DigiTrak® F5

Directional Drilling Locating System

Operator's Manual

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Trademarks

Limited Warranty

All products manufactured and sold by Digital Control Incorporated (DCI) are subject to the terms of a Limited Warranty. A copy of the Limited Warranty is included at the end of this manual; it can also be obtained by contacting DCI Customer Service, 425-251-0559 or 800-288-3610, or by connecting to DCI's website, **www.digitrak.com**.

Important Notice

All statements, technical information, and recommendations related to the products of DCI are based on information believed to be reliable, but the accuracy or completeness thereof is not warranted. Before utilizing any DCI product, the user should determine the suitability of the product for its intended use. All statements herein refer to DCI products as delivered by DCI and do not apply to any user customizations not authorized by DCI nor to any third-party products. Nothing herein shall constitute any warranty by DCI nor will anything herein be deemed to modify the terms of DCI's existing Limited Warranty applicable to all DCI products.

FCC Compliance Statement

This device complies with Part 15 of the Rules of the FCC. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device 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 B-103, Kent, WA 98032; phone 425-251-0559 or 800-288-3610.

Changes or modifications to the DCI equipment not expressly approved and carried out by DCI will void the user's Limited Warranty and the FCC's authorization to operate the equipment.

Table of Contents

Safety Precautions and Warnings

Important Note: 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.

- 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 marked accurately 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.
  - Comply with state and local governmental regulations (e.g., OSHA).
  - Follow all other safety procedures.
- The DigiTrak F5 system 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. For more information see the *Transmitter* section of this manual.

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

- The battery charger provided with the DigiTrak F5 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 is not to be installed into caravans, recreational vehicles, or similar vehicles
- Remove the batteries from all system components during shipping and prolonged storage; damage caused by leakage may occur.

Safety Precautions and Warnings (Continued)

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 by handing it over to 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. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that 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.

- Before each drilling run, test the DigiTrak F5 system with the transmitter inside the drill head to confirm that it is operating properly and is providing accurate drill head location and heading information (see the *Receiver* and *Locating* sections) and accurate transmitter depth, pitch, and roll 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 that 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 kept level and the height-above-ground has been set correctly.

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

- Interference can cause inaccuracies in the measurement of depth and loss of the transmitter's pitch, roll, or heading. You should always perform an electrical interference 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 water, rebar, radio frequencies, and other unknown sources of interference.
  - Interference with the operation of 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, other directional drilling locating equipment, etc.
  - Background noise must be minimal and signal strength must be at least 150 points above the background noise during all locating operations.

- Carefully review this manual and be sure you always operate the DigiTrak F5 system properly to obtain accurate depth, pitch, roll, and locate points. If you have any questions about the operation of the system, please call DCI's Customer Service Department at any of the phone numbers provided on the cover, and we will do our best to assist you.

Dear Customer:

Thank you for choosing the DigiTrak® F5™ Locating System. We are proud of the equipment that 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 mail it to DCI headquarters or fax it to us at 253-395-2800; you can also complete and submit the form online at our website. 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 at any of our global offices listed on the front cover if you have any problems or questions. Our Customer Service Department is available 24 hours a day, 7 days a week to provide assistance.

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. Stay current by visiting our web site on the internet at www.digitrak.com or by giving us a call.

We welcome questions, comments, and ideas.

Digital Control Incorporated
Kent, Washington
2010

Introduction

DigiTrak F5 Locating System

The DigiTrak F5 Locating System is used during horizontal directional drilling operations to locate and track a transmitter installed in the drill head. The system consists of a handheld receiver, a transmitter, a remote display with battery and cable power options (not pictured), a battery charger system, and three rechargeable F Series battery packs for powering the receiver and remote.

There are several transmitter options for use with the F5 system including five frequency options (1.3 kHz, 8.4 kHz, 12 kHz, 18.5 kHz, and 19.2 kHz). See the *Transmitter* section for more information.

In addition to the basic locating capabilities of directional tracking and depth, the F5 system includes the advanced features of predicted depth, off-track locating, and *Target Steering* to navigate the drill head easily and accurately even when obstacles prevent walkover tracking.

The DigiTrak LWD (Log While Drilling) feature on the receiver allows you to record data points along the bore path. The computer software included with the DigiTrak LWD manual allows you to view and print the logged bores. See the DigiTrak LWD manual for more information.

This manual provides information on each F5 system component—battery charger, receiver, transmitter, and remote display—in separate sections following this *Introduction*. These sections are followed by the *Locating* section, which explains locating terms and gives step-by-step locating instructions.

The F5 system is programmed to comply with varying global operating requirements. The receiver's regional designation number must match that of the transmitter for proper communication (see *Receiver* and *Transmitter* sections). Also, the receiver's telemetry frequency designation must match that of the remote display (see *Receiver* and *Remote Display* sections).

Appendix A presents the F5 system's power, environmental, and maintenance requirements. *Appendix B* explains how to calculate depth when the transmitter is deep (greater than 15 ft or 4.6 m) and/or at a steep pitch (greater than ±30% or ±17°). *Appendix C* explains how to calculate the transmitter depth based on the distance between the front and rear locate points and the pitch of the transmitter. *Appendix D* provides calculated depth increases for 10-ft (3-m) and 15-ft (4.6-m) rods depending on pitch. Finally, *Appendix E* contains a list of the radio frequency restrictions for each country in the EU and the required declaration of conformity documents.

F Series Battery Charger System

General Description

F Series Battery Charger System

The DigiTrak F Series Battery Charger (FBC) system includes AC and DC power cords, an AC adapter, and three rechargeable F Series battery packs (FBPs). The battery packs are used to power the F5 receiver and the FSD remote.

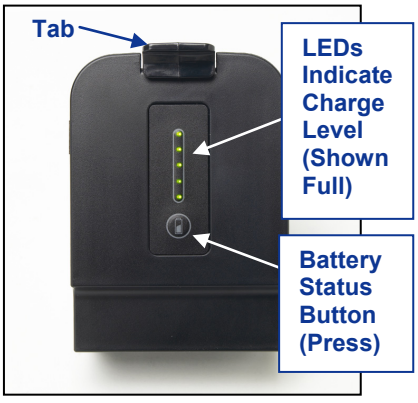
The battery charger can operate from AC (100–240 V, 50–60 Hz, 1500 mA max.) or DC (12 V, 5000 mA max.) power sources, and power cords are provided for both. The AC power cord that is shipped with your system is standard to your global area of operation.

Checking Battery Status

Press the battery status button. Each of the 5 LEDs represents 20% of the battery charge.

The battery charge status can be checked even if it is installed in a unit.

A fully charged FBP will power an F5 receiver for approximately 10 hours or an FSD remote for approximately 14 hours before recharging is necessary.



F Series Battery Pack

Charging a Battery Pack

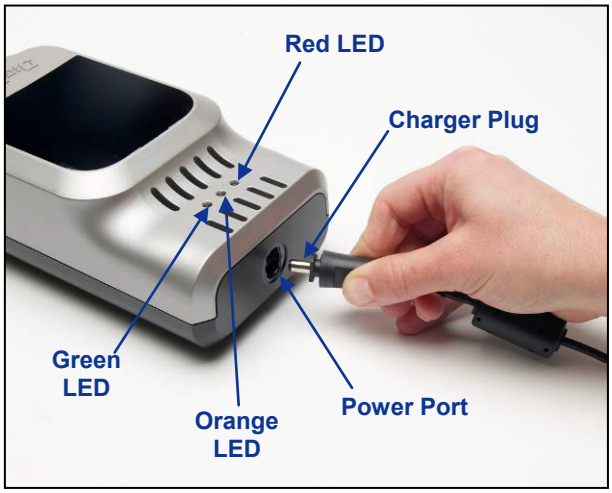
Only use F Series battery packs with the F Series battery charger. Power must be supplied to the battery charger, as indicated by the flashing orange LED, before charging a battery.

Supply Power to the Battery Charger:

Install either the AC adapter or DC power cord's charger plug into the battery charger power port by inserting it as shown to the right and rotating it a quarter of a turn to secure.

- If using AC power, connect the AC power cord to the AC adapter and then plug the cord into an AC power receptacle (wall outlet, 100–240 V, 50–60 Hz, 1500 mA max).
- If using the DC power cord, plug it directly into the DC power source (12 V, 5000 mA max).
- Once powered, the orange LED on the battery charger will begin to flash.

The battery pack is properly installed when the red LED on the battery charger illuminates indicating active charging. The level of charge on the battery pack is indicated throughout the charging cycle by the green LEDs on the battery pack. When the battery is done charging, all of the LEDs on the battery pack will briefly illuminate and battery charger's green LED illuminates.



DCI F Series Battery Charger

To begin charging, install the battery pack into the charger with the orientation shown below.

DCI F Series Battery Charger with F Series Battery Pack

Battery Charger LED Indicators

The battery charger has three LEDs (red, orange, and green) that are on, off, or flashing, depending on the charger status. The chart below summarizes the charger status indicated by the various LED settings, including the battery's status, where applicable, and the charge time.

