartment, as shown by the number inside the globe icon (🌐) in the photo below. This number must match that of your receiver for proper communication. To determine your receiver's global designation number, see the startup screen shown under "Turning On the Receiver" in the *Receiver* section.

The standard-range LT transmitter provides a depth range of 40 ft (12.2 m) and is 15.00 in. (381.0 mm) long and 1.25 in. (31.8 mm) in diameter. It is powered by two C-cell alkaline batteries or one DCI SuperCell lithium battery.

Standard-Range LT Transmitter

The short-range LS2 transmitter provides a depth range of approximately 15 ft (4.6 m) and is 8.00 in. (203 mm) long and 1.00 in. (254 mm) in diameter. It is powered by one AA alkaline battery.

Short-Range LS2 Transmitter

NOTE: The range of any transmitter with any DCI receiver is largely dependent upon the amount of interference at a job site. The range decreases as interference increases.

Transmitter Batteries

Transmitter Battery Status Display Symbol

The standard-range LT transmitter is powered by two C-cell alkaline batteries or one DCI SuperCell lithium battery, and the short-range LS2 transmitter is powered by one AA alkaline battery.

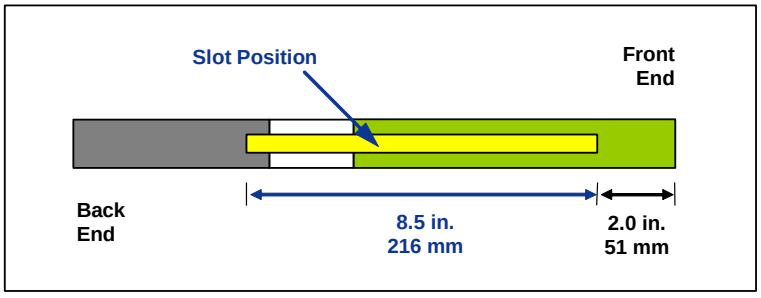
To install batteries into the transmitter, remove the battery cap by rotating it counterclockwise using a tool such as a large flat screwdriver inserted in the notch in the battery cap. Insert the batteries positive terminal first, and replace the battery cap ensuring the cap bottoms out for proper seal.

The transmitter battery symbol at the bottom of the display screen continuously shows the status of the transmitter battery power using progress bars that decrease as the battery power is used. The battery is fully charged when it shows seven bars.

Transmitter Housing Requirements

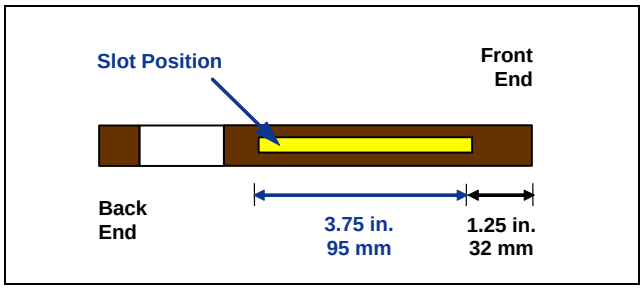
To achieve maximum range and battery life for all of DCI's transmitters, the slots in the drill housing must be long enough and correctly positioned. Slot measurements should always be taken from the inside of the housing. DCI recommends at least three slots equally spaced around the circumference of the housing. The slots should be at least 1/16 or 0.0625 in. (1.6 mm) wide.

For the standard-range LT transmitter (15.00 in./381 mm long), each slot should begin at least 2.0 in. (51 mm) and not more than 3 in. (76 mm) from the front of the transmitter and must be at least 8.5 in. (216 mm) long (see figure below).



LT Transmitter Housing Slot Requirements

For the short-range LS2 transmitter (8.00 in./203 mm long), each slot should begin at least 1.25 in. (32 mm) and not more than 2 in. (51 mm)from the front of the transmitter and must be at least 3.75 in. (95 mm) long (see figure below).

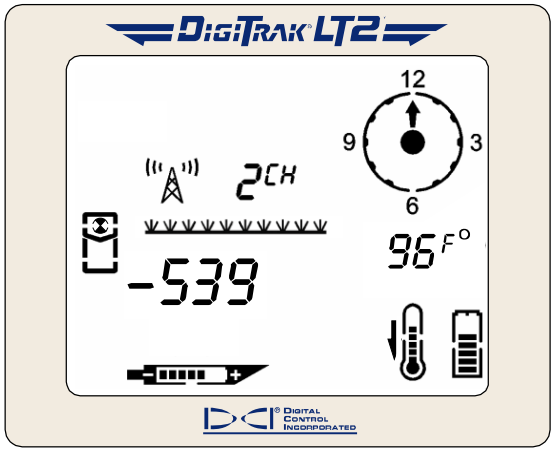


LS2 Transmitter Housing Slot Requirements

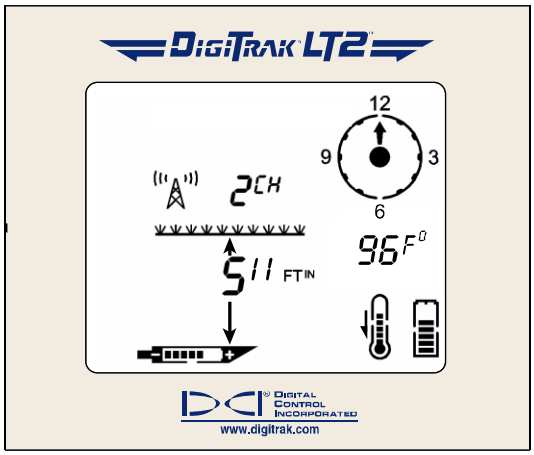
Transmitter Temperature

Transmitter Temperature Display Symbol

The transmitter temperature symbol at the bottom of the display gives an indication of the temperature, with progress bars and an up or down arrow. An up arrow accompanied by a beep indicates the temperature is increasing; a down arrow indicates the temperature is decreasing. A digital temperature reading can be viewed below the clock in place of the pitch by holding in the trigger. The drill rig operator can view the transmitter temperature by holding in the function button on the remote display. Drilling should be suspended when temperatures reach 95°F (35°C) to permit cooling.



Receiver Display Screen Showing Transmitter Temperature



Remote Display Screen Showing Transmitter Temperature

If the transmitter reaches 118°F (48°C), the receiver will emit warning tones at regular intervals (see table below), and the transmitter temperature symbol will change to indicate the transmitter has reached a dangerous temperature—three curved lines will be seen extending from the top of the thermometer, and the thermometer symbol will appear full, as shown in the figure to the right. When the transmitter temperature reaches 140°F (60°C), the thermometer symbol will flash and the beeps from the receiver will become more rapid (see table below).

Dangerous Transmitter Temperature Indicator

The warning tones that will be emitted due to transmitter temperature overheat are summarized in the following table. Warning tones will occur for every 7°F (4°C) increase in temperature unless otherwise noted in this table.

Transmitter Temperature Warning Tones

Temperature	Warning Tones
Below 90°F (32°C)	Double-beep sequence (beep-beep)
From 96°F–111°F (36°C–44°C)	Two double-beep sequences (beep-beep, beep-beep)
From 118°F–133°F (48°C–56°C)	Three double-beep sequences (beep-beep, beep-beep, beep-beep)
From 140°F–169°F (60°C–76°C)	Three double-beep sequences every 5 seconds
Above 169°F (76°C)	Continuous triple-beeps; transmitter shuts down above 176°F (80°C)

The transmitter also has a temperature overheat indicator (temp dot) that has an outer yellow ring with a 1/8-inch (3-mm) white dot in the center. This temp dot is located on the stainless-steel front end cap. The temp dot should be white if the transmitter has not been exposed to excessive heat. If the temp dot is silver or gray, it indicates the transmitter has been exposed to heat but not in excess of the specifications. A black temp dot indicates the transmitter has been exposed to temperatures in excess of 220°F (104°C) for an LT transmitter and in excess of 180°F (82°C) for an LS2 transmitter.

Front End Cap of Transmitter Showing Temp Dot, Index Slot, and Black Temp Dot

If the temp dot is black, the transmitter should be considered unreliable. If the transmitter overheats, it may appear to operate normally; however, exposure to excessive temperatures greatly increases the likelihood of inaccurate information and will contribute to premature failure of the transmitter. The DCI warranty does not apply to any transmitter that has been overheated or that has had its temp dot removed.

Avoid transmitter overheating by practicing proper drilling techniques. Abrasive soils, clogged jets, inadequate mud flow, and poorly mixed mud are some of the factors that can contribute significantly to the risk of an overheated transmitter.

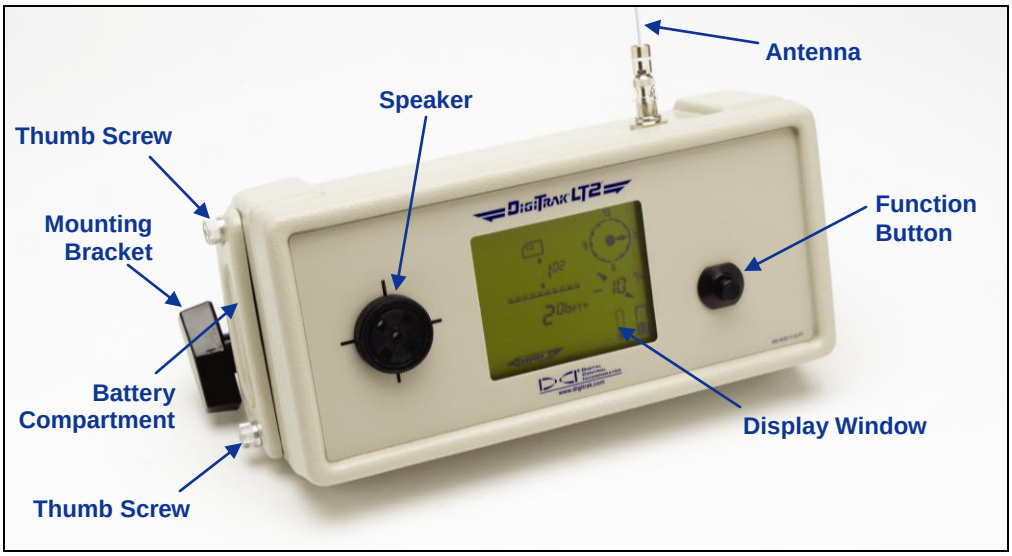
Sleep Mode (Automatic Shutoff)

LT2 transmitters will shut down (go into “sleep” mode) to conserve battery power if they are stationary for 15 minutes. To “wake up” the transmitter, simply rotate the drill string.

General Transmitter Care Instructions

- Clean the springs in the battery compartment and the threads of the battery cap and O-ring to provide proper signal return and watertight seal for the batteries. Emery cloth can also be used to remove any oxidation buildup.
- Verify that the transmitter fits snugly in the housing. It may be necessary to wrap the transmitter with tape or O-rings.
- Send in the Product Registration card for the 90-day limited warranty.

Remote Display

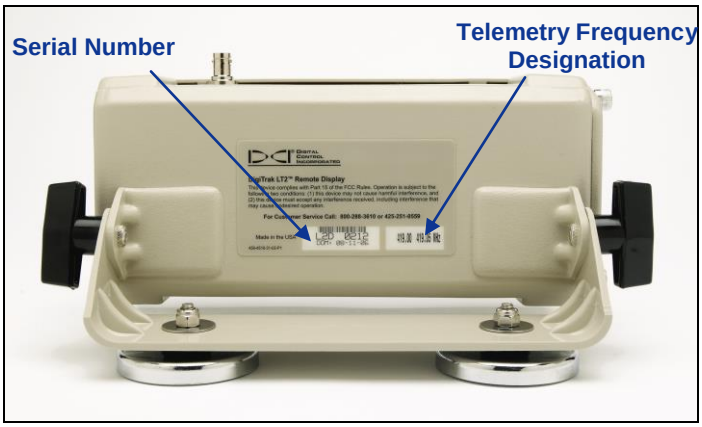


DigiTrak LT2 Remote Display

General Description

The DigiTrak LT2 remote display, which is located at the drill rig, receives signals from the LT2 receiver and displays that information on the remote display window. The remote comes with an antenna that must be attached before drilling. The speaker to the left of the display window emits audible tones to accompany menu changes and to warn the operator if the transmitter temperature is increasing.

To meet global requirements and for proper communication; the frequency designation shown on the remote display's serial number label (see figure below) must match that shown on the receiver. To determine the receiver's frequency designation, see the figure showing the receiver back label in the "Turning On the Receiver" discussion in the *Receiver* section.



Back of Remote Display Showing Serial Number and Telemetry Frequency Designation

The remote display has a main display screen and four menu options (power off, telemetry channel settings, backlight on/off, and hour meter). The power on/off functions, including instructions for installing the battery, the main display screen, and the remote display menu options are explained in this section.

Power On/Off

Installing the Battery Pack

1. Remove the battery compartment cover from the side of the remote display by rotating the thumb screws counterclockwise.
2. Insert a fully charged battery pack terminal end first with exposed terminals aligned with springs in battery compartment.
3. Replace the battery compartment cover and tighten the thumb screws by rotating them clockwise.

Turning On the Remote Display

The function button on the remote works similarly to the trigger on the receiver. To turn the LT2 remote on, press or click the function button. You will hear a long tone followed by a set of numbers that represent the firmware versions in the remote display.

Turning Off the Remote Display

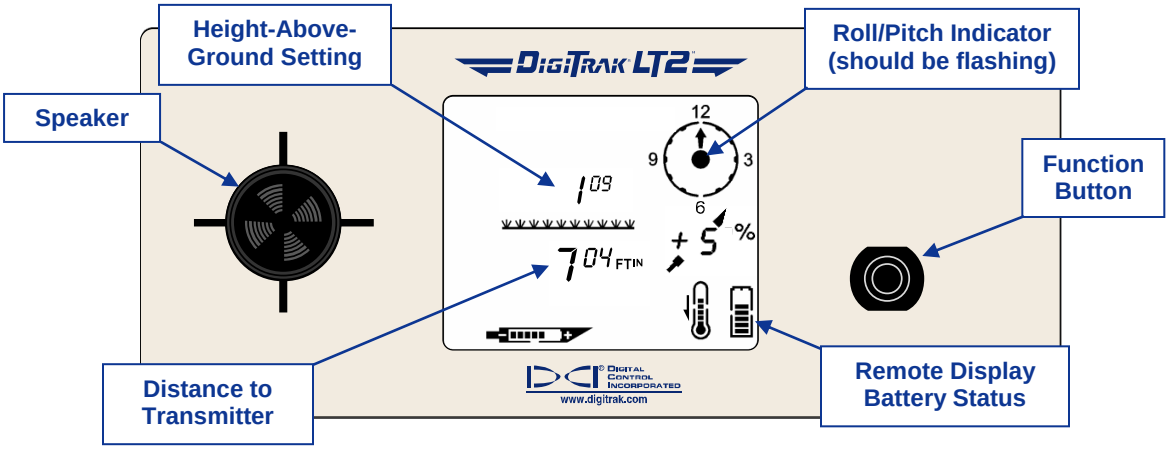
To turn the remote off, you must first access the power off menu (see “Remote Display Menus”). Press or click the function button to reach the power off menu, then hold the button in during the countdown from 3 to 0 to shut the remote off; you will hear a beep each time the counter decreases followed by three short confirmation beeps before the unit shuts off.