Battery Charger LED Indicators

LEDs	Charger Status	Battery Status	Charge Time
Orange	Power supplied to charger	N/A	N/A
Solid Red	Battery charging	4–16.8 V	<3–8 hr
Flashing Red	Battery or communication fault	Varies	Varies
Solid Green	Battery Installed and receiving trickle charge	16.6–16.8 V	Approaching full charge
Flashing Green	Battery installed and fully charged	16.8–17 V	N/A (Fully Charged)
Solid Red and Green	Temperature fault (see *Appendix A* for environmental operating specifications)	Freezing or Overheated	Will not charge

Removing a Battery Pack or Brace Insert

To remove the battery pack or brace insert from the FSD remote, F5 receiver, or F Series battery charger, push the tab towards the face of the battery pack/brace insert and pull it away from the unit as shown the figure to the right. When the battery pack/brace insert is released, grasp it firmly to lift it out of the unit.

Note: The brace insert is installed in the FSD remote when the remote is powered through the DC power cable. See the *Remote Display* section for more information.

Removing Battery Pack or Brace Insert

Battery Pack Storage

If you plan to store the battery packs for any period of time, please follow the guidelines listed below.

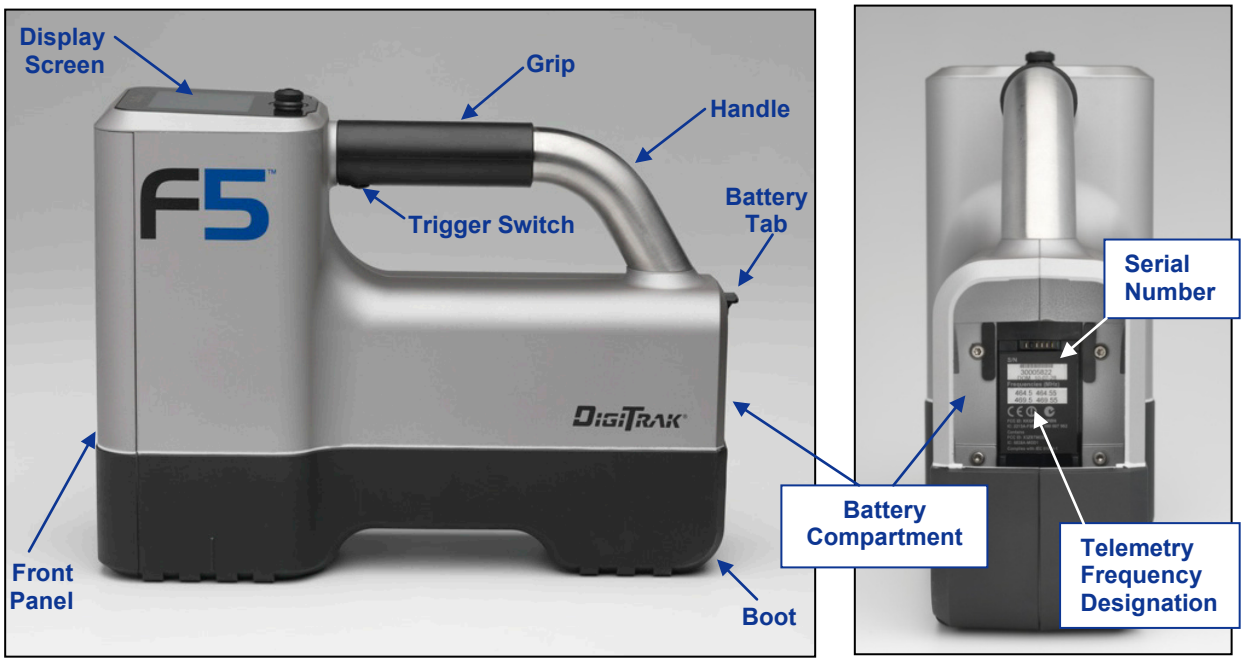
- Do not store the battery pack at temperatures greater than 113°F (45°C).
- Do not store the battery pack in a fully discharged state.
- Do not store the battery pack in the battery charger.
- If the battery pack is going to be stored for an extended period of time, pre-charge the battery to a charge level of 20% to 30% (two to three LEDs illuminated on the battery pack).

Warnings and Precautions

DCI assumes no liability for problems that occur when you do not follow these warnings and precautions, as well as the general precautions outlined in the *Safety Precautions and Warnings* section.

	**WARNING:** The charger is designed with adequate safeguards to protect you from shock and other hazards when used as specified within this manual. If you use the charger in a manner not specified by this document, the protection provided by the charger may be impaired. Please read this manual before using the charger.
	**WARNING:** If you transport the charger in checked baggage, be sure to remove the batteries from the charger before packing it.
Battery Temperature	• The temperature of the air around the battery charger should be between +32°F to +95°F (0°C to +35°C). Charging the battery outside this range may increase charge time, harm battery performance, or reduce battery life. • It is important to maintain free airflow around the charger, especially near the top and bottom vents. • If the battery internal temperature is below +32°F (0°C) or above 113°F (+45°C), the charger will not deliver charge current and will indicate a temperature fault.
Battery Voltage	• The battery voltage should be in the range of 8 V to 16.8 V when inserted into the charger. • If the battery voltage is above 17 V, the charger will display a flashing red battery fault indicator and will not charge the battery. • If the battery voltage is between 16.8 V and 17 V, the charger will display a charge complete status. • If the battery voltage is between 4 V and 8 V, a small trickle charge current will be applied to bring the battery voltage up to 8 V. If the battery voltage does not increase to above 8 V within 2 minutes, a battery fault will be displayed and charging discontinued.
Charge Time	• The charger will fully charge a battery in less than 3 hours if the ambient temperature is inside the operating ambient temperature specification. • If the ambient temperature is above or below the operating ambient temperature range, the charger may eventually charge the battery, but the charge time will be longer than 3 hours. • If charging is not complete inside 8 hours, a battery fault will be displayed and charging discontinued.
Power Input	Use the supplied AC/DC adapter or the cigarette lighter adapter cable to power the charger with DC power in the specified voltage range. Failure to do so could damage the charger, void the warranty, and cause a safety hazard.
User Serviceability	Do not disassemble the charger. It contains no user-serviceable parts.
Liquids	Avoid spilling liquids on the charger. Liquids spilled onto the charger could short circuit it. If liquids are accidentally spilled, send the charger to DCI for repair.
Battery Disposal	All DCI lithium-ion batteries are classified by the federal government as non-hazardous waste and are safe for disposal in the normal municipal waste stream. These batteries, however, do contain recyclable materials and are accepted for recycling by the Rechargeable Battery Recycling Corporation's (RBRC) Battery Recycling Program. Please call 1-800-8-BATTERY or go to the RBRC website at www.rbrc.org for information on recycling your used battery.

Receiver



F5 Receiver – Side and Back Views

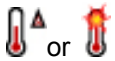
General Description

The F5 receiver is a handheld unit used for locating, tracking, and mapping the path of an F5 or F-Series transmitter. The receiver converts signals from the transmitter and displays the following information: depth, pitch, roll, temperature, and battery level. The F5 receiver can send this same information to the remote display at the drill rig.

To meet regional requirements and for proper communication, the telemetry frequency designation for the receiver must match that for the remote display. The telemetry frequency designation is identified on the receiver's serial number label, which is located inside the battery compartment (see photo). It must match one of those listed on the remote display's serial number label located on the back of the unit (see *Remote Display* section).

The receiver and transmitter must also meet specific operational requirements for different global regions. A regional designation number is provided in the receiver's software (see figure titled "Receiver Startup Screen" later in this section). This number must match that stamped on the transmitter for proper communication (see *Transmitter* section). In addition, the receiver must be set to the same frequency as the transmitter (see "Settings Menu" later in this section) and be calibrated for use with the selected transmitter (see "Calibration Menu" later in this section).

Standard Receiver Display Screen Symbols

	**Transmitter Roll** – The transmitter's clock positions are represented by the lines at the edge of the circle. The long line aligns with the clock position, and the clock setting appears in the center to indicate the roll of the transmitter. The number of clock positions is a function of the transmitter. When roll offset is used, the letters "RO" appear at the bottom left.
	**Warning Clock** – Appears on the locate mode screen when there has been a failure in the self test or when calibration is required. Calibrate the receiver to the transmitter being used or contact DCI for support.
	**Globe Icon** – Identifies the regional designation number that appears on the receiver startup screen; must match that on the transmitter battery compartment.
	**Roll/Pitch Update Meter** – The update meter shows the quality of data reception from the transmitter (specifically, data rate). This feature lets you know if you are in an area of interference or are reaching the range limit of the transmitter.
	**Transmitter Pitch Angle** – The number next to this icon on the locating screen indicates the transmitter pitch. It is also the menu selection icon for changing the pitch angle units between percent and degrees.
	**Transmitter Signal Strength** – The number next to this icon on the locate mode screen indicates the transmitter signal strength.
 or	**Transmitter Temperature** – The number next to either of these icons shows the temperature of the transmitter (Fahrenheit when depth units are in feet or inches, Celsius when depth units are in meters). An up or down arrow and a change in the thermometer level will accompany a change in temperature. The latter icon represents dangerous drilling temperatures.
	**Receiver Icon** – Indicates the position of the receiver relative to the ground for the HAG function, depth readings, the two-point calibration procedure, and the *Target Steering* function.
	**Ground Level** – Represents the ground for the HAG function, depth readings, and the two-point calibration procedure.
	**Locating Icon** – Represents a bird's-eye view of the receiver. The square at the top of this icon is referred to as the "box" in the terms *target-in-the-box* and *line-in-the-box* locating.
	**Locate Target** – Represents the front and rear locate points (FLP and RLP). See the *Locating* section for more information.
	Locate Line – Represents the locate line (LL). The LL is found at some location between the front and rear locate points only after a reference point has been obtained. See the *Locating* section for more information about the locate line.
R	**Reference Lock** – Indicates that a reference signal has been obtained for locating the transmitter. See the *Locating* section for more information.
	**Transmitter Battery/Drill Head** – Depicts the remaining battery life of the transmitter when alkaline batteries are used (shown fully charged here). Also used to represent the position of the drill head relative to the receiver in the depth screen.
	**Receiver Battery** – Depicts the remaining battery life of the receiver (shown 80% full here). Displayed on the main menu screen. When empty, the icon will appear in the locate mode screen and will flash signifying that it is critical to change the battery immediately.
	**Dual Transmitter Symbol** – Appears to the upper left of the clock icon when a dual mode transmitter is detected. The letters "DL" or "DH" will accompany this symbol to show whether the receiver is set to detect the dual low (1.3 kHz) or dual high (12 kHz) respectively.

Power On

Install a charged battery pack as shown to the right ensuring the tab latches the battery in place.

Inserting Battery Pack

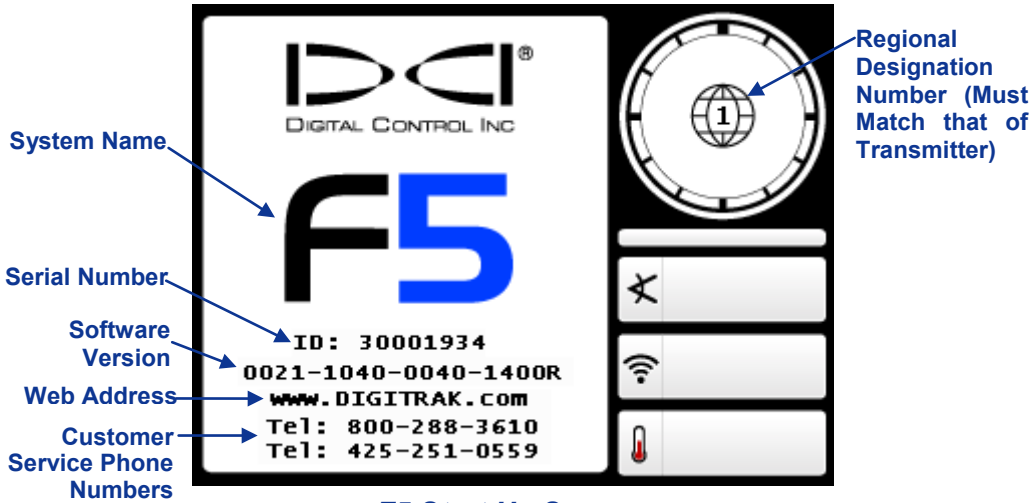
Pull in and hold the trigger switch for at least two full seconds to turn on the receiver. A splash screen will display while the receiver performs it's self-test.

The warning screen shown below will then display.

Warning Screen

Pull and release (click) the trigger switch to indicate that you have read and understand this manual.

If all items of the self-test passed, the startup screen shown below will display.



F5 Start Up Screen

If an item of the self test fails, the failure will show in place of the system name. Contact DCI at one of the phone numbers shown on the start up screen for support. **Note:** If a critical failure is detected, the receiver will not exit the startup screen. You must contact DCI.

Click the trigger to open the Main Menu. See “Main Menu” later in this section for more information.

Power Off 

To turn off the receiver, select the power off option in the main menu.

> To access the main menu from the locate mode screen, push the toggle switch toward the handle. See “Main Menu” later in this section for more information.

Four long beeps will sound as the unit turns off.

Automatic Shutdown

The F5 receiver will shut down if no trigger action and no transmitter signal are detected for 15 minutes.

Toggle & Trigger Switches

The F5 receiver has two types of switches for operating the system – a toggle (thumb switch) located on the top of the unit and a trigger located under the handle.

Toggle Switch – Used to access and navigate menus. It moves in four directions – left, right, up (toward the display), and down (toward the handle). Each movement of the switch has a corresponding action on the display. See the menu discussions later in this section.

Trigger Switch – Used to turn on the unit, select menu options, and to change the screen view for depth readings. See the menu discussions later in this section and *Locating* sections for more information.

Audible Tones

The F5 receiver gives audible tones to signal power on/off, menu changes, and the pass/fail status of actions, as summarized below. The receiver also emits tones with transmitter temperature increases (see “Transmitter Temperature Warning Tones” in the *Transmitter* section).

Power On – One short beep followed by a long beep.

Power Off – Four long beeps.

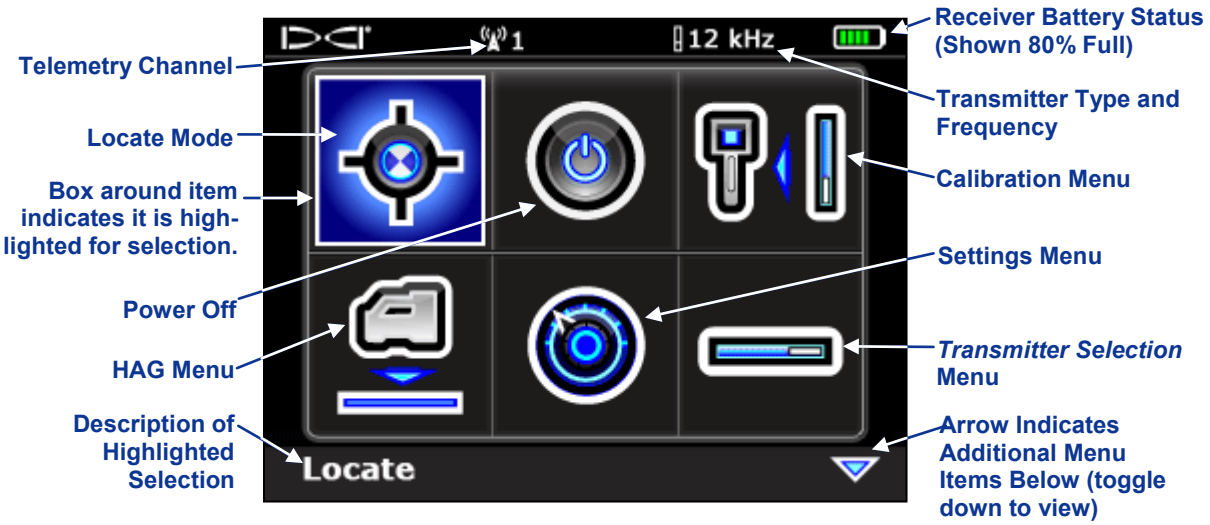
Confirmation Signal – Four short beeps to confirm menu selection has been successfully executed.

Failure Signal – Two long beeps to indicate a problem with the menu item selected. A failure screen will appear. The failure screen will display until the trigger is clicked.

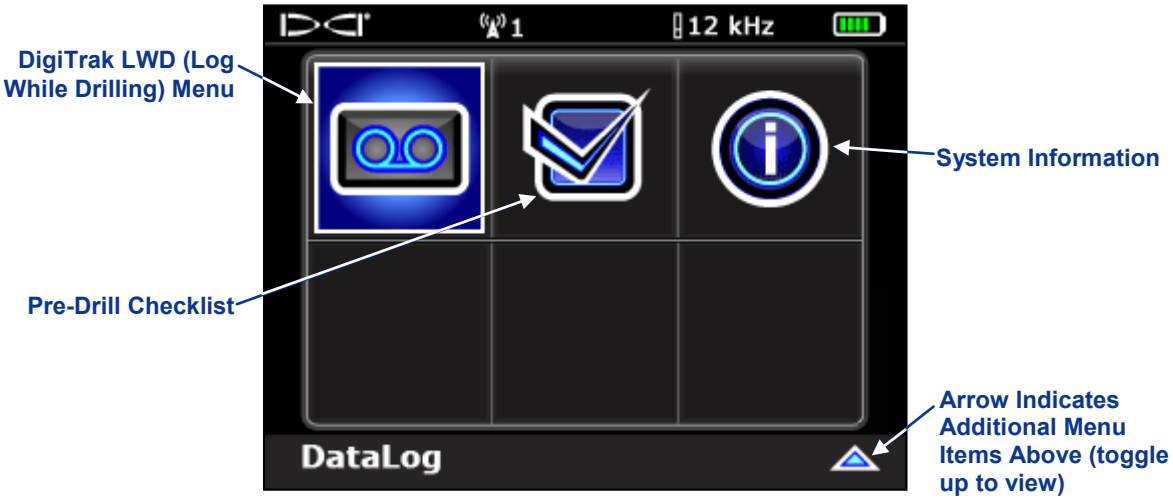
Main Menu

The main menu screen appears after the startup screen in the power on sequence. To access the main menu from the locate mode screen, toggle down (push toggle switch toward the handle). Use the toggle switch to highlight different menu options and pull the trigger switch to select menu items.