Automatic Shutoff

The remote display will automatically shut itself off without an audible indicator if no data is received for 15 minutes.

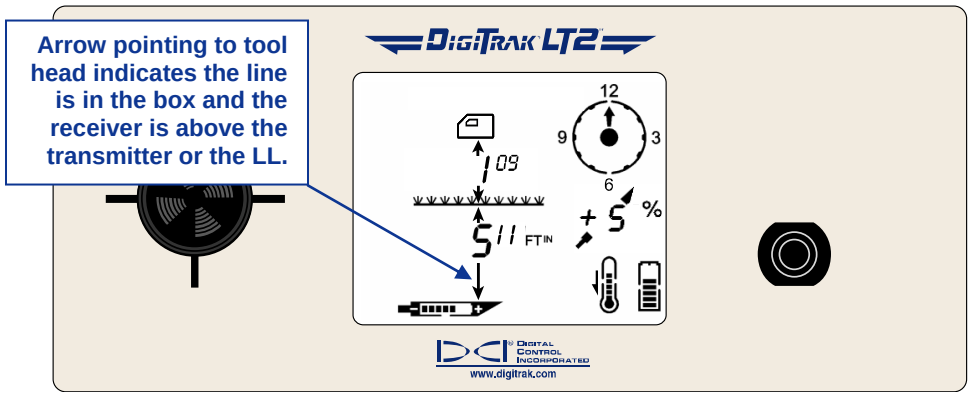
Main Display Screen

The main remote display screen shows information sent from the receiver in a format very similar to the display on the receiver. However, the battery status symbol displays the status of the remote display battery rather than that of the receiver, as shown in the following drawing.



Main Remote Display Screen

The main display screen indicates when the receiver is over the transmitter or the locate line (LL) by showing arrows above and below the depth value, as shown in the following figure. The receiver display will show the line in the box.

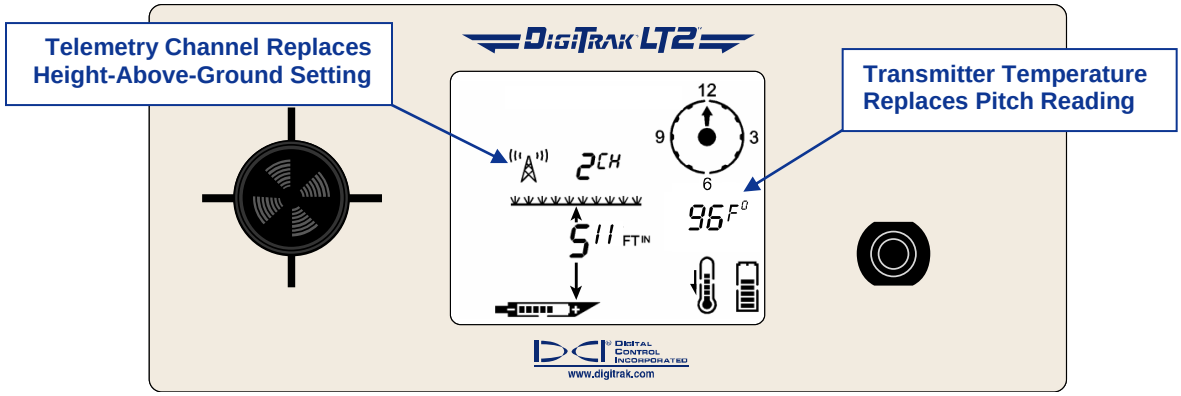


Depth Reading When Receiver Is Above Transmitter or LL

In this display, the downward arrow is pointing to the transmitter to indicate that the reading is the actual depth of the transmitter or LL. If there is not an arrow pointing down from the depth reading, then the depth value shown indicates the slant distance (see *Locating Instructions* section).

NOTE:	If you see four dashed lines (— — — —) where the distance/depth number should display, then the receiver is too close to the transmitter and it is getting saturated with signal (see "Height Above Ground" menu discussion in the *Receiver* section).

By holding in the function button for 2 seconds or more, the transmitter temperature will display in place of the pitch information and the telemetry channel will display in place of the height-above-ground setting, as shown in the following figure.



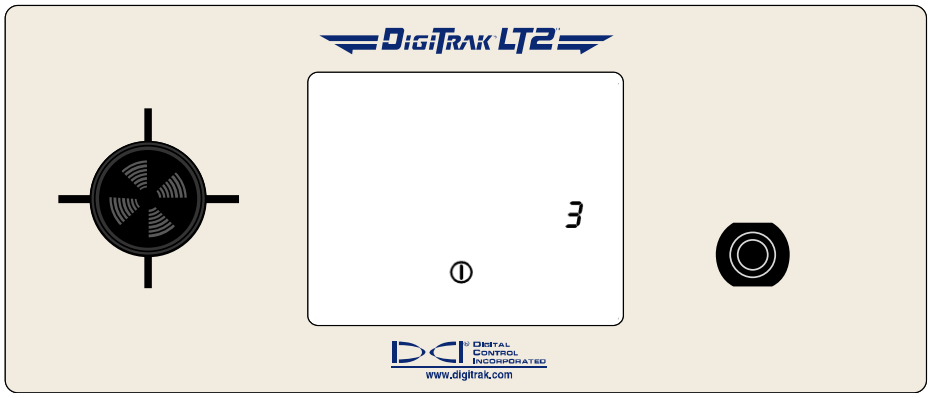
Function Button Held In

Remote Display Menus

To access the remote display menus, click or press the function button. Each click advances you to the next menu item. The function button on the remote works in the same manner as the trigger on the receiver (see “Accessing and Changing Menu Settings” in the *Receiver* section).

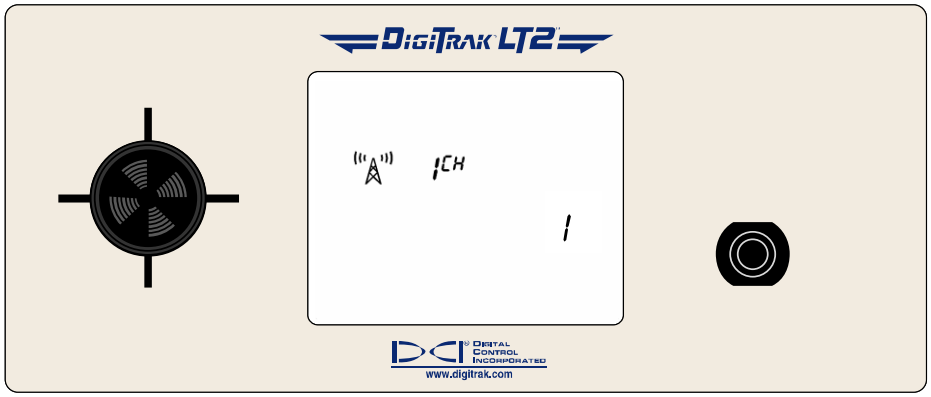
Power Off

Click the button once to display the power off menu, as shown in the following picture. Hold the button in for the countdown sequence from 3 to 0 to turn the unit off. Three short confirmation beeps will be heard as the unit shuts down. The remote display will automatically shut itself off without an audible indicator if no data is received for 15 minutes.



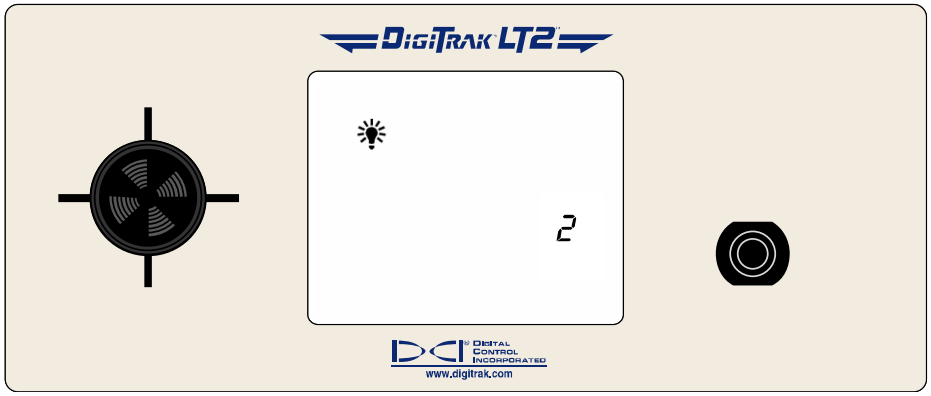
Telemetry Channel Settings

The telemetry channel menu allows you to change the telemetry channel setting and is accessed by clicking the button twice. With the telemetry channel menu displayed, as shown in the following picture, hold the button in to cycle through the four channel options (1, 2, 3, 4), and release when the desired setting is selected. You will hear three short confirmation beeps and see the channel number change on the display.



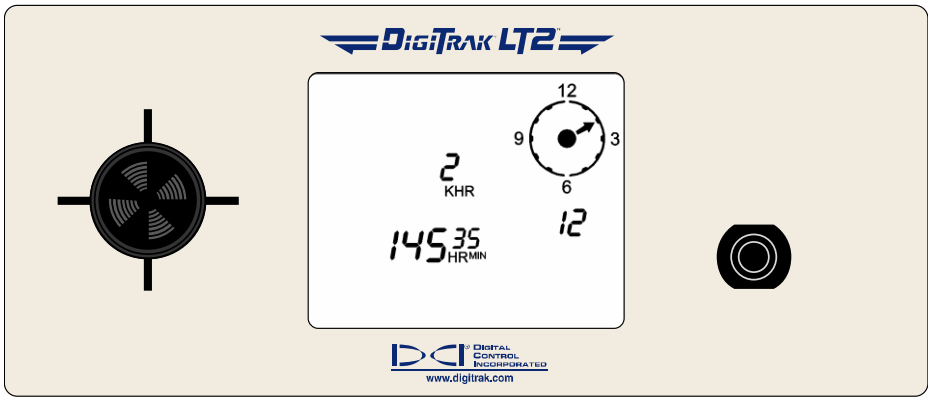
Backlight On/Off

The backlight on/off menu option is accessed by clicking the button three times. At the backlight on/off menu option, shown in the following picture, hold the function button in to turn the display backlight on or off. The remote will emit a beep with the countdown sequence followed by three short confirmation beeps when the menu item is successfully changed.

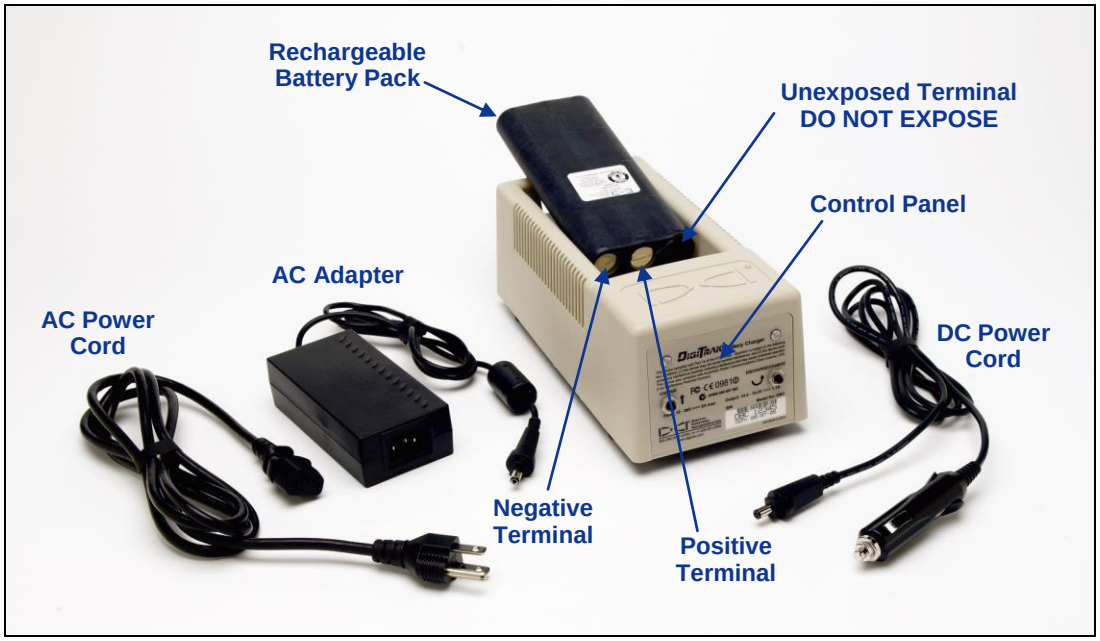


Hour Meter

The hour meter menu option displays the amount of time that the remote display unit has been running (turned on) and is accessed by clicking the button four times. In the following picture, the hour meter shows that the remote display unit has been running for 2,145 hours, 35 minutes, and 12 seconds. Click the function button once to exit the hour meter and return to the main information screen.



Battery Charger



Battery Charger

General Description

The DCI battery charger unit, which includes AC and DC power cords and an AC adapter, is provided with the LT2 system, along with three rechargeable DCI battery packs. The battery packs are used to power the LT2 receiver and the remote display.

The battery charger can operate from AC (100–240 V) or DC (12–28 V) power sources. The battery charger has specific cords for AC or DC power sources, as shown in the photo above. The AC power cord is also specific to your global geographic area of operation.

A fully charged battery pack measures between 16.5 V and 17.1 V and will power an LT2 receiver for approximately 8 hours or an LT2 remote display for approximately 12 hours before recharging is required. A battery is considered discharged at 14.4 V.

Only two terminals are exposed on a battery pack (as shown in above photo). If the third terminal becomes exposed or the insulating material over the battery shows signs of damage, the battery pack must be replaced through an authorized dealer.