The main menu is shown below followed by a description of each menu option.



Receiver Main Menu Screen I



Receiver Main Menu Screen II

The main menu screen also displays the receiver battery status (in the top right corner), the transmitter frequency setting (to the left of the battery status), and the current telemetry channel selection (channel 1 is shown in the example above).

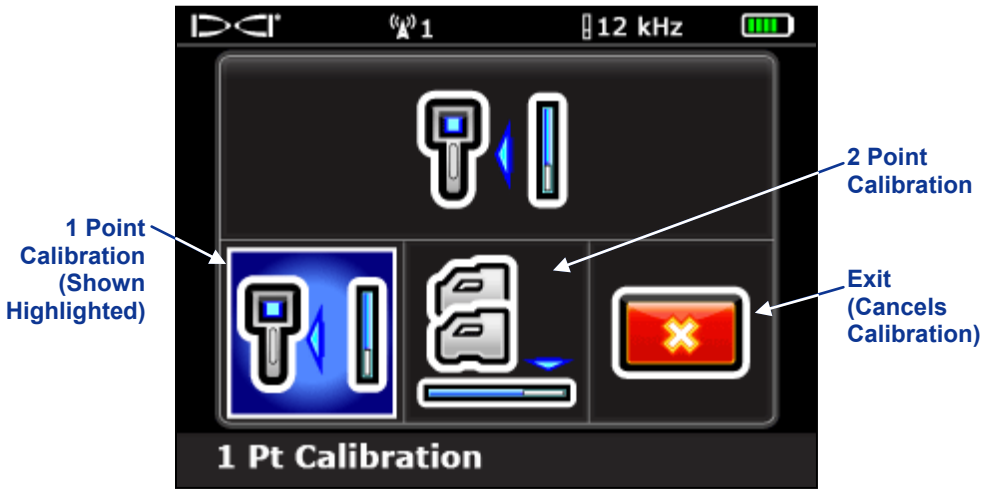
The table below summarizes the main menu options.

Receiver Main Menu Options

	**Locate Mode** – Opens the locate mode screen where transmitter data is displayed. See “Standard Display Screens” later in this section.
	**Power Off** – Turns the unit off accompanied by four long tones.
	**Calibration Menu** – Calibrates the receiver to the transmitter using the above-ground (1-point) method or the below-ground (2-point) method. Calibration is necessary prior to first-time use and before a different transmitter, receiver, or drill head is to be used. See “Calibration Menu” below for more information.
	**Height-Above-Ground (HAG) Menu** – Turns on, turns off, or sets the height at which the receiver will be held during depth readings. This feature allows you to take a depth reading without placing the receiver on the ground. See “Height-Above-Ground (HAG) Menu” below for more information.
	**Settings Menu** – Changes the depth units, pitch units, and transmitter options, and activates the roll offset function, which is used when the transmitter’s roll position must be compensated to match the drill head’s roll position. See “Settings Menu” below for more information.
	**Transmitter Selection Menu** – Displays the transmitter type and frequency options. See “Transmitter Selection Menu” below and the *Transmitter* Section for more information.
	**DigiTrak LWD (Log While Drilling) Menu** – Opens the LWD menu where you can setup to record a drilling or pull back job, view a logged job, upload logged data to a computer, or delete a log. See the “DigiTrak LWD (Log While Drilling Menus” below and the DigiTrak LWD Manual for more information.
	**Pre-Drill Checklist** – Allows you to check the internal level of the F5 receiver and perform a receiver self test. If you have any questions about the operation of this menu item or suspect a failure, contact DCI for support.
	**System Info** – Opens the system info screen where you can see the software versions, identification, and configuration of the unit.

Calibration Menu 

The calibration menu allows you to calibrate the receiver to a transmitter with the transmitter above ground (1-point calibration at a distance of 10 ft or 3 m) or below ground (2-point calibration). Calibration is required each time a different housing or transmitter is to be used with the receiver. When you select the calibration menu, the 1 point calibration option is highlighted for selection as shown below.



Receiver Calibration Menu

To select the 1 point calibration option from this screen, click the trigger. See “Calibrating the Receiver to the Transmitter” and “1 Pt Calibration” below for more information.

To select the 2 point calibration option, toggle right to highlight the 2 Pt Calibration option and click the trigger. See “Calibrating the Receiver to the Transmitter” and “2 Pt Calibration” below for more information.

To cancel the calibration, toggle right until the Exit option is highlighted then click the trigger. You will be returned to the main menu with no change to the calibration.

Calibrating the Receiver to the Transmitter

DCI does not recommend calibrating every day, but you should verify the receiver’s depth reading daily at several locations using a tape measure.

NOTE:	Calibration is necessary prior to first-time use and before a different transmitter, receiver, or drill head is to be used.

A tape measure is required for both calibration methods.

The 1 Pt Calibration is the preferred calibration method and is used to calibrate the receiver to the transmitter when the transmitter is above the ground. When using this method, the receiver and transmitter should be parallel and level with each other.

The 2 Pt Calibration is for calibrating the receiver to the transmitter when the transmitter is below ground. When using this method the transmitter must be below ground, approximately level, and have been properly located. See the *Locating* section for information on locating the transmitter.

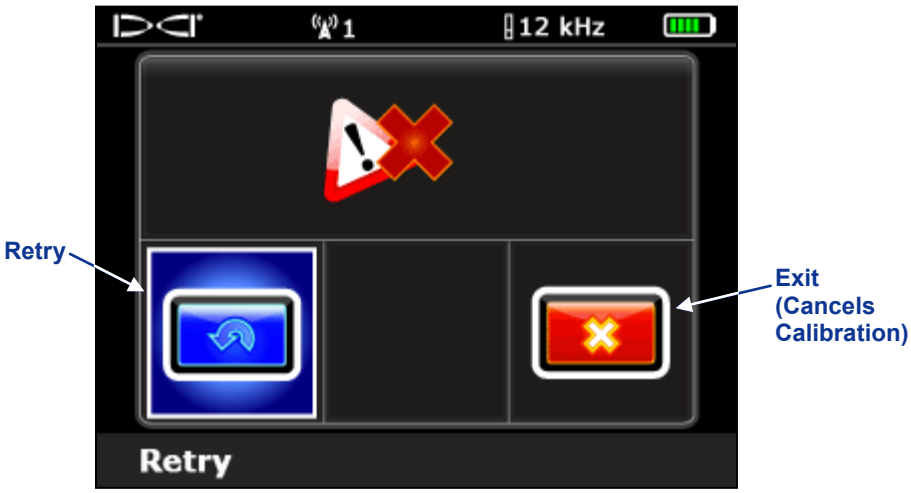
Do not calibrate if:

- You are within 10 ft (3 m) of metal structures, such as steel pipe, chain-link fence, metal siding, construction equipment, automobiles, etc.
- The receiver is over rebar or underground utilities.
- The receiver is in the vicinity of excessive electrical interference.

  Note: Electrical interference is determined by observing the signal strength with the transmitter turned on and then with the transmitter turned off. If the difference between these numbers is less than 150, the electrical interference is excessive.

- The transmitter is not turned on.
- The transmitter is not installed in the housing.
- The receiver is not programmed to detect the frequency of transmitter you are using. See the *Transmitter* section for more information.
- The signal strength from the transmitter is less than 300 points or greater than 950 points.

  If the signal is not within the specified range during calibration, the following screen will display.



Calibration Failed Screen

Click the trigger to retry the calibration or toggle right to select exit and be returned to the main menu. If the calibration failed screen appears, verify the setup and try again or contact DCI for support.

1-Point Calibration (Above Ground)

The 1-point calibration is the preferred calibration method. It requires the drill head be above ground.

To calibrate:

1. The receiver must be parallel to and level with the transmitter.
2. The transmitter must be on and in its housing. It is preferable to conduct the procedure on level ground.
3. Measure 10 ft (3 m) from the center of the transmitter to the inside edge of the receiver as shown below in the 1 point calibration screen.
4. Verify that roll and pitch values are being displayed on the receiver and that a steady signal is being received from the transmitter.
5. Select the 1 point calibration option from the main menu. The following screen will display.

1 Point Calibration Screen

6. Click the trigger to initiate the calibration or toggle right and select the exit option to be returned to the main menu.
7. After the checkmark is selected, the screen will show that the receiver is calibrating. Do not move the receiver. Four short tones and a check mark on the screen indicate a successful calibration. Two long tones indicate a failure, verify the setup and try again or contact DCI for support.

After a successful calibration, take a depth measurement with the transmitter and receiver in the same orientation as during calibration. The depth should be 10 ft ± 5 in. (or 3 m ± 15 cm).

NOTE: It may be necessary to obtain a “reference lock” on a locate point before the depth data will display. See the locating section for more information on obtaining a reference lock.

2 Point Calibration (In Ground)

Two-point calibration is rarely needed. If you must calibrate with the transmitter in the ground, use this procedure with caution.

To Calibrate:

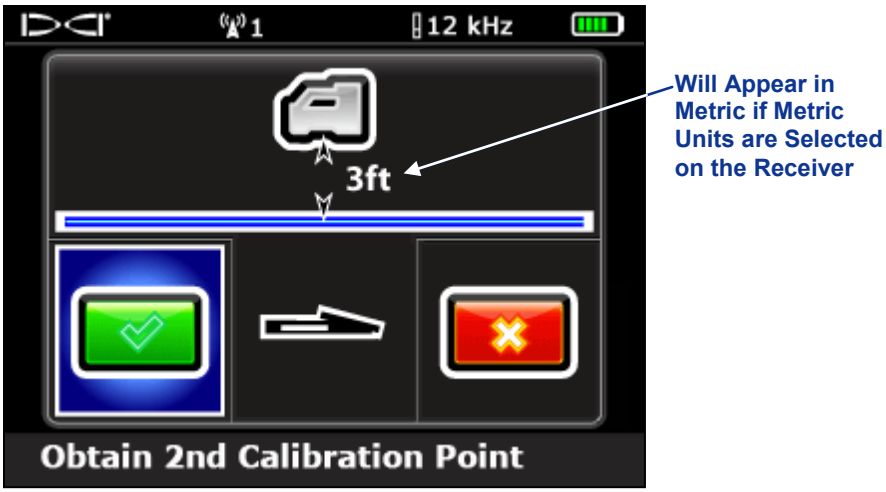
1. Position the receiver directly above an approximately level transmitter. See the locating section for instructions on aligning the receiver directly above the transmitter.
2. Verify the signal strength at both calibration points (on the ground and raised 3 ft or 1 m) is between 300 and 950 points. If the signal strength is too high at the first calibration point, lift the receiver until the signal is within an acceptable range. The second point for calibration will then be taken 3 ft (or 1 m) directly above the first point. If the signal is too low, you will have to pull back to calibrate.
3. Verify that roll and pitch values are being displayed on the receiver and that a steady signal is being received from the transmitter.
4. Select the 2 Pt Calibration option from the calibration menu. The following screen will display.

2 Point Calibration, Obtain 1st Point

5. Click the trigger to obtain the first calibration point or toggle right and select the exit option to be returned to the main menu.

After selecting the checkmark, the screen will show that the receiver is calibrating. Do not move the receiver while it is calibrating.

The second calibration point screen will then appear.



2 Point Calibration, Obtain 2nd Point

6. Lift the receiver 3 ft (or 1m) directly up and click the trigger to initiate calibration of the second point or toggle right and select the exit option to be returned to the main menu with no change to the calibration.

After selecting the checkmark, the screen will show that the receiver is calibrating. Do not move the receiver while it is calibrating. Four short tones and a check mark on the screen indicate a successful calibration.

After the 2-point calibration procedure has passed, verify the distance between the two calibration points by taking depth measurements at the first point and the second point and then determining the difference between the two values. The difference should be 3 ft ± 2 in. (or 1 m ± 5 cm). Repeat these measurements several times as you continue drilling to verify that the depth remains valid as the pitch of the transmitter changes.

Height-Above-Ground (HAG) Menu

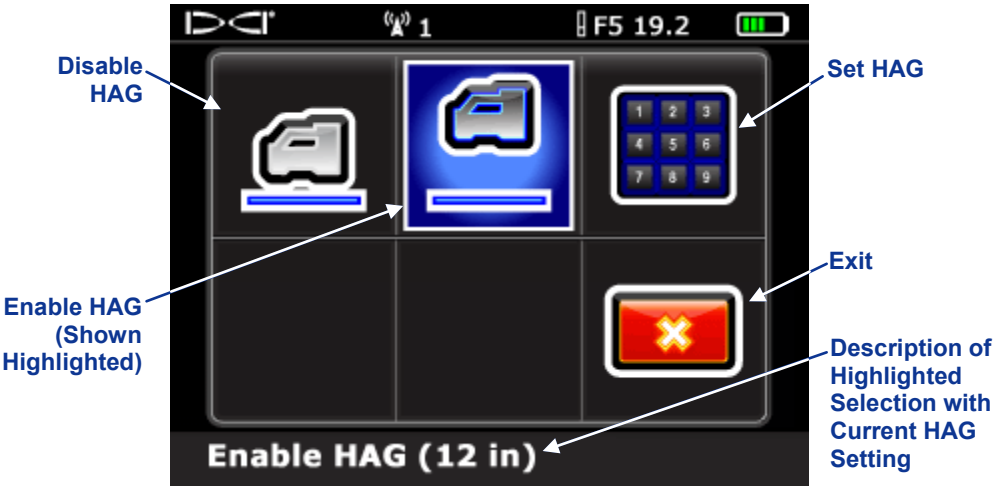
The height-above-ground (HAG) function allows you to program a height measurement into the receiver so that you do not have to set the receiver on the ground for a depth reading. Raising the receiver above the ground is also helpful in passive interference situations. See “Interference: What It Is and How to Check for It” in the *Locating* section.

The HAG menu has three options: Enable, Disable, and Set. Set allows you to change the current height setting. The default setting for the HAG function is off. Until you enable or set a new HAG, the receiver must be placed on the ground for accurate depth readings. The HAG function automatically shuts off when depth units are changed, when *Target Steering* is used, and during calibration.

Before accessing the HAG menu to turn on or set the HAG, you should measure your desired HAG. To do so, hold the receiver comfortably at your side and measure the distance from the bottom of the receiver to the ground. The available values range from 12–100 in., or 0.30–2.54 m.

Enable/Disable HAG

When the HAG menu is accessed, a screen such as the following displays. If the HAG had previously been enabled, the disable option would show automatically highlighted for selection.



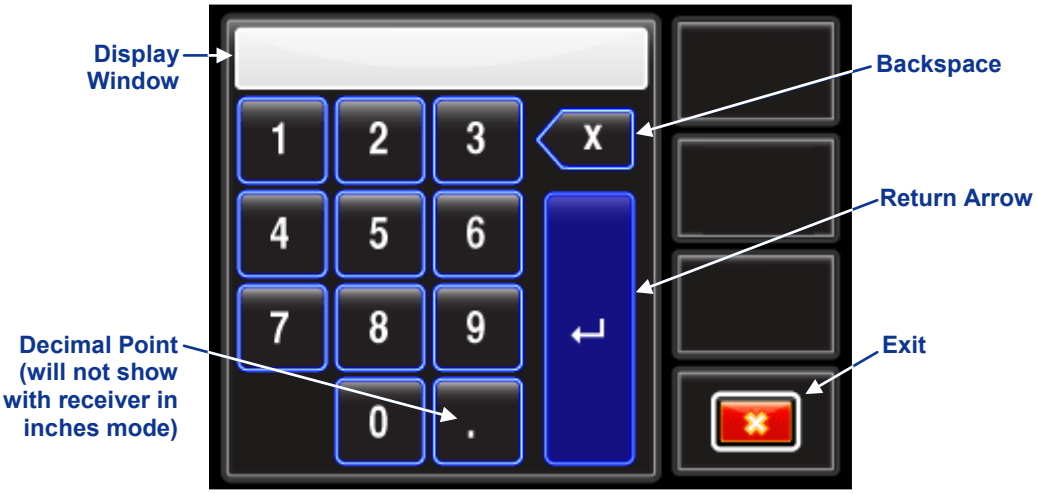
HAG Menu Screen

Selecting the enable HAG option will turn on the Height-Above-Ground function to the value shown at the bottom of the screen (default value or last set value). Depth readings must be taken with the receiver held at this height.

Selecting the disable HAG option will turn off the HAG function. Depth readings must be taken with the receiver on the ground.

Set HAG

Selecting the set HAG option will open the keypad for setting an HAG value. The keypad will appear slightly differently depending on the units the receiver is set to display. See “Using the Keypad” at the end of this section for more information.