Charging or using damaged or non-DCI battery packs may damage the charger, the receiver, or the remote display, and will void the warranty.

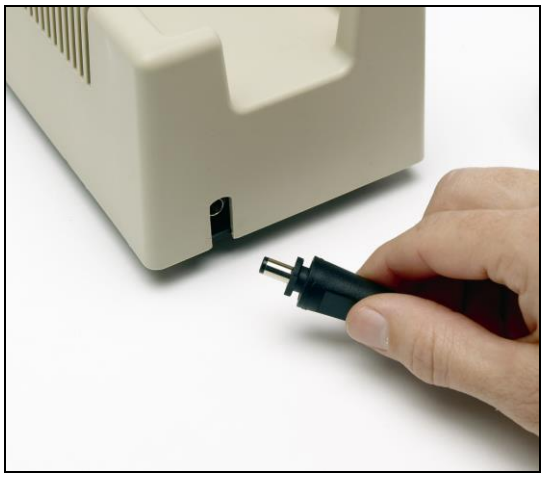
AC/DC Power Setup

To install either the AC adapter or the DC power cord, insert the charger plug into the power port on the back of the battery charger (see photo to right) and rotate a quarter turn in either direction to lock it in place.

If using AC power, connect the AC power cord to the power adapter, then plug the cord into the AC power receptacle (wall outlet).

If using DC power, plug the DC power cord directly into the DC power receptacle.

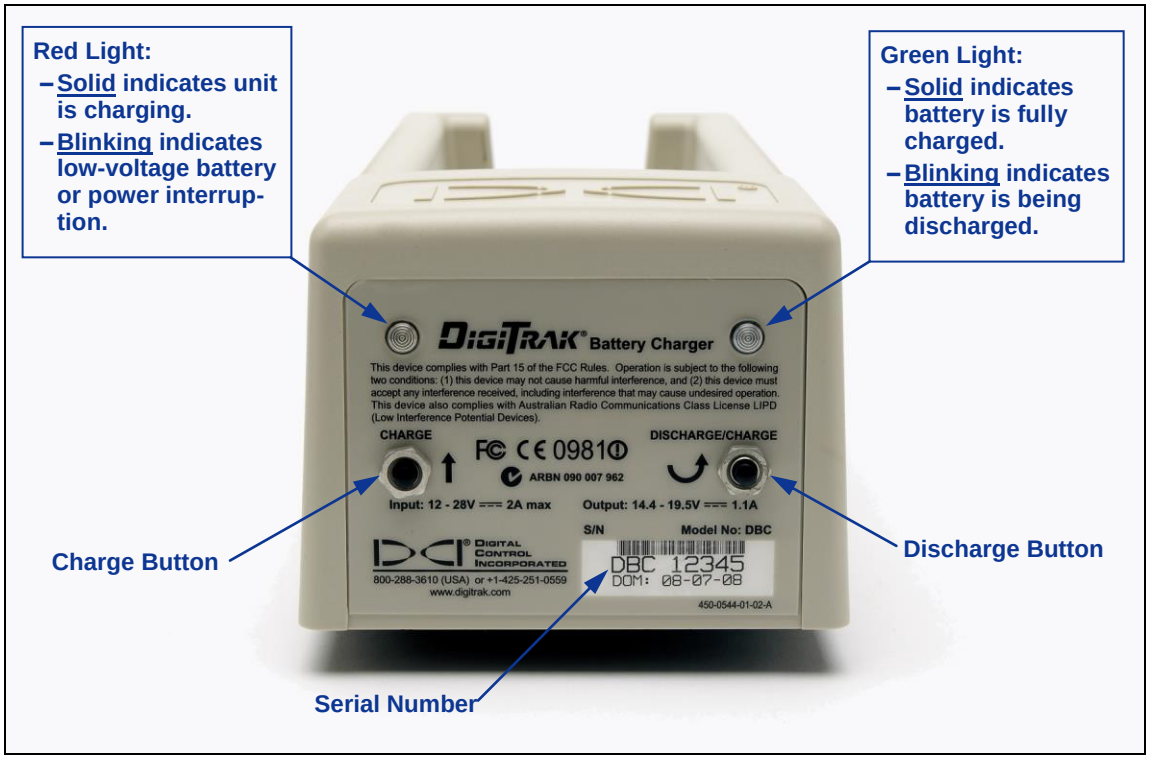
Your battery charger is now ready to use.



Inserting Charger Plug into Power Port

Charging a Battery

1. With power supplied to the battery charger, place a battery pack into the charger with the terminal end making contact with the springs in the battery charger. The red light will illuminate, indicating that the battery is charging. However, the battery may require discharging to remove any residual charge and prolong the battery life; DCI recommends that you discharge a battery pack, as instructed in step 2, at least once a month.



Battery Charger Control Panel

NOTE: If a battery becomes drained below 4 V, the charger will not immediately recognize the battery. Leave the battery in the charger and press the charge button. Within a few minutes, the red light will begin to blink indicating the charger has recognized the battery. The red light will illuminate solidly within 30 seconds to 1 minute indicating that the battery is charging on a full cycle.

2. If the battery needs discharging, press the discharge button on the battery charger; the green light will begin to blink indicating the battery is being discharged. When the battery is completely discharged, the green light will stop blinking and the charge cycle will automatically start, as indicated by the solid red light.

NOTE: The discharge cycle may last for up to 4 hours depending on the amount of residual charge in the battery. Typically, discharging will last for just a few minutes if the LT2 receiver or remote has indicated low battery voltage.

3. When the charging cycle is complete, the green light will automatically illuminate indicating that the battery is charged and ready for use. The battery may take up to 4 hours to charge. The voltage on a fully charged battery is between 16.5 V and 17.1 V.

NOTE: If a battery is left in the charger during a power interruption, the red or green light may flash and the battery will begin to discharge on its own. After the power has resumed, simply remove and replace the battery pack.

Locating Instructions

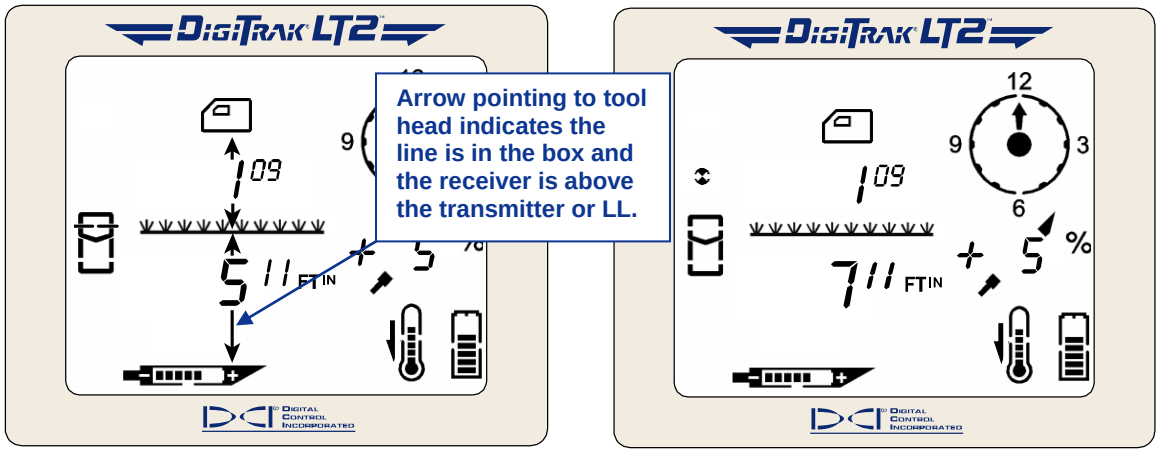
Introduction

The DigiTrak LT2 Locating System is easy to use, but there are basic principles that must be understood before you begin to operate the system. This section gives important information regarding the depth or slant distance; the locate points and locate line; the geometry of these elements with respect to the transmitter; and the proper method for marking locate points once they are found. It then describes the standard locating procedure and an alternate technique referred to as the plus/minus method. The last section discusses tracking the transmitter when you cannot walk over it, which is called off-track locating.

For a detailed explanation of how to track the transmitter when it is steep and deep, please read the information provided in Appendix B: Projected Versus Actual Depth and Fore/Aft Offset.

Depth or Slant Distance

When the receiver is held directly above the transmitter, the distance to the transmitter is referred to as the depth. At any other location, the distance is referred to as the slant distance. When the depth is displayed, there will always be arrows pointing up and down from the depth reading. If the arrows are not displayed, then the reading is actually the slant distance.



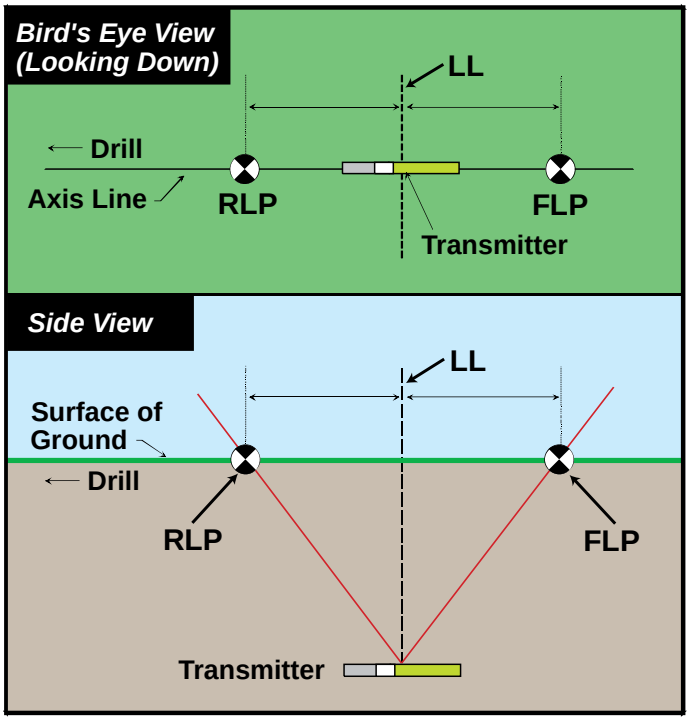
Line in the Box
Arrows indicate reading is actual depth.

Target Moving Toward the Box
No arrows indicate reading is slant distance.

NOTE:	If the transmitter is shallower than approximately 24 in. (61 cm) you will see four dashed lines (— — — —) where the depth should display. This means that the receiver is too close to the transmitter and it is getting saturated with signal (see “Height Above Ground” menu discussion in the *Receiver* section).

Locate Points (FLP & RLP) and Locate Line (LL)

Two of the three locations used for locating are points that represent extensions of the transmitter. One point is in front of the transmitter (the front locate point or FLP), and the other is behind the transmitter (the rear locate point or RLP). The third location is a line that represents the position of the transmitter. This line, referred to as the locate line or LL, is perpendicular to the transmitter at 0% slope.



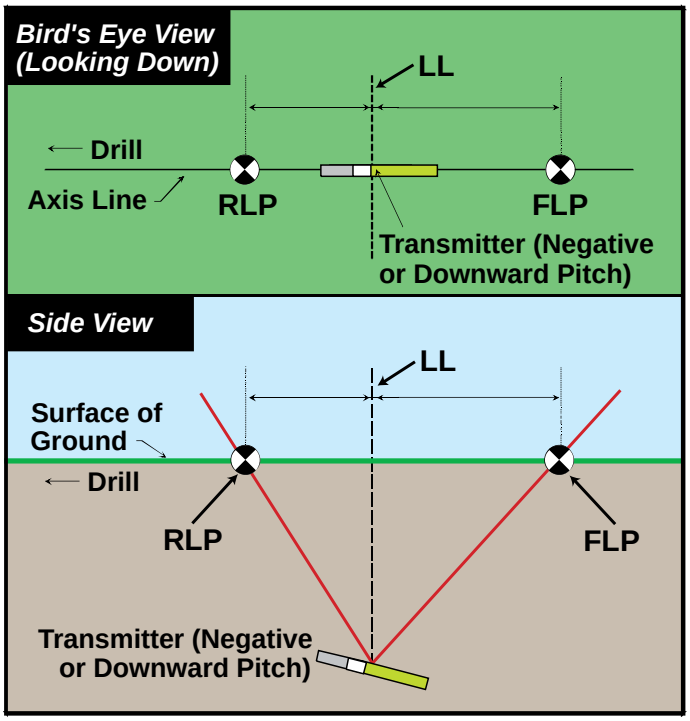
Geometry of FLP, RLP, and LL from Top and Side Views
Note how the RLP and FLP are equal distances from the LL when the transmitter is level.

NOTE:	If the transmitter pitch exceeds ±30% (or 17°) and/or the transmitter depth exceeds 15 ft (4.5 m), the position of the locate line will be somewhat ahead of or behind the transmitter's actual position; the depth displayed on the receiver is referred to as the projected depth. Refer to Appendix B: Projected Versus Actual Depth and Fore/Aft Offset, for information regarding this situation.

Effects of Depth, Pitch, and Topography on Distance Between FLP and RLP

Because of the transmitter's field shape, the deeper the transmitter is, the further apart the FLP and RLP will be. The distance between the FLP and RLP with respect to the location of the LL is also a function of the transmitter pitch and the topography. (For more information on these topics, please see Appendix B: Projected Versus Actual Depth and Fore/Aft Offset.)

When the transmitter pitch is negative, the FLP will be further from the LL than the RLP (see figure below). When the transmitter pitch is positive, the RLP will be further from the LL than the FLP. If the ground surface or topography slopes significantly, the locations of the FLP and RLP will also be affected with respect to the LL even though the transmitter itself is level.