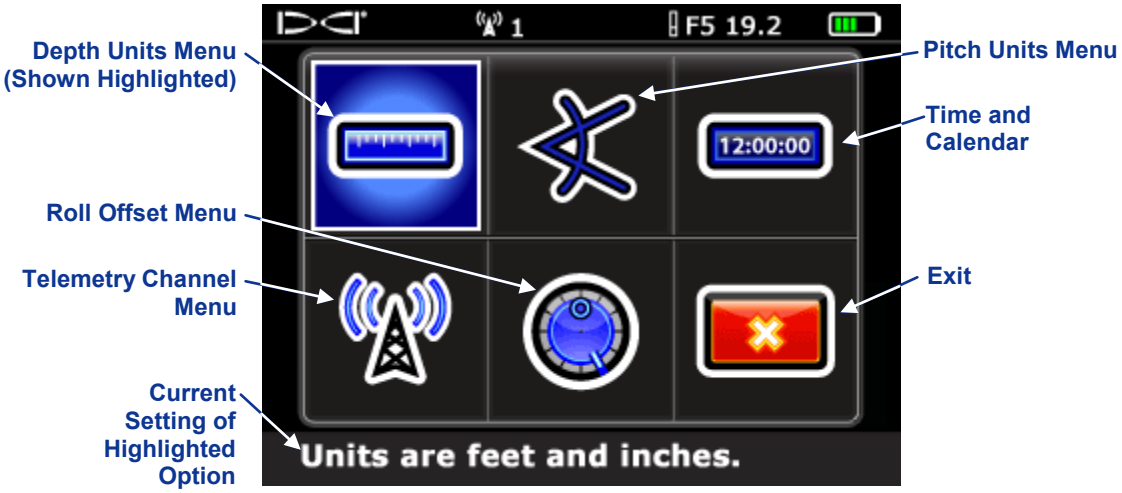


Decimal Keypad

Use the toggle switch to highlight the values you wish to set and pull the trigger after each selection to put it in the display window. When the value in the display window matches the value you wish to set, select the return arrow to lock in the value and turn on the function. You will be returned to the main menu with HAG enabled.

Settings Menu

The settings menu allows has six menu options shown below.



Receiver Settings Menu

Use the toggle switch to highlight an option, and then pull the trigger to select it. Each item is discussed in detail below.

Depth Units Menu

The depth units menu displays four options: xx" represents the use of inches only; x'xx" represents the use of both feet and inches; x.xx m represents the use of metric units (meters and centimeters); and x.xx' represents the use of feet only. Use the toggle switch to highlight the desired option and pull the trigger to select it. You will hear the confirmation signal and be returned to the settings menu with the exit option highlighters.

NOTE: The temperature units are determined by the depth units selected. Celsius (°C) temperature units will display if metric depth units are selected, and Fahrenheit (°F) temperature units will display if English depth units (inches or feet and inches) are selected.

Pitch Units Menu

The pitch units menu has two options, degrees (x°) and percent (x%). Use the toggle switch to highlight the desired option and pull the trigger to select it. You will hear the confirmation signal and be returned to the settings menu with the exit option highlighted.

Time and Calendar Setting

After selecting the “Set Time and Calendar” option from the settings menu, a screen such as the following will display.

Date and Time Keypad (Clock Active)

Setting the Time

The time function runs on a 24 hour clock.

To Set the Time:

1. Ensure that the clock is the active function on the keypad as shown above.
2. Select the desired value for time one digit at a time left to right. For example to set the clock to 14:39 (2:39 pm):
   - Toggle to highlight the “1” then pull the trigger to select it.
   - Toggle to highlight the “4” then pull the trigger to select it.
   - Toggle to highlight the “3” then pull the trigger to select it.
   - Toggle to highlight the “9” then pull the trigger to select it.
3. Confirm the time reads as desired.
4. Toggle to highlight the return arrow and pull the trigger.

The confirmation tone will sound as the screen returns to the settings menu.

Setting the Date 

The date function displays the date by month/day/year.

To Set the Date:

1. Ensure the calendar is the active function (yellow-orange) on the keypad. If necessary, toggle to highlight it and pull the trigger to select it. The display window on the keypad will change to show a date format.

2. Enter the date one digit at a time (month, then day, then the last two digits of the year) left to right. For example to set the date to January 2nd of 2011 (01/02/11):

   - Toggle to highlight the “0” then pull the trigger to select it.
   - Toggle to highlight the “1” then pull the trigger to select it.
   - Toggle to highlight the “0” then pull the trigger to select it.
   - Toggle to highlight the “2” then pull the trigger to select it.
   - Toggle to highlight the “1” then pull the trigger to select it.
   - Toggle to highlight the “1” then pull the trigger to select it.

3. Confirm the date reads as desired.

4. Toggle to highlight the return arrow and pull the trigger to select it.

The confirmation tone will sound as the screen returns to the settings menu.

Telemetry Channel Menu 

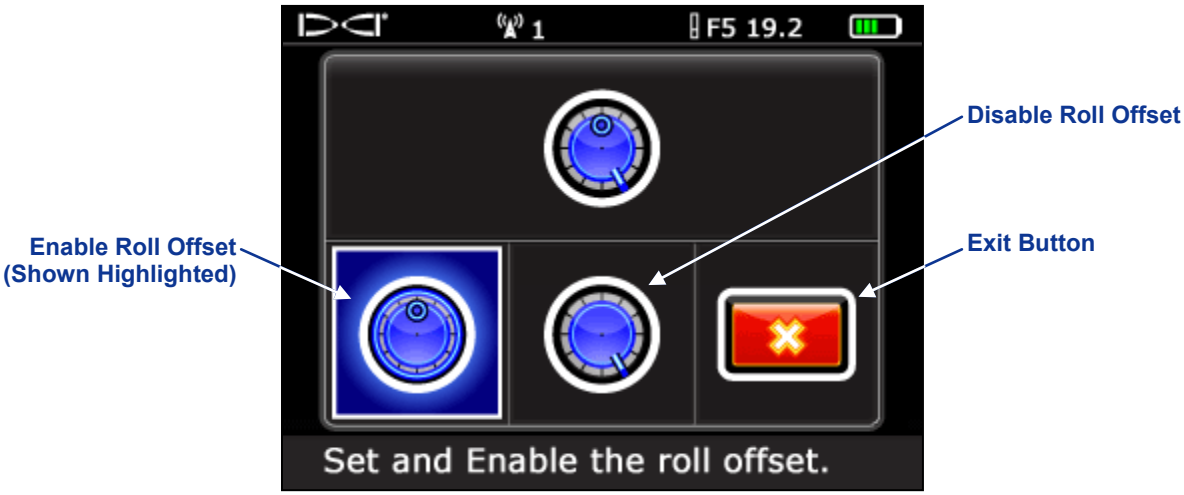
The telemetry channel menu has five telemetry setting options (1, 2, 3, 4, and 0) and an exit button. The current setting is automatically highlighted for selection when the telemetry channel menu is accessed. Selecting the exit button will return the screen to the settings menu with no change to the telemetry channel setting. Selecting “0” will turn off the telemetry function.

For communication to occur between the receiver and remote display, both devices must be set to the same telemetry channel.

To set the telemetry channel on the receiver, use the toggle switch to highlight the desired telemetry channel in the telemetry channel menu then pull the trigger. The confirmation tone will sound as the screen returns to the settings menu.

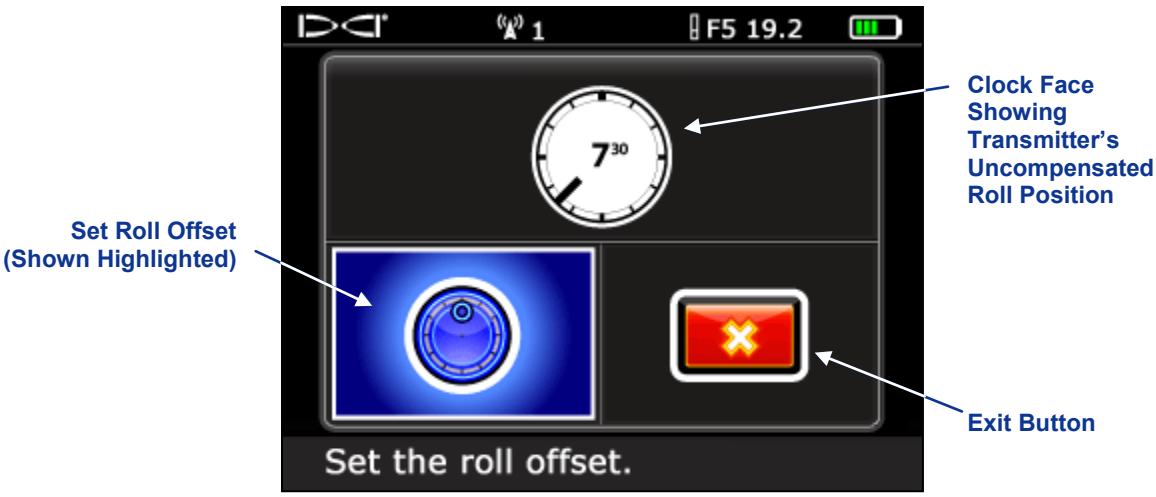
Roll Offset Menu 

Roll offset is needed when the 12 o'clock position of the transmitter cannot be indexed to that of the drill head. The roll offset function is an electronic compensation to match the transmitter's 12 o'clock position to the drill head's 12 o'clock position.