Effect of Pitch on Distance Between FLP, RLP, and LL

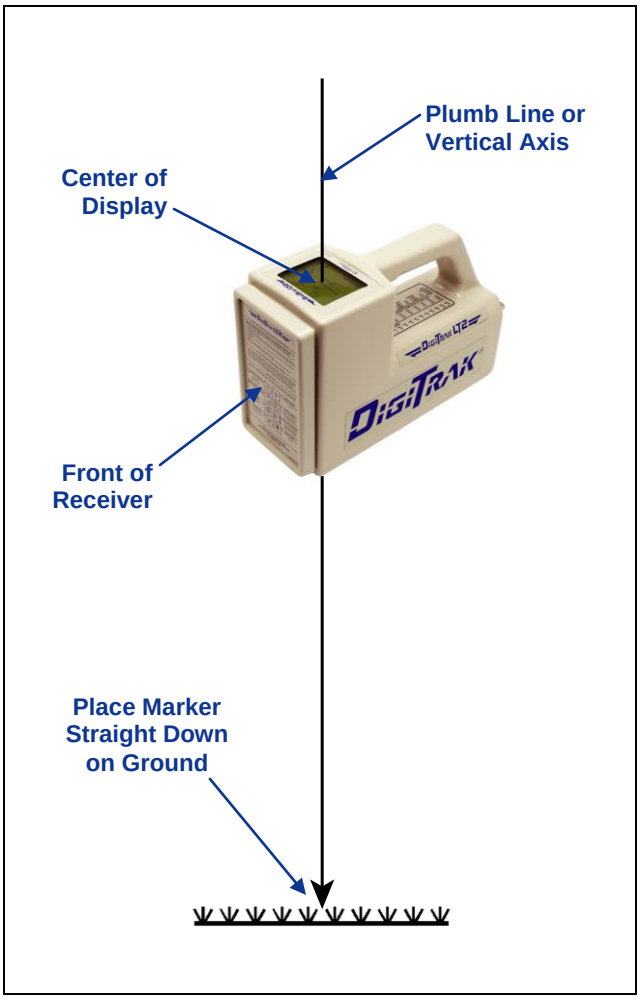
Note how the RLP and FLP are at different distances from the LL when the transmitter is at a negative pitch (compare with figure on previous page in which transmitter is level).

It is possible to calculate depth (as a comparison to the receiver's depth reading) using the distance between the locate points and pitch. For additional information, please see Appendix C: Calculating Depth Based on Distance Between FLP and RLP.

It is also possible to track the locate line when walk-over locating is not feasible, such as when surface obstructions or interference occur. For more information about this feature, called off-track locating, see "Off-Track Locating" at the end of the *Locating* section.

Marking Locate Points

The front and rear locate points (FLP and RLP) and the locate line (LL) must be found and accurately marked during the locating procedure. To mark a locate position after you have found it, stand with the receiver level directly above the locate point. Look down the vertical axis that runs through the center of the display to project a plumb line to the ground. The point where this plumb line hits the ground is the location that you should mark.



Plumb Line for Marking Locate Points

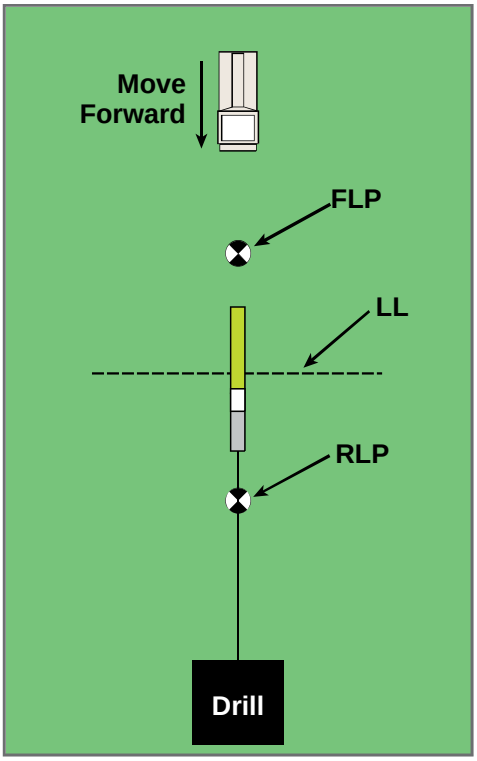
HANDLING THE RECEIVER

NOTE: It is critical that you hold the receiver correctly to obtain accurate readings. You must hold the receiver **level at all times** and maintain a **constant height-above-ground distance** that matches the value it has been set to (see "Height Above Ground" menu discussion in the *Receiver* section).

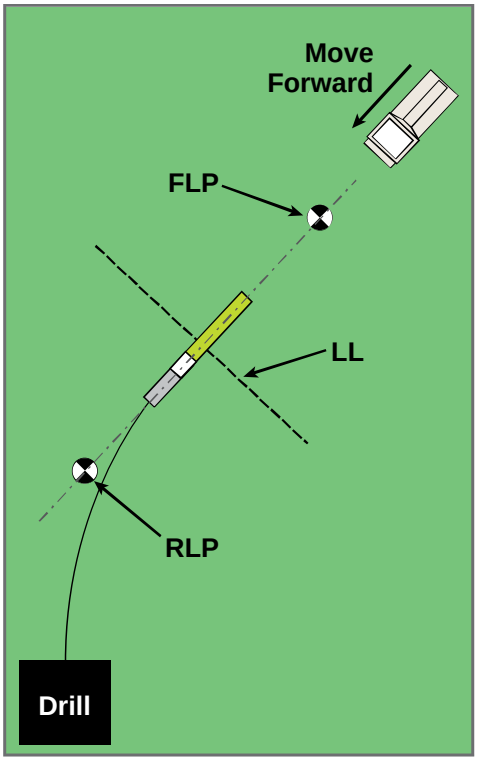
Standard Method for Locating the Transmitter

With the LT2 system, you can locate the transmitter *and* its heading while it moves, whether standing in front of it, behind it, or toward the side. You can also locate the transmitter facing either toward or away from the drill rig.

The standard method described in this section guides you to the transmitter while standing out in front of it, facing the drill rig. This is the recommended method for locating. As you continue to drill or as the bore path curves, you may be facing the last marked locate point rather than the drill rig.



Setup for Standard Locating Method

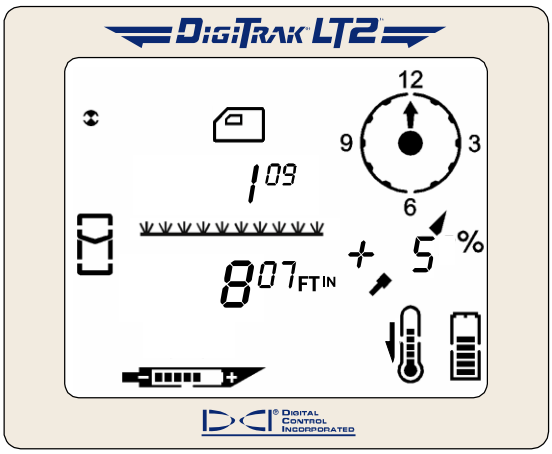


Standard Locating Method with a Curved Path

It is not necessary to hold the trigger in to view the depth/slant distance when using the standard method. If you want to view the signal strength (with its associated plus/minus symbols) while locating, please refer to the next subsection entitled “Plus/Minus ("+/–") Method for Locating the Transmitter.”

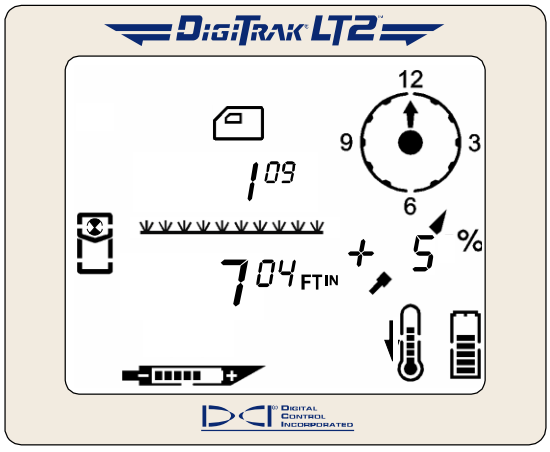
Finding the FLP

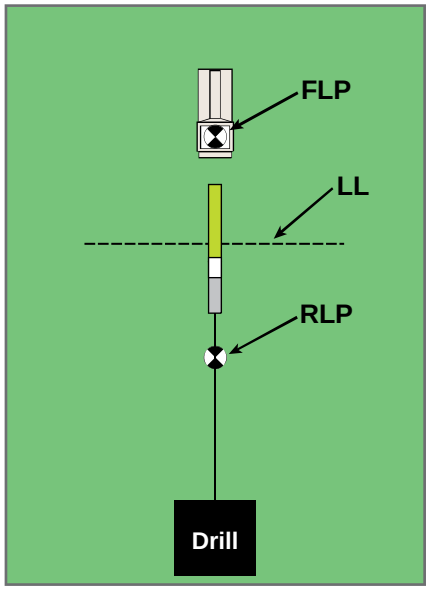
The first position to find is the front locate point or FLP. The FLP gives you the transmitter heading. The FLP's distance ahead of the transmitter is dependent upon the transmitter depth and pitch; the deeper it is, the further in front the FLP will be. The FLP is represented as a target ( ) on the receiver display.



Target in Top Left Corner

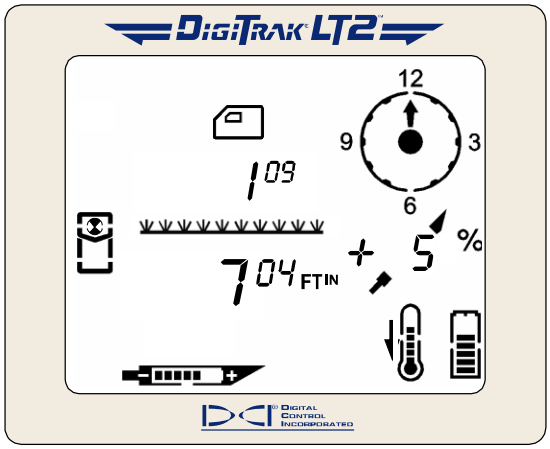
1. Stand out in front of the drill head (facing the drill) at a distance of approximately one drill rod length.
2. As you approach the FLP, the target appears in the top left corner of the display and the depth number decreases.
3. Continue to walk forward until the target moves into the locating icon (box). You have found the fore/aft position of the FLP; the next step will describe how to find the left/right position of the FLP.



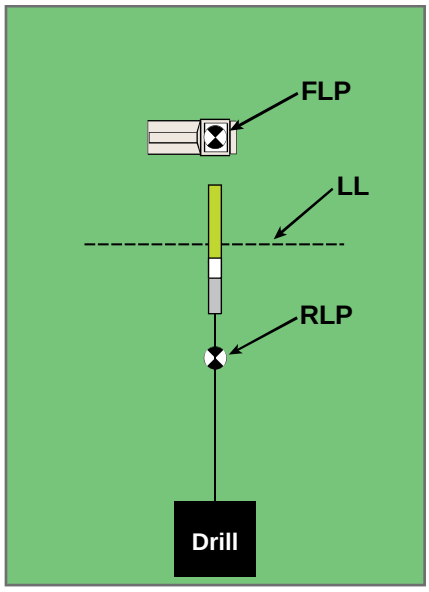


Target in the Box at the FLP Fore/Aft Position

4. Turn the receiver 90° from the transmitter heading while holding the receiver steady and level, and again center the target in the box by moving the receiver forward or backward as needed. This is the FLP, which is where the transmitter will end up if it does not get a steering command.
5. Mark the location directly below the display screen as the FLP.



Target in the Box at the FLP



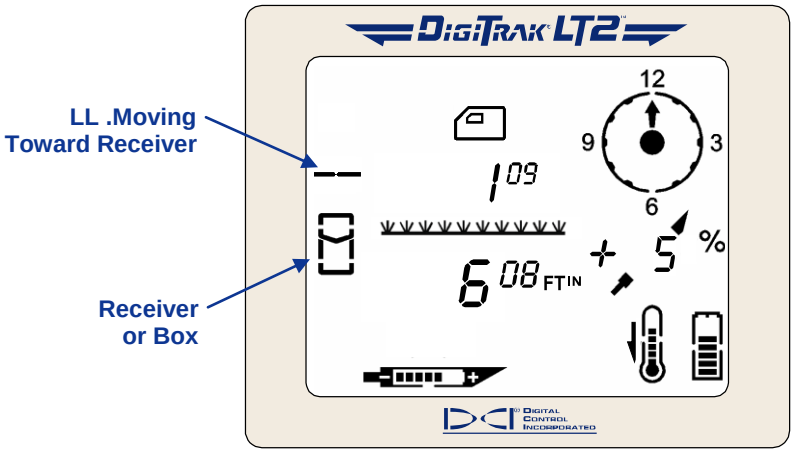
Turn Receiver 90° and Move Back and Forth to Center Target in Box at FLP

NOTE:	Both active and passive interference sources can affect the accuracy of the locate points and depth readings.

Finding the Transmitter and the LL

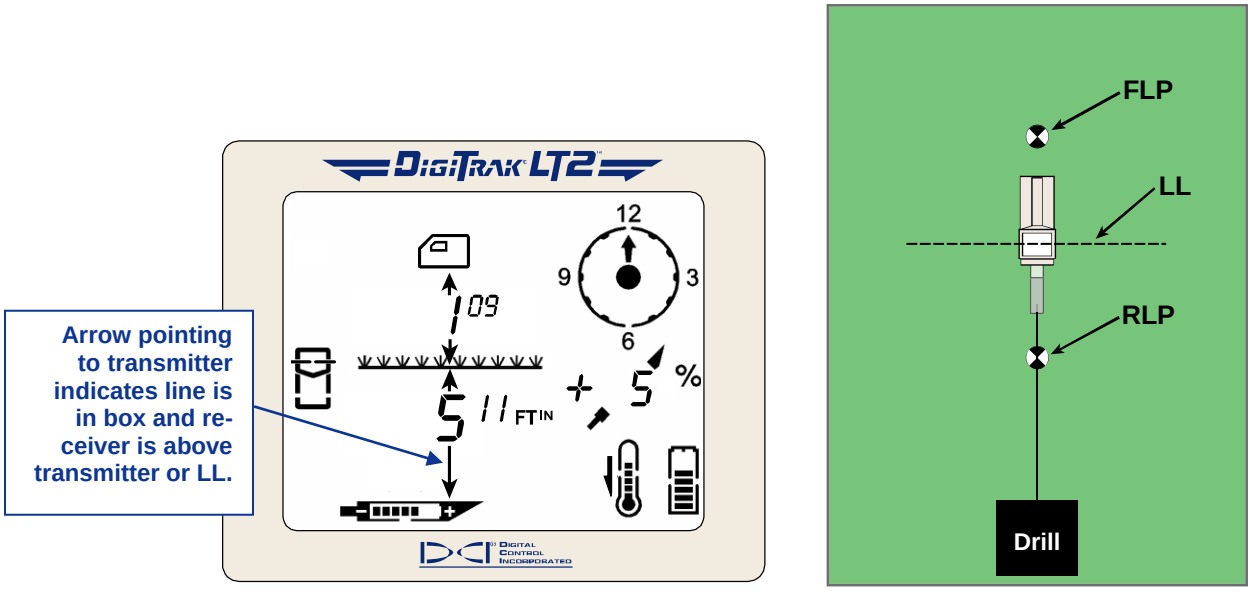
Once you have found the FLP, then you will find the LL, where you can determine the depth of the transmitter. The LL is represented by a short line (——) on the receiver display. The receiver must be held level and in alignment with the transmitter when over the drill head to obtain an accurate depth reading.

1. At the FLP, turn again to face the drill head (and drill) and walk forward toward the last locate point.
2. Note that the LL appears in the top left of the display.



LL Moving Toward the Box

3. Walk forward and the LL moves closer to the box.
4. Center the LL in the box. You should now see an arrow pointing to the transmitter battery symbol, which indicates that the value is the projected transmitter depth.



Line in the Box at the LL

NOTE:	The arrow that appears below the depth measurement and that points to the transmitter also appears on the remote display.

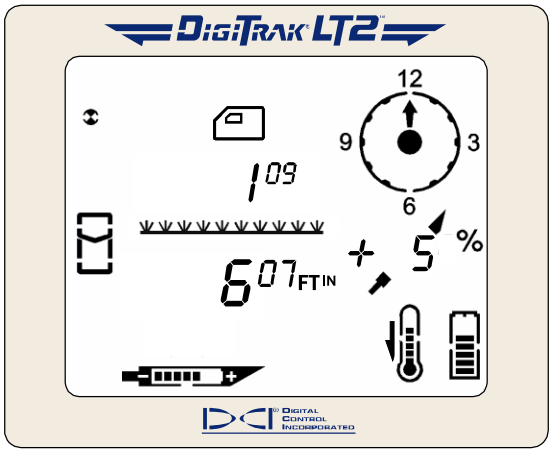
5. Mark this location as the LL. You should now be standing above the transmitter.

NOTE:	If the transmitter pitch exceeds ±30% (or 17°) and/or the transmitter depth exceeds 15 ft (4.5 m), you may not get reliable depth information. Refer to Appendix B: Projected Versus Actual Depth and Fore/Aft Offset, for information regarding this situation.

Finding the RLP to Confirm Transmitter Heading and Position

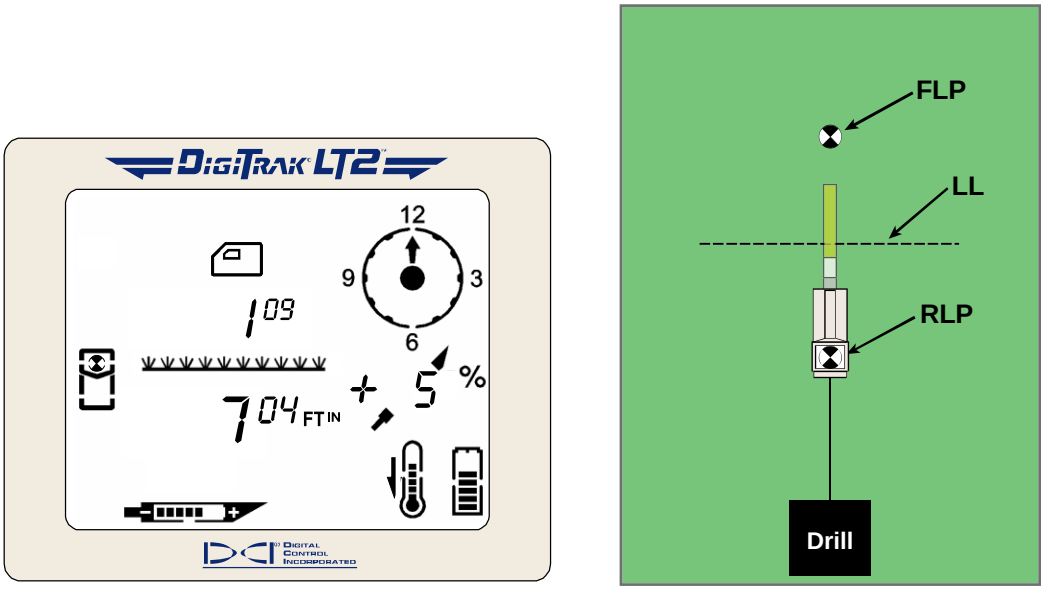
Next, you will find the RLP, where you can confirm the transmitter heading and position. Like the FLP, the RLP is represented as a target ( ) on the receiver display. Once the RLP is found, you can connect the RLP to the FLP to form a line that represents the exact heading of the transmitter. The transmitter is located at the point where this line intersects the LL. Using the locate points and the LL to find the transmitter is more reliable and efficient than using the peak signal or shallowest depth.

1. While standing above the transmitter still facing the drill, continue walking toward the drill; the target will appear in the top left corner of the display and the depth will increase.



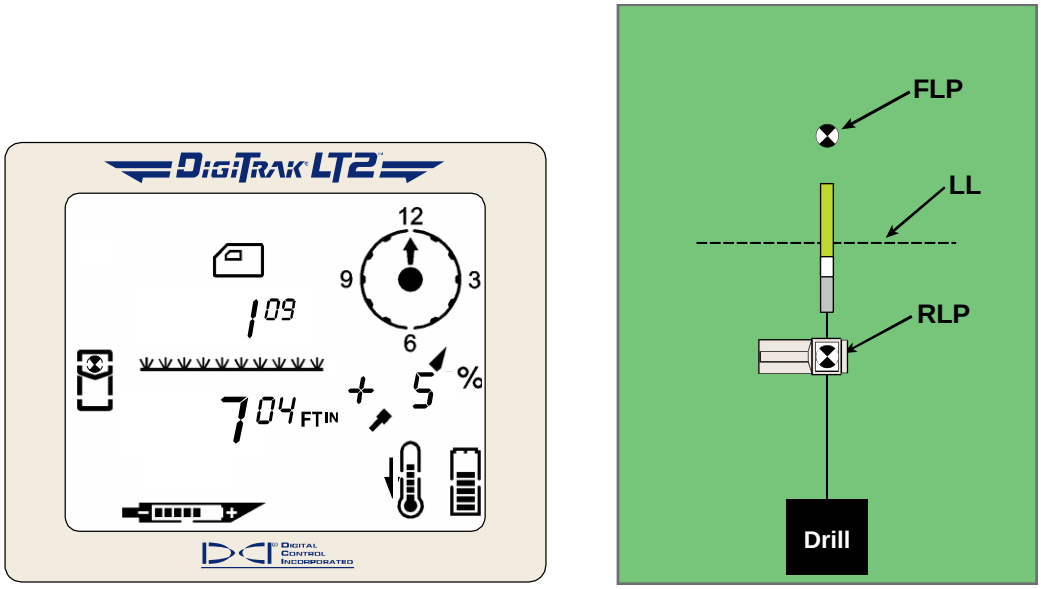
Target in Top Left Corner

2. Walk forward until the target moves into the box. You have found the fore/aft position of the RLP. The next step describes how to find the left/right position of the RLP.



Target in the Box at the RLP

3. Turn the receiver 90° from the transmitter heading while holding the receiver steady and level, and again put the target in the box by moving the receiver forward or backward as needed.



Target in the Box at the RLP

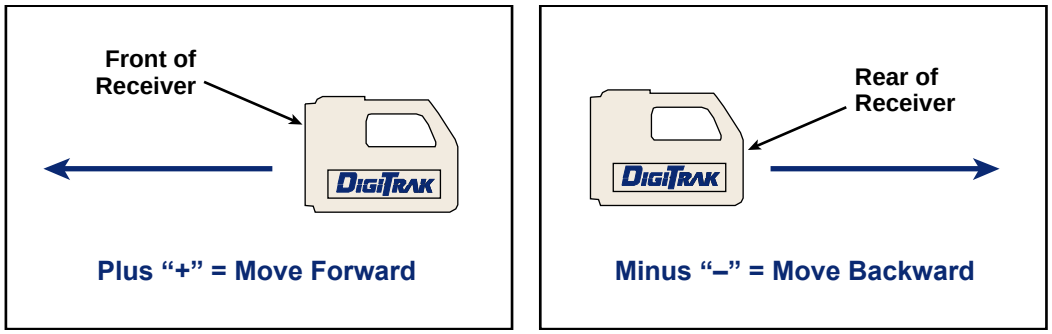
Turn Receiver 90° and Move Back and Forth to Center Target in Box at RLP

4. Mark this location as the RLP.
5. Connect the RLP to the FLP by a line. This line represents the actual transmitter heading.

NOTE:	Both active and passive interference sources can affect the accuracy of the locate points and depth readings.

Plus/Minus ("+/–") Method for Locating the Transmitter

The plus/minus method is the same as that used in DCI's Mark series receivers for finding the front and rear locate points. This method is similar to the standard locating method except here you hold the trigger in and use the signal strength and plus/minus signs for locating. In general, the plus sign ("+") means move the receiver forward, and the minus sign ("–") means move it backward, to find the locate point.



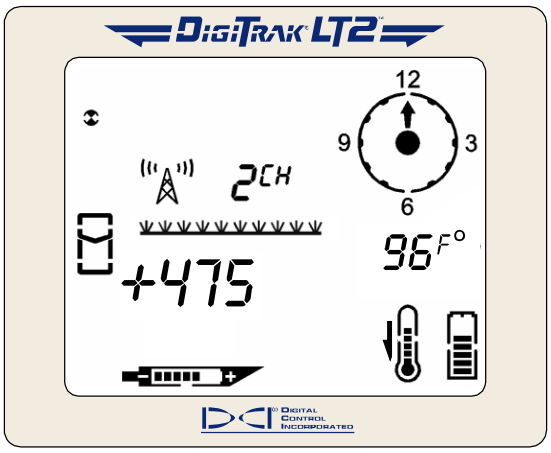
Using Plus/Minus ("+/–") Indicators for Finding Locate Points

The front and rear locate points each represent a *point* where the sign changes from *positive* to *negative*. It doesn't matter if the receiver and transmitter are facing in the same direction or in opposite directions, the "+" sign will change to a "–" sign at either of the locate points.

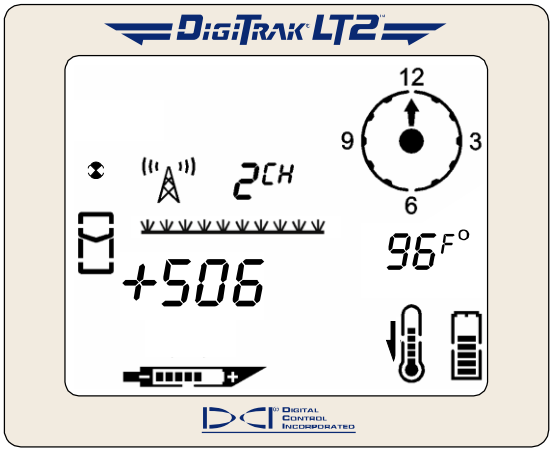
Anywhere along the locate line, when the receiver crosses it, the "–" sign will change to a "+" sign. The position of the transmitter along the LL can be determined by finding the FLP or RLP.

Finding the FLP

1. Stand out in front of the drill head (facing the drill) at a distance of approximately one drill rod length.
2. Hold in the trigger and approach the FLP. The signal strength will be positive and will increase. Note that the target appears in the top left corner of the display, and the target gets closer to the box (locating icon) as you walk toward the FLP.

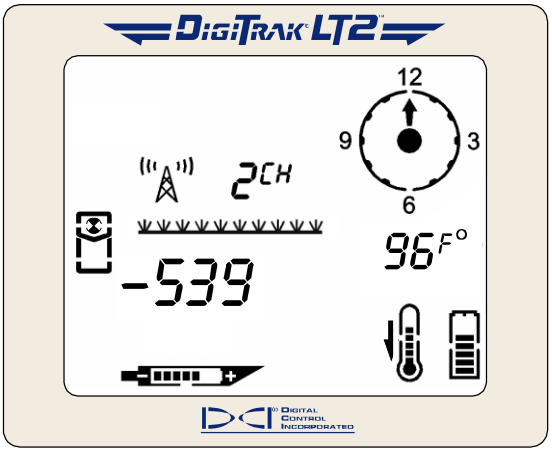


Target in Top Left Corner



Target Moving Toward the Box

3. Continue to walk forward until the "+" sign changes to a "–". Note that the target has moved into the box and the signal strength has increased.

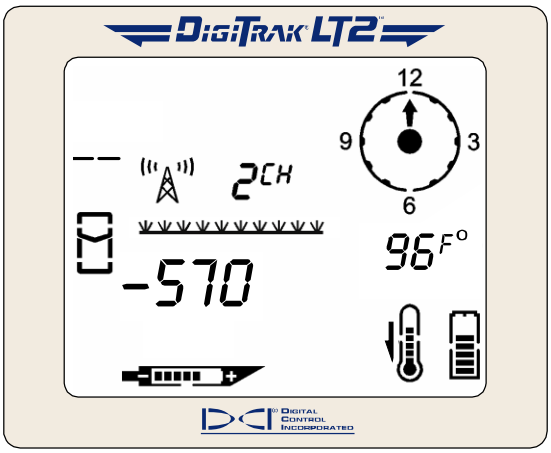


Target in the Box

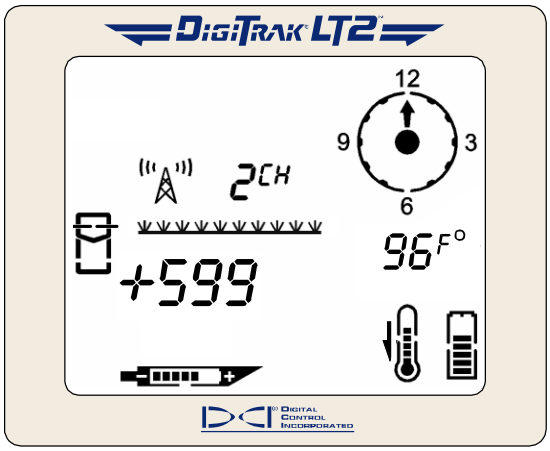
4. Turn the receiver 90° from the transmitter heading while holding the receiver steady and level, and again find the point where the "+" sign changes to a "–" by moving the receiver forward or backward as needed; the target should be in the box. This is the FLP, which is where the transmitter will end up if it does not get a steering command. Release the trigger.
5. Mark the location directly below the display screen as the FLP.