Roll Offset Menu

To electronically compensate the transmitter to match the drill head's 12 o'clock position, select the enable roll offset option from the roll offset menu. A screen such as the following will display.



Enable Roll Offset Menu

Ensure the drill head is as its 12 o'clock position and that the transmitter is on (showing a roll value on the screen). With the set roll offset option highlighted, pull the trigger to activate it. The confirmation tone will sound and you will be returned to the settings menu.

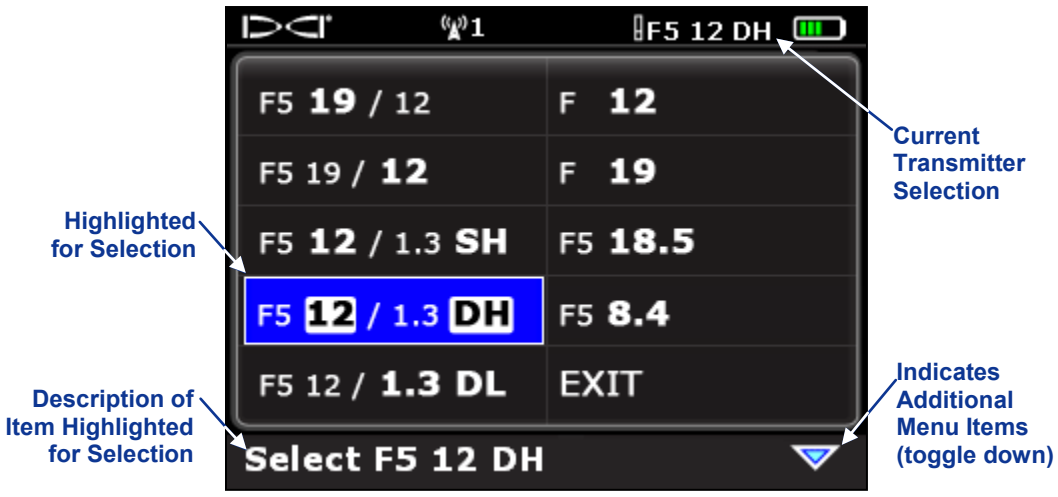
To turn off the roll offset function, select the disable the roll offset option from the roll offset menu. The confirmation tone will sound as the screen returns to the settings menu. The value that displays for roll on the locate mode screens will be that of the transmitter.

Transmitter Selection Menu

The transmitter selection menu allows you to select the type ("F" for an F Series or "F5" for an F5 transmitter) and frequency (1.3 kHz, 8.4 kHz, 12 kHz, 18.5 kHz, or 19 kHz) of transmitter you are using.

If a new transmitter selection is made, calibration will be required. Calibration coefficients are saved for each transmitter option therefore calibration is not required when switching between transmitters that were last calibrated under the transmitter option being used. Calibration is required every time a new transmitter or housing is used.

When the transmitter selection menu is selected from the main menu, a screen such as the following will display.

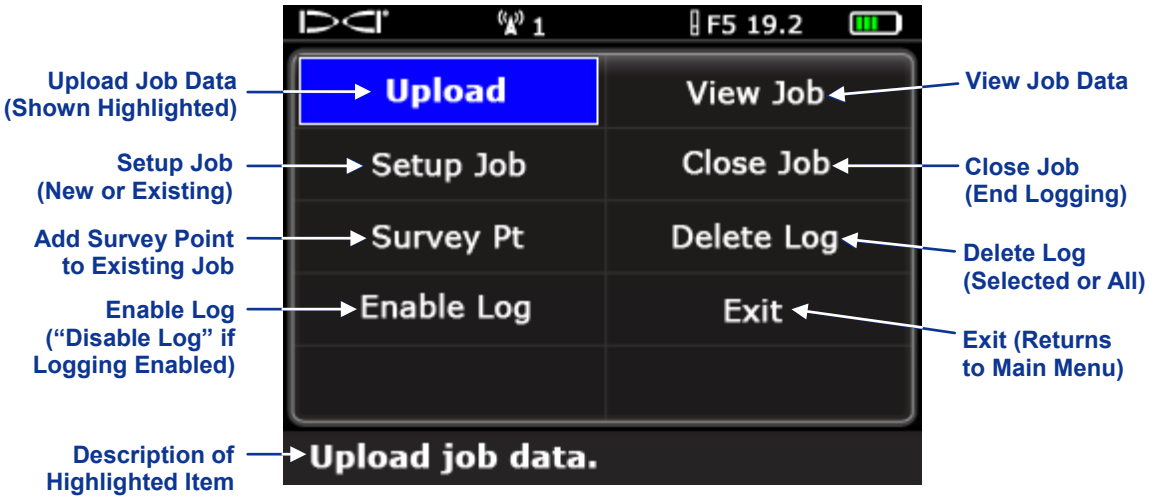


Transmitter Selection Menu

The current transmitter selection is highlighted automatically. Use the toggle switch to highlight the desired option then pull the trigger. Selecting "Exit" will return you to the main menu with no change to the transmitter selection. See the *Transmitter* section for more information on the transmitter options.

DigiTrak LWD (Log While Drilling) Menus

When the LWD option has been selected from the lower page of the main menu, the screen shown below will display.



DigiTrak LWD Menu

Each menu item is discussed in more detail below. Please see the DigiTrak LWD manual for more information.

DigiTrak LWD Menu Options

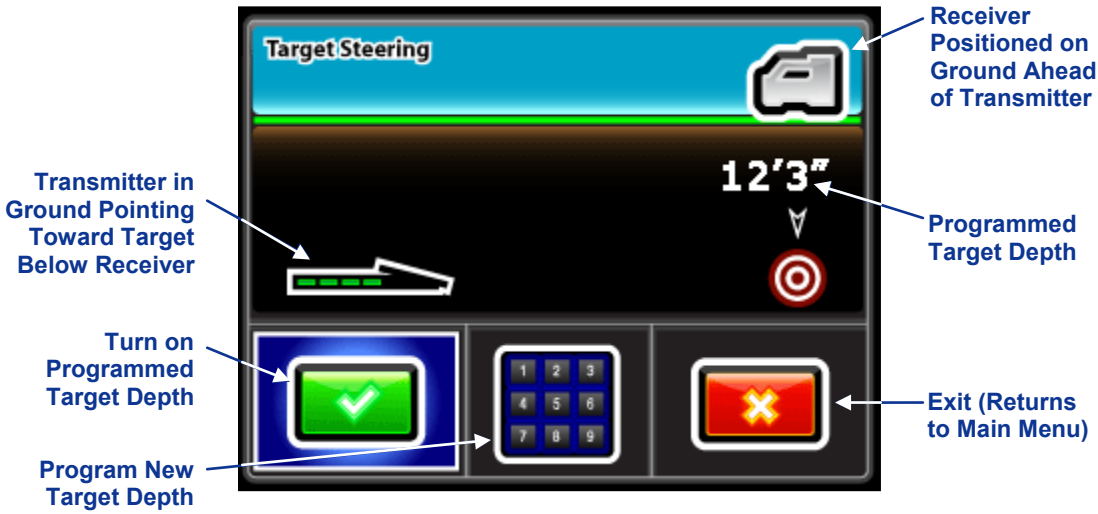
Upload	The upload job data option allows you to load the data from a logged bore to a PC with DigiTrak LWD software installed via Bluetooth connection. A maximum of 20 jobs may be stored in the receiver.
Setup Job	The setup option allows you to start a new job or append an existing job. When starting a new job, use this menu program the rod lengths and set a different length for the first logged rod. When the LWD function is enabled, this option can also be accessed from the locate mode screen by holding the trigger in and toggling right.
Survey Pt	The add survey point option allows you to record a surveyed value for the difference in elevation between the start and end of the bore.
Enable/Disable Log	When "Enable Log" shows, the LWD function is disabled in the receiver and no logging can occur. When "Disable Log" shows, the LWD function is enabled; setting up, appending, and logging a job from the depth mode screen is allowed.
View Job Data	The view job data option allows you to select a specific job and view logged data.
Close Job	Select to stop recording data points on an open job. The job can be viewed, reopened, and appended until it is deleted from the job list.
Delete Job	The delete job option allows you to select and delete jobs from the receiver. If you wish to save a job, upload it to a PC before deleting it from the receiver. Once a job is deleted, it can no longer be appended in the receiver.