Finding the Transmitter and the LL

1. At the FLP, while continuing to hold in the trigger, turn again to face the drill head (and drill) and walk forward toward the last locate point.
2. Note that the signal strength is negative and the value is increasing. The LL will appear in the top left of the display.
3. Continue to walk forward until the "–" sign changes to a "+" sign. Note that the LL is centered in the box.

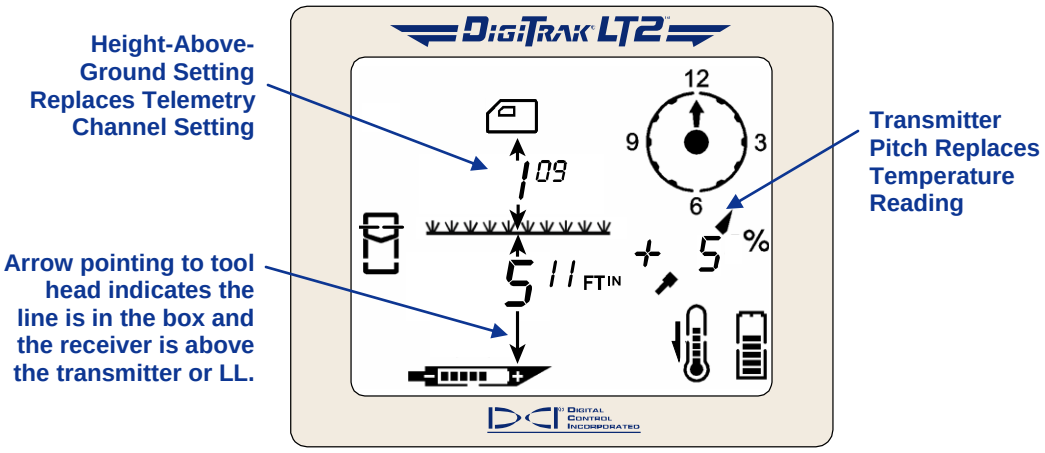


LL Moving Toward the Box



Line in the Box

4. Release the trigger to see the depth display.



Depth Screen

NOTE: The arrow that appears below the depth measurement and that points to the transmitter also appears on the remote display when the line is in the box.

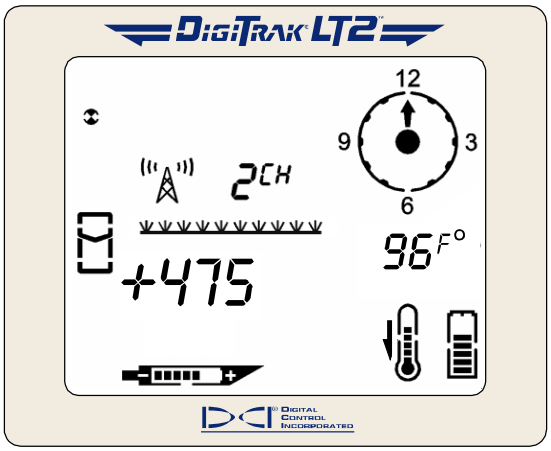
5. Mark this location as the LL. You should now be standing above the transmitter.

Confirmation of Exact Heading and Transmitter Position

Like in the standard locating method, you can confirm the actual transmitter heading by locating the rear locate point or RLP and then drawing a line between the RLP and FLP. That line represents the transmitter heading. Where this line intersects the LL is the position of the transmitter.

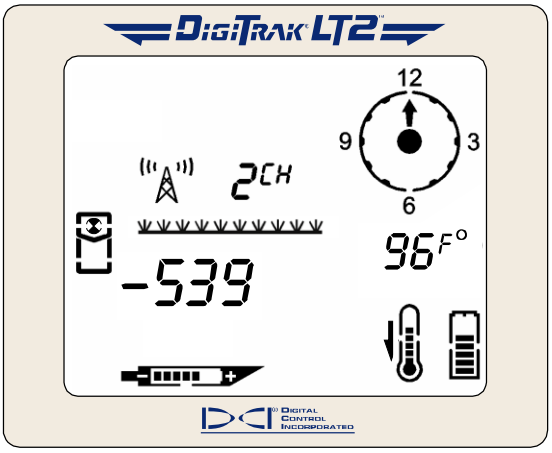
Finding the RLP

1. While standing above the transmitter still facing the drill, hold in the trigger and continue walking toward the drill; the signal strength will decrease and the target will appear in the top left corner of the display.



Target in Top Left Corner

2. Walk forward until the "+" sign changes to a "–" sign. Note that the target has moved into the box.



Target in the Box

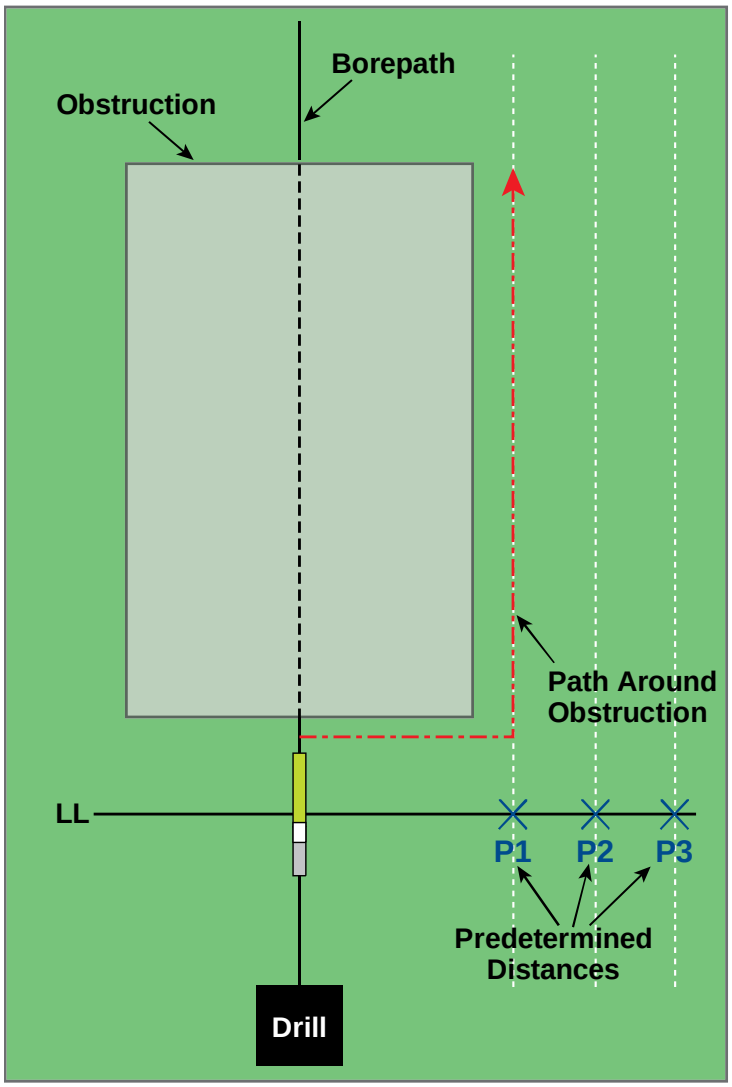
3. Turn the receiver 90° from the transmitter heading while holding the receiver steady and level, and find the point where the "–" sign changes to a "+" by moving the receiver forward or backward as needed; the target should be in the box. This is the RLP. Release the trigger.
4. Mark this location as the RLP.
5. Connect the RLP to the FLP by a line. This line represents the transmitter heading.

Off-Track Locating

The off-track locating technique is useful when it is not possible to walk above the transmitter due to a surface obstruction or interference. Using the locate line's perpendicular relationship to the transmitter, it is possible to track the transmitter heading and also to determine if it is maintaining its intended depth. This method is only valid if the pitch of the transmitter is close to 0% and the ground surface is level. The transmitter pitch must also stay constant for the most accurate off-track locating. A full description of the off-track locating procedure follows.

NOTE:	The off-track locating method is only effective when the pitch of the transmitter is the same as the pitch of the terrain and this pitch value is less than 10%.

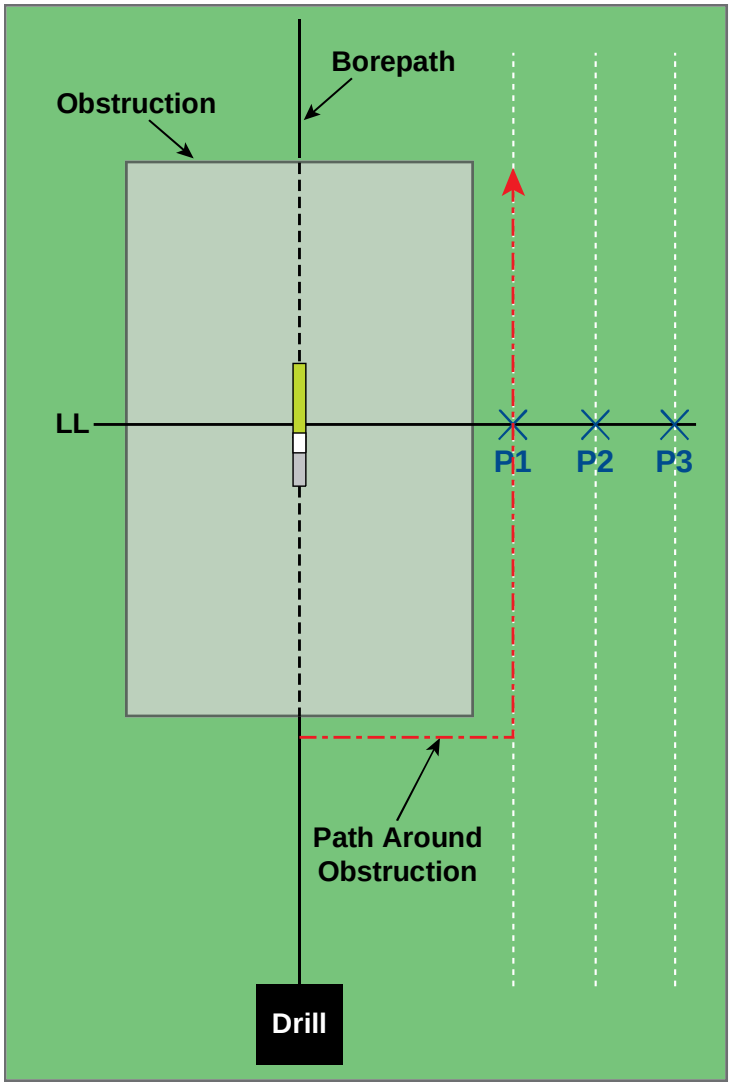
In the figure shown below, a building exists over the intended borepath and the transmitter is just about to go under the building.



Preparing for Off-Track Locating

1. Find the LL of the transmitter by putting the line in the box.
2. Walk a predetermined distance to the side of the transmitter (P1), sufficient to avoid the obstruction, and find the LL. Note the slant distance and signal strength (hold trigger in for signal strength) at this location, and mark the location.
3. Step another predetermined distance further away from the transmitter (P2) and again find the LL. Note the slant distance and signal strength, and mark this location.
4. Step another predetermined distance further away from the transmitter (P3) and find the LL. Note the slant distance and signal strength, and mark this location.

5. After finding the three locations to the side of the transmitter, P1, P2, and P3, connect these locations with a line. This is the locate line. Because the LL runs perpendicular (or at a 90° angle) to the transmitter, it is possible to determine the heading of the tool. By comparing the slant distances at the predetermined distances of P1, P2, and P3, as the transmitter progresses you can verify if the tool is moving away from or closer to the intended borepath. This allows steering corrections to be made.



Off-Track Locating

Appendix A: System Specifications

The power requirements, environmental requirements, and equipment maintenance requirements for the DigiTrak LT2 Locating System are listed below.

Power Requirements

Device	Voltage	Current
DigiTrak LT2 Receiver	14.4 V DC (nominal)	0.25 A DC
DigiTrak LT2 Remote Display	14.4 V DC (nominal)	0.25 A DC
DigiTrak LT2 Battery Charger	12–28 V DC 100–240 V AC, 50/60 Hz	2.0 A DC

Environmental Requirements

Altitude	Up to 6561 ft. (2000 m)
Temperature	-4°F to 140°F (-20°C to 60°C)
Relative Humidity	< 90%

Appendix B: Projected Depth Versus Actual Depth and the Fore/Aft Offset

What Happens When the Transmitter Is Steep and Deep

The signal field emitted by the transmitter, as shown in Figure B1, consists of a set of elliptical signals or flux lines. The flux lines indicate the position of the transmitter. When the transmitter is level with respect to the ground, you will find that the locate line (LL) is directly over the transmitter, and the depth displayed on the receiver is the actual depth. You will also find that the locate points (FLP and RLP) are at equal distances from the transmitter. The location of the LL is found at the intersection of the ground and the horizontal component of the flux field, and the FLP and RLP are found where the vertical components of the flux field intersect with the ground. Some of the horizontal and vertical components are identified by short yellow lines in Figure B1.

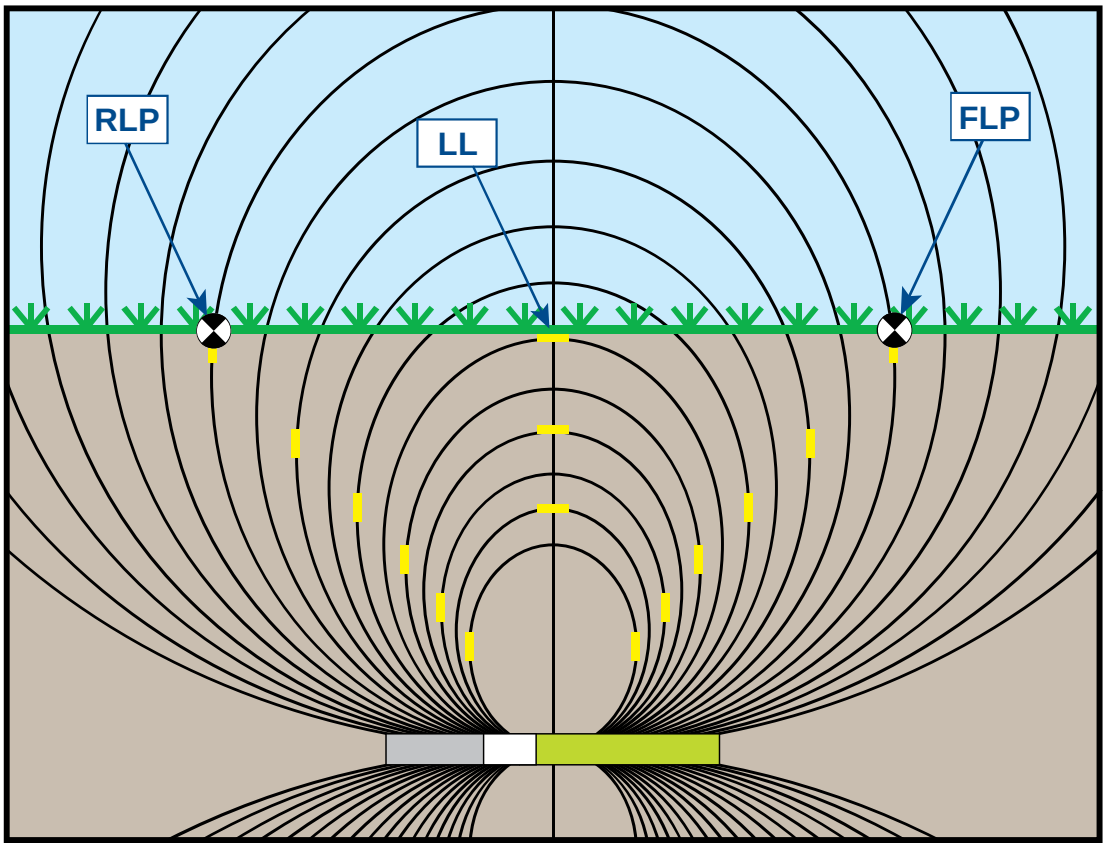


Figure B1. Flux Field and Geometry of FLP, RLP, and LL (side view)

Due to the shape of the transmitter's signal field (flux lines), when it is at a pitch greater than ±30% (±17°) and/or a depth of 15 ft (4.5 m) or more, the position of the locate line will be some distance ahead of or behind the transmitter's actual position. In this case, the depth displayed on the receiver becomes what is called the projected depth. The transmitter's distance ahead of or behind the locate line is called the fore/aft offset.

The projected depth and fore/aft offset, shown in Figure B2, must be accounted for when the transmitter is steep and/or deep. See the tables provided later in this appendix (Tables A1 and A2) to determine the actual depth and fore/aft offset when you know the displayed (projected) depth and pitch of the transmitter.

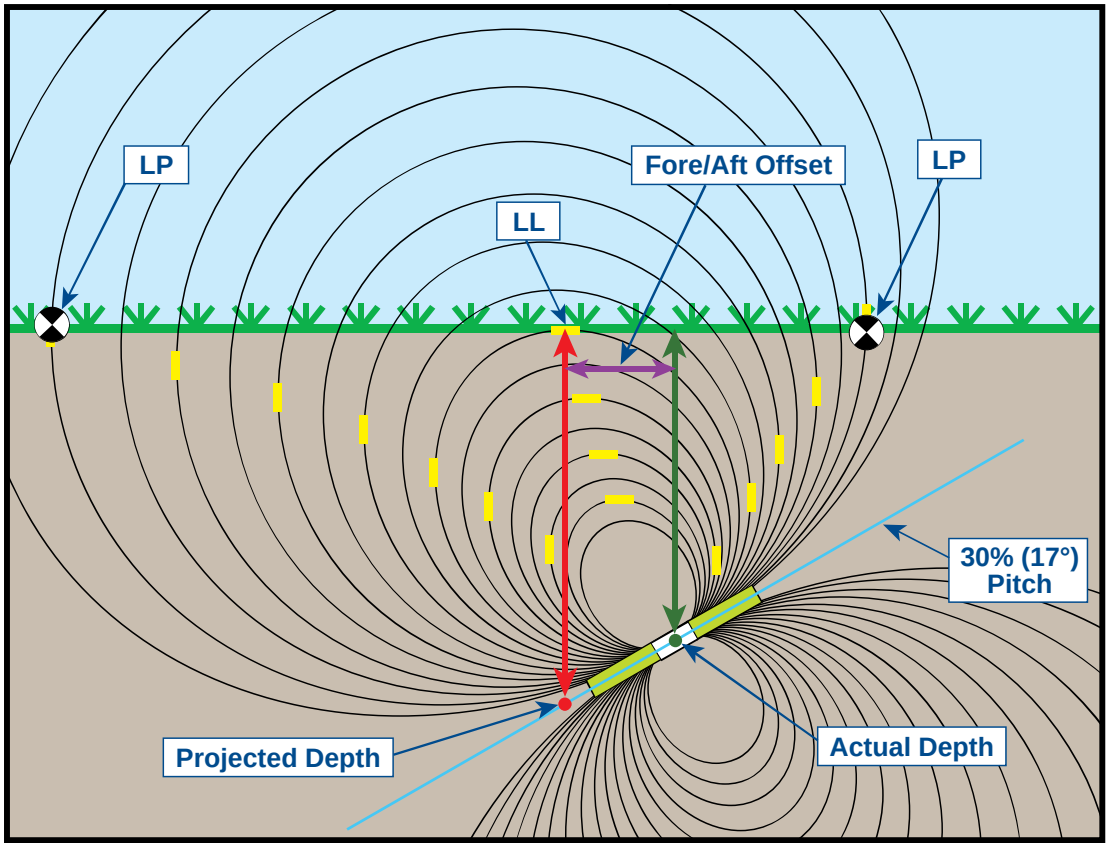


Figure B2. Projected Depth vs. Actual Depth and Fore/Aft Offset When Steep and Deep

Figure B2 above shows a transmitter positioned in a drill string that is meant to illustrate drilling at either a positive or a negative pitch—the pitch is positive if you are drilling left to right, and it is negative if you are drilling right to left. The transmitter's signal field is also pitched at the same angle as the transmitter. The locate line (LL), which is where the depth measurement is taken, is the horizontal component of the transmitter's signal field flux lines. That is, the LL is found where the flux lines are horizontal, as illustrated with short horizontal yellow lines in the figure above.

The locate points are also shown in Figure B2. These points are located at the vertical components of the signal field, as illustrated with short vertical yellow lines in the figure above. Note that the locate points are not the same distance from the LL when the tool is pitched. Again, this situation requires compensation for the projected depth and the fore/aft offset.

Using the tables provided below, you can look up the actual depth (Table B1) and the fore/aft offset (Table B2) based on the receiver's depth reading (projected depth) and the transmitter pitch. You can also look up the projected depth (Table B3) if you know the required depth (actual depth) of your installation and you want to find the corresponding projected depth reading that you will see on the receiver during drilling. The final table (Table B4) provides conversion factors for determining the projected depth from the actual depth or the actual depth from the projected depth at various transmitter pitches.

Table B1 lists the projected or displayed depth values (shown in red) in 5 ft (1.52 m) increments in the first column and provides values for the actual depth (shown in green) at different transmitter pitches. For example, if you have a displayed depth of 25 ft (7.62 m) and your transmitter is at a 40% (22°) pitch, then you can see from Table B1 that the actual depth of the transmitter is 22 ft 8 in. (6.91 m).

Table B1. Determining Actual Depth from Displayed (Projected) Depth and Pitch

Pitch→ Displayed Depth ↓	±10% (5.7°)	±20% (11°)	±30% (17°)	±40% (22°)	±50% (27°)	±60% (31°)	±75% (37°)	±90% (42°)	±100% (45°)
5' (1.52 m)	5' (1.52 m)	4' 11" (1.50 m)	4' 9" (1.45 m)	4' 6" (1.37 m)	4' 4" (1.32 m)	4' 2" (1.27 m)	3' 10" (1.17 m)	3' 6" (1.07 m)	2' 6" (0.76 m)
10' (3.05 m)	9' 11" (3.02 m)	9' 9" (2.97 m)	9' 5" (2.87 m)	9' 1" (2.77 m)	8' 8" (2.64 m)	8' 3" (2.51 m)	7' 7" (2.31 m)	7' (2.13 m)	5' (1.52 m)
15' (4.57 m)	14' 11" (4.55 m)	14' 8" (4.47 m)	14' 2" (4.32 m)	13' 7" (4.14 m)	13' (3.96 m)	12' 5" (3.78 m)	11' 5" (3.48 m)	10' 6" (3.20 m)	7' 6" (2.29 m)
20' (6.10 m)	19' 11" (6.07 m)	19' 6" (5.94 m)	18' 10" (5.74 m)	18' 1" (5.51 m)	17' 4" (5.28 m)	16' 6" (5.03 m)	15' 3" (4.65 m)	14' (4.27 m)	10' (3.05 m)
25' (7.62 m)	24' 11" (7.59 m)	24' 5" (7.44 m)	23' 7" (7.19 m)	22' 8" (6.91 m)	21' 8" (6.60 m)	20' 8" (6.30 m)	19' (5.79 m)	17' 6" (5.33 m)	12' 6" (3.81 m)
30' (9.14 m)	29' 10" (9.09 m)	29' 3" (8.92 m)	28' 3" (8.61 m)	27' 2" (8.28 m)	26' (7.92 m)	24' 9" (7.54 m)	22' 10" (6.96 m)	21' (6.40 m)	15' (4.57 m)
35' (10.67 m)	34' 10" (10.62 m)	34' 2" (10.41 m)	33' 1" (10.08 m)	31' 8" (9.65 m)	30' 4" (9.25 m)	28' 11" (8.81 m)	26' 8" (8.13 m)	24' 6" (7.47 m)	17' 6" (5.33 m)
40' (12.19 m)	39' 10" (12.14 m)	39' (11.89 m)	37' 9" (11.51 m)	36' 2" (11.02 m)	34' 8" (10.57 m)	33' (10.06 m)	30' 5" (9.27 m)	28' (8.53 m)	20' (6.10 m)
45' (13.72 m)	44' 9" (13.64 m)	43' 11" (13.39 m)	42' 5" (12.93 m)	40' 9" (12.42 m)	39' (11.89 m)	37' 2" (11.33 m)	34' 3" (10.44 m)	31' 7" (9.63 m)	22' 6" (6.86 m)
50' (15.24 m)	49' 9" (15.16 m)	48' 9" (14.86 m)	47' 2" (14.38 m)	45' 3" (13.79 m)	43' 4" (13.21 m)	41' 3" (12.57 m)	38' 1" (11.61 m)	35' 1" (10.69 m)	25' (7.62 m)

Table B2 lists the projected or displayed depth values in 5 ft (1.52 m) increments in the first column and provides values for the fore/aft offset (shown in purple), rounded to the nearest inch (or cm) at different transmitter pitches.

Table B2. Determining Fore/Aft Offset from Displayed (Projected) Depth and Pitch

Pitch→ Displayed Depth ↓	±10% (5.7°)	±20% (11°)	±30% (17°)	±40% (22°)	±50% (27°)	±60% (31°)	±75% (37°)	±90% (42°)	±100% (45°)
5' (1.52 m)	4" (0.10 m)	8" (0.20 m)	11" (0.28 m)	1' 3" (0.38 m)	1' 7" (0.48 m)	1' 9" (0.53 m)	2' 1" (0.64 m)	2' 5" (0.74 m)	2' 6" (0.76 m)
10' (3.05 m)	8" (0.20 m)	1' 4" (0.41 m)	1' 11" (0.58 m)	2' 6" (0.76 m)	3' 1" (0.94 m)	3' 6" (1.07 m)	4' 2" (1.27 m)	4' 9" (1.45 m)	5' (1.52 m)
15' (4.57 m)	1' (0.30 m)	2' (0.61 m)	2' 11" (0.89 m)	3' 9" (1.14 m)	4' 7" (1.40 m)	5' 4 " (1.63 m)	6' 3" (1.91 m)	7' 1" (2.16 m)	7' 6" (2.29 m)
20' (6.10 m)	1' 4" (0.41 m)	2' 7" (0.79 m)	3' 10" (1.17 m)	5' (1.52 m)	6' 1" (1.85 m)	7' 1" (2.16 m)	8' 4" (2.54 m)	9' 6" (2.90 m)	10' (3.05 m)
25' (7.62 m)	1' 8" (0.51 m)	3' 3" (0.99 m)	4' 10" (1.47 m)	6' 3" (1.91 m)	7' 7" (2.31 m)	8' 10" (2.69 m)	10' 5" (3.18 m)	11' 10" (3.61 m)	12' 6" (3.81 m)
30' (9.14 m)	2' (0.61 m)	3' 11" (1.19 m)	5' 10" (1.78 m)	7' 6" (2.29 m)	9' 2" (2.79 m)	10' 7" (3.23 m)	12' 6" (3.81 m)	14' 2" (4.32 m)	15' (4.57 m)
35' (10.67 m)	2' 4" (0.71 m)	4' 7" (1.40 m)	6' 9" (2.06 m)	8' 9" (2.67 m)	10' 8" (3.25 m)	12' 5" (3.78 m)	14' 8" (4.47 m)	16' 7" (5.05 m)	17' 6" (5.33 m)
40' (12.19 m)	2' 8" (0.81 m)	5' 3" (0.69 m)	7' 9" (2.36 m)	10' (3.05 m)	12' 2" (3.71 m)	14' 2" (4.32 m)	16' 9" (5.11 m)	18' 11" (5.77 m)	20' (6.10 m)
45' (13.72 m)	3' (0.91 m)	5' 11" (1.80 m)	8' 8" (2.64 m)	11' 4" (3.45 m)	13' 8" (4.17 m)	15' 11" (4.85 m)	18' 10" (5.74 m)	21' 3" (6.48 m)	22' 6" (6.86 m)
50' (15.24 m)	3' 4" (1.02 m)	6' 7" (2.01 m)	9' 4" (2.84 m)	12' 7" (3.84 m)	15' 3" (4.65 m)	17' 8" (5.38 m)	20' 11" (6.38 m)	23' 8" (7.21 m)	25' (7.62 m)

Table B3 lists the actual depths in 5 ft (1.52 m) increments in the first column and provides projected depth values at different transmitter pitches.

Table B3. Determining Projected Depth from Actual Depth and Pitch

Pitch→ Actual Depth ↓	±10% (5.7°)	±20% (11°)	±30% (17°)	±40% (22°)	±50% (27°)	±60% (31°)	±75% (37°)	±90% (42°)	±100% (45°)
5' (1.52 m)	5' (1.52 m)	5' 2" (1.57 m)	5' 3" (1.60 m)	5' 6" (1.68 m)	5' 8" (1.73 m)	5' 11" (1.80 m)	6' 3" (1.91 m)	6' 6" (1.98 m)	7' 6" (2.29 m)
10' (3.05 m)	10' 1" (3.07 m)	10' 3" (3.12 m)	10' 7" (3.23 m)	10' 11" (3.33 m)	11' 4" (3.45 m)	11' 9" (3.58 m)	12' 5" (3.78 m)	13' (3.96 m)	15' (4.57 m)
15' (4.57 m)	15' 1" (4.60 m)	15' 5" (4.70 m)	15' 10" (4.83 m)	16' 5" (5.00 m)	17' (5.18 m)	17' 8" (5.38 m)	18' 7" (5.66 m)	19' 6" (5.94 m)	22' 6" (6.86 m)
20' (6.10 m)	20' 1" (6.12 m)	20' 6" (6.25 m)	21' 2" (6.45 m)	21' 11" (6.68 m)	22' 8" (6.91 m)	23' 6" (7.16 m)	24' 9" (7.54 m)	26' (7.92 m)	30' (9.14 m)
25' (7.62 m)	25' 2" (7.67 m)	25' 8" (7.82 m)	26' 5" (8.05 m)	27' 5" (8.36 m)	28' 4" (8.64 m)	29' 5" (8.97 m)	31' (9.45 m)	32' 6" (9.91 m)	37' 6" (11.43 m)
30' (9.14 m)	30' 2" (9.19 m)	30' 9" (9.37 m)	31' 9" (9.68 m)	32' 10" (10.01 m)	34' (10.36 m)	35' 3" (10.74 m)	37' 2" (11.33 m)	39' (11.89 m)	45' (13.72 m)
35' (10.67 m)	35' 2" (10.72 m)	35' 11" (10.95 m)	37' (11.28 m)	38' 4" (11.68 m)	36' 8" (11.18 m)	41' 2" (12.55 m)	43' 4" (13.21 m)	45' 6" (13.87 m)	52' 6" (16.00 m)
40' (12.19 m)	40' 2" (12.24 m)	41' (12.50 m)	42' 3" (12.88 m)	43' 10" (13.36 m)	45' 4" (13.82 m)	47' (14.33 m)	49' 7" (15.11 m)	52' (15.85 m)	60' (18.29 m)
45' (13.72 m)	45' 3" (13.79 m)	46' 2" (14.07 m)	47' 7" (14.50 m)	49' 3" (15.01 m)	51' (15.54 m)	52' 2" (15.90 m)	55' 9" (16.99 m)	58' 6" (17.83 m)	67' 6" (11.43 m)
50' (15.24 m)	50' 3" (15.32 m)	51' 3" (15.62 m)	52' 10" (16.10 m)	54' 9" (16.69 m)	56' 8" (17.27 m)	58' 9" (17.91 m)	61' 11" (18.87 m)	64' 11" (19.79 m)	75' (22.86 m)

Table B4 allows you to calculate the exact projected depth reading as well as the actual depth using a multiplier. Values for the multiplier, or conversion factor, are provided at different transmitter pitches.

Table B4. Conversion Factors for Calculating Exact Projected Depth or Actual Depth

Pitch →	±10% (5.7°)	±20% (11°)	±30% (17°)	±40% (22°)	±50% (27°)	±60% (31°)	±75% (37°)	±90% (42°)
From Actual to Projected Depth	**1.005**	**1.025**	**1.06**	**1.105**	**1.155**	**1.212**	**1.314**	**1.426**
From Projected to Actual Depth	**0.995**	**0.975**	**0.943**	**0.905**	**0.866**	**0.825**	**0.761**	**0.701**

For example, referring to Table B4, if you have a required (actual) depth of 24 ft (7.32 m), you can determine the receiver's projected depth reading at a 30% (17°) pitch. You will use the first row of conversion factors (From Actual to Projected Depth) to select the corresponding value for a pitch of 30%, which is 1.06. Multiply this value by the required depth, which is 24, and you will find that your receiver's projected depth reading at the locate line should display as 25 ft 5 in. (7.75 m)

Using the projected depth displayed on your receiver, you can calculate the actual depth of the transmitter using the second row of conversion factors. Select the corresponding conversion factor associated with your pitch value, then multiply that value by the projected depth. For example, if your pitch is 30% and your projected depth reading is 24 ft (7.32 m), then you would multiply 0.943 by 24 to determine that the actual depth of the transmitter is 22.63 ft or 22 ft 8 in. (6.90 m).

Appendix C: Calculating Depth Based on Distance Between FLP and RLP

It is possible to estimate the transmitter depth should the information displayed on the receiver become unreliable. This is only possible if you know the transmitter pitch and the positions of the front locate point (FLP) and the rear locate point (RLP) and if the ground surface is level.

To estimate the transmitter depth, first measure the distance between the FLP and the RLP. The pitch of the transmitter must also be reliably known. Using the Depth Estimation Table below, find the divider that most closely corresponds to the transmitter pitch. Then use the following formula to estimate the depth:

$$\text{Depth} = \frac{\text{Distance between FLP and RLP}}{\text{Divider}}$$

For example, if the transmitter pitch is 34% (or 18.8°) then the corresponding divider value (from the table) is 1.50. In this example, the distance between the FLP and the RLP is 11.5 ft (3.5 m). The depth would be:

$$\text{Depth} = \frac{11.5\,\text{ft}}{1.50} = 7.66\,\text{ft}$$ or approximately 7.7 ft (2.35 m)

Table C1. Depth Estimation Table

Pitch (% / °)	Divider	Pitch (% / °)	Divider	Pitch (% / °)	Divider
0 / 0.0	1.41	34 / 18.8	1.50	68 / 34.2	1.74
2 / 1.1	1.41	36 / 19.8	1.51	70 / 35.0	1.76
4 / 2.3	1.42	38 / 20.8	1.52	72 / 35.8	1.78
6 / 3.4	1.42	40 / 21.8	1.54	74 / 36.5	1.80
8 / 4.6	1.42	42 / 22.8	1.55	76 / 37.2	1.82
10 / 5.7	1.42	44 / 23.7	1.56	78 / 38.0	1.84
12 / 6.8	1.43	46 / 24.7	1.57	80 / 38.7	1.85
14 / 8.0	1.43	48 / 25.6	1.59	82 / 39.4	1.87
16 / 9.1	1.43	50 / 26.6	1.60	84 / 40.0	1.89
18 / 10.2	1.44	52 / 27.5	1.62	86 / 40.7	1.91
20 / 11.3	1.45	54 / 28.4	1.63	88 / 41.3	1.93
22 / 11.9	1.45	56 / 29.2	1.64	90 / 42.0	1.96
24 / 13.5	1.46	58 / 30.1	1.66	92 / 42.6	1.98
26 / 14.6	1.47	60 / 31.0	1.68	94 / 43.2	2.00
28 / 15.6	1.48	62 / 31.8	1.69	96 / 43.8	2.02
30 / 16.7	1.48	64 / 32.6	1.71	98 / 44.4	2.04
32 / 17.7	1.49	66 / 33.4	1.73	100 / 45.0	2.06

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LIMITED WARRANTY

Digital Control Incorporated ("DCI") warrants that when shipped from DCI each DCI Product will conform to DCI's current published specifications in existence at the time of shipment and will be free, for the warranty period ("Warranty Period") described below, from defects in materials and workmanship. The limited warranty described herein ("Limited Warranty") is not transferable, shall extend only to the first end-user ("User") purchasing the DCI Product from either DCI or a dealer expressly authorized by DCI to sell DCI Products ("Authorized DCI Dealer"), and is subject to the following terms, conditions and limitations:

1. A Warranty Period of twelve (12) months shall apply to the following new DCI Products: receivers/locators, remote displays, battery chargers and rechargeable batteries, and DataLog® modules and interfaces. A Warranty Period of ninety (90) days shall apply to all other new DCI Products, including transmitters, accessories, and software programs and modules. Unless otherwise stated by DCI, a Warranty Period of ninety (90) days shall apply to: (a) a used DCI Product sold either by DCI or by an Authorized DCI Dealer who has been expressly authorized by DCI to sell such used DCI Product; and (b) services provided by DCI, including testing, servicing, and repairing an out-of-warranty DCI Product. The Warranty Period shall begin from the later of: (i) the date of shipment of the DCI Product from DCI, or (ii) the date of shipment (or other delivery) of the DCI Product from an Authorized DCI Dealer to User.
2. DCI's sole obligation under this Limited Warranty shall be limited to either repairing, replacing, or adjusting, at DCI's option, a covered DCI Product that has been determined by DCI, after reasonable inspection, to be defective during the foregoing Warranty Period. All warranty inspections, repairs and adjustments must be performed either by DCI or by a warranty claim service authorized in writing by DCI. All warranty claims must include proof of purchase, including proof of purchase date, identifying the DCI Product by serial number.
3. The Limited Warranty shall only be effective if: (i) within fourteen (14) days of receipt of the DCI Product, User mails a fully completed Product Registration Card to DCI; (ii) User makes a reasonable inspection upon first receipt of the DCI Product and immediately notifies DCI of any apparent defect; and (iii) User complies with all of the Warranty Claim Procedures described below.

WHAT IS NOT COVERED

This Limited Warranty excludes all damage, including damage to any DCI Product, due to: failure to follow DCI's operator's manual and other DCI instructions; abuse; misuse; neglect; accident; fire; flood; Acts of God; improper applications; connection to incorrect line voltages and improper power sources; use of incorrect fuses; overheating; contact with high voltages or injurious substances; use of batteries or other products or components not manufactured or supplied by DCI; or other events beyond the control of DCI. This Limited Warranty does not apply to any equipment not manufactured or supplied by DCI nor, if applicable, to any damage or loss resulting from use of any DCI Product outside the designated country of use. By accepting a DCI Product and not returning it for a refund within thirty (30) days of purchase, User agrees to the terms of this Limited Warranty, including without limitation the Limitation of Remedies and Liability described below, and agrees to carefully evaluate the suitability of the DCI Product for User's intended use and to thoroughly read and strictly follow all instructions supplied by DCI (including any updated DCI Product information which may be obtained at the above DCI website). In no event shall this Limited Warranty cover any damage arising during shipment of the DCI Product to or from DCI.

User agrees that the following will render the above Limited Warranty void: (i) alteration, removal or tampering with any serial number, identification, instructional, or sealing labels on the DCI Product, or (ii) any unauthorized disassembly, repair or modification of the DCI Product. In no event shall DCI be responsible for the cost of or any damage resulting from any changes, modifications, or repairs to the DCI Product not expressly authorized in writing by DCI, and DCI shall not be responsible for the loss of or damage to the DCI Product or any other equipment while in the possession of any service agency not authorized by DCI.

DCI reserves the right to make changes in design and improvements upon DCI Products from time to time, and User understands that DCI shall have no obligation to upgrade any previously manufactured DCI Product to include any such changes.

THE FOREGOING LIMITED WARRANTY IS DCI'S SOLE WARRANTY AND IS MADE IN PLACE OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, IMPLIED WARRANTY OF NON-INFRINGEMENT, AND ANY IMPLIED WARRANTY ARISING FROM COURSE OF PERFORMANCE, COURSE OF DEALING, OR USAGE OF TRADE, ALL OF WHICH ARE HEREBY DISCLAIMED AND EXCLUDED. If DCI has substantially complied with the warranty claim procedures described below, such procedures shall constitute User's sole and exclusive remedy for breach of the Limited Warranty.

LIMITATION OF REMEDIES AND LIABILITY

In no event shall DCI or anyone else involved in the creation, production, or delivery of the DCI Product be liable for any damages arising out of the use or inability to use the DCI Product, including but not limited to indirect, special, incidental, or consequential damages, or for any cover, loss of information, profit, revenue or use, based upon any claim by User for breach of warranty, breach of contract, negligence, strict liability, or any other legal theory, even if DCI has been advised of the possibility of such damages. In no event shall DCI's liability exceed the amount User has paid for the DCI Product. To the extent that any applicable law does not allow the exclusion or limitation of incidental, consequential or similar damages, the foregoing limitations regarding such damages shall not apply.

This Limited Warranty gives you specific legal rights, and you may also have other rights which vary from state to state. This Limited Warranty shall be governed by the laws of the State of Washington.

WARRANTY CLAIM PROCEDURES

1. If you are having problems with your DCI Product, you must first contact the Authorized DCI Dealer where it was purchased. If you are unable to resolve the problem through your Authorized DCI Dealer, contact DCI's Customer Service Department in Kent, Washington, USA at the above telephone number between 6:00 a.m. and 6:00 p.m. Pacific Time and ask to speak with a customer service representative. (The above "800" number is available for use only in the USA and Canada.) Prior to returning any DCI Product to DCI for service, you must obtain a Return Merchandise Authorization (RMA) number. Failure to obtain an RMA may result in delays or return to you of the DCI Product without repair.
2. After contacting a DCI customer service representative by telephone, the representative will attempt to assist you in troubleshooting while you are using the DCI Product during actual field operations. Please have all related equipment available together with a list of all DCI Product serial numbers. It is important that field troubleshooting be conducted because many problems do not result from a defective DCI Product, but instead are due to either operational errors or adverse conditions occurring in the User's drilling environment.
3. If a DCI Product problem is confirmed as a result of field troubleshooting discussions with a DCI customer service representative, the representative will issue an RMA number authorizing the return of the DCI Product and will provide shipping directions. You will be responsible for all shipping costs, including any insurance. If, after receiving the DCI Product and performing diagnostic testing, DCI determines the problem is covered by the Limited Warranty, required repairs and/or adjustments will be made, and a properly functioning DCI Product will be promptly shipped to you. If the problem is not covered by the Limited Warranty, you will be informed of the reason and be provided an estimate of repair costs. If you authorize DCI to service or repair the DCI Product, the work will be promptly performed and the DCI Product will be shipped to you. You will be billed for any costs for testing, repairs and adjustments not covered by the Limited Warranty and for shipping costs. In most cases, repairs are accomplished within 1 to 2 weeks.
4. DCI has a limited supply of loaner equipment available. If loaner equipment is required by you and is available, DCI will attempt to ship loaner equipment to you by overnight delivery for your use while your equipment is being serviced by DCI. DCI will make reasonable efforts to minimize your downtime on warranty claims, limited by circumstances not within DCI's control. If DCI provides you loaner equipment, your equipment must be received by DCI no later than the second business day after your receipt of loaner equipment. You must return the loaner equipment by overnight delivery for receipt by DCI no later than the second business day after your receipt of the repaired DCI Product. Any failure to meet these deadlines will result in a rental charge for use of the loaner equipment for each extra day the return of the loaner equipment to DCI is delayed.