DigiTrak LWD Basic Menu Symbols

	**Standard Transmitter** – Select when logging data from a standard, non-pressure sensing, transmitter.
	**Pressure Sensing Transmitter** – Select when logging data from a pressure sensing transmitter.
	**TensiTrak Transmitter** – Select when logging data from a TensiTrak transmitter.
	**Create New Job** – Select to start logging a new drilling job.
	**Append Existing Job** – Select to continue logging on a previously opened drilling job. You must select the job type and number from the list. A maximum of 20 bores can be saved for appending.
	**Stop Job** – Select to stop recording data points on an open job. This will close the job. The job can be viewed, reopened, appended, and uploaded until it is deleted from the job list.
	**Delete One Job** – Select to delete a specific drilling job log. You must select the job type and number you wish to delete from the list.
	**Delete All Jobs** – Select to delete all drilling jobs logged. All existing jobs will be selected for deletion from the receiver.
	**Confirm Delete** – Appears in menu after a delete jobs option has been selected. Select this option to confirm deletion or select exit to cancel deletion.
	**Record Depth/Pitch** – Select to log a data point with depth and pitch information.
	**Record Pitch** – Select to log a data point with only pitch information.
	**Record Blank Rod** – Select to log a data point with no pitch or depth information.
	**Record Partial Rod** – Select to log a data point after drilling ¼, ½, or ¾ of rod and to log a data point after finishing the partial rod.
	**View/Delete Rod Data** – Select to view all logged data points and to delete the last logged data point.

Target Steering Menu

The target steering menu is accessed from the locate mode screen by pushing the toggle switch up (toward the display). The following screen will display.



Target Steering Menu

If the depth value on the display matches your target depth value, pull the trigger to select the checkmark. You will be returned to the locate mode screen with *Target Steering* activated.

If you wish to program a new target depth, toggle right to highlight the keypad and pull the trigger. See "Using the Keypad" below for more information. Once a target depth is programmed with the keypad, you will be returned to the locate mode screen with *Target Steering* activated.

See the *Target Steering* section for more information on correctly positioning the receiver as a target and determining the target depth.

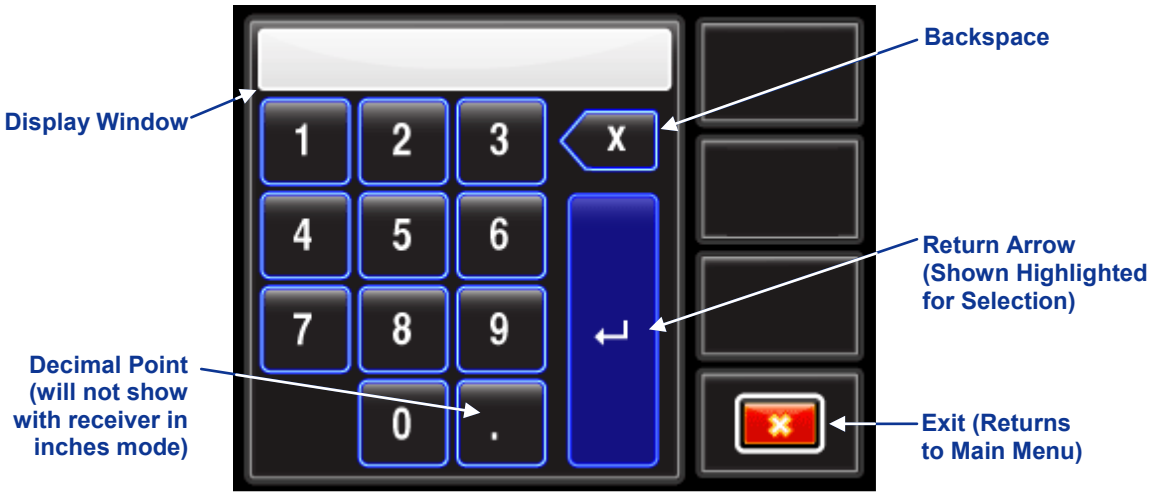
Using the Keypad 

A keypad menu shows anytime the keypad icon is selected. It is used for setting a height-above-ground in the HAG function, setting a target depth in the *Target Steering* function, and programming rod lengths in the LWD function. A variation of the keypad is used to set the date and time; it is covered under "Settings Menu" earlier in this section.

The keypad menu will appear slightly differently depending on which units are active in the receiver.

Inches and Decimal Keypad

The decimal keypad will appear when keypad menu is accessed and the receiver units are set to meters (x.xx m) or feet (x.xx'). The inches keypad appears when the receiver units are set to inches (xx"). The inches keypad is the same as the decimal keypad shown below except the decimal option will not show.



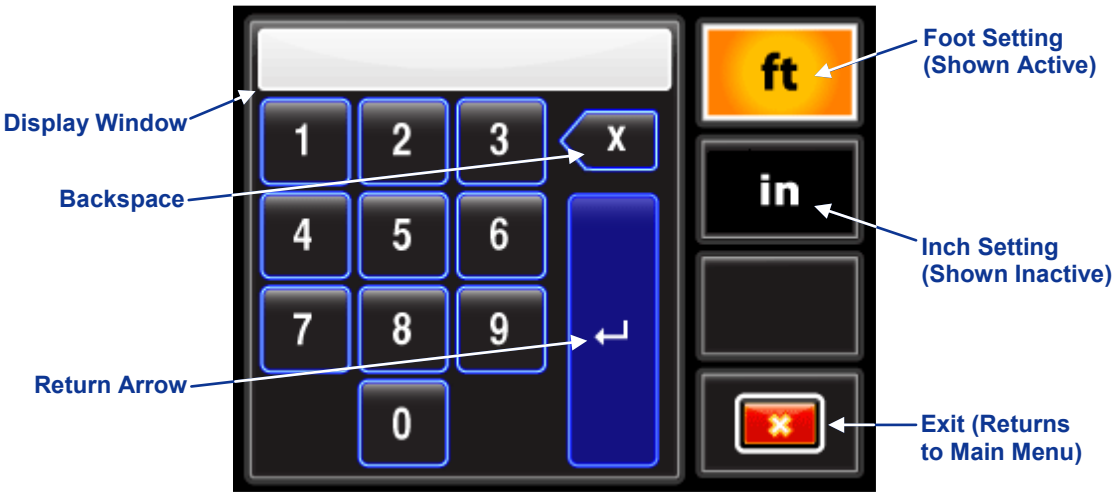
Decimal Keypad

Use the toggle switch to highlight the number or decimal you wish to select then pull the trigger to select it. Do this for each digit left to right. To delete the last digit entered, select the backspace button.

When the number in the display window matches the value you wish to program, select the return arrow to lock in the value and turn on the function.

Feet and Inches Keypad

The feet and inches keypad appears when the keypad menu is selected and the receiver units are set to feet/inches (x'xx").



Feet and Inches Keypad

When the foot setting is active as shown in the image above, numbers entered on the keypad will be for the foot value.

To activate the keypad for inputting inch values, use the toggle switch to highlight the inch setting option then pull the trigger to select it. The foot setting option will inactivate. Numbers entered on the keypad will be for the inch value.

To enter a value, use the toggle switch to highlight the number you wish to select then pull the trigger to select it. Enter each number left to right. To delete the last number entered, select the backspace button.

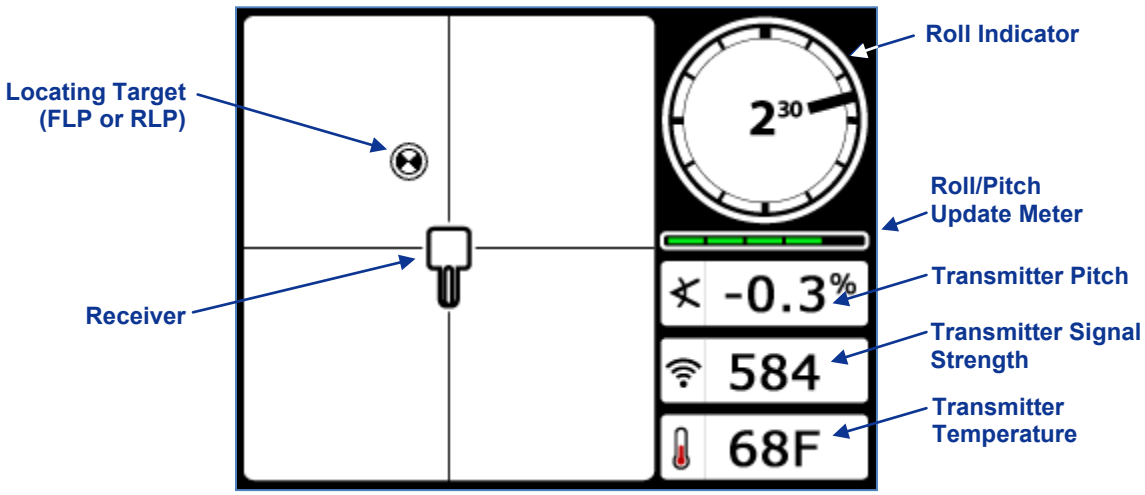
When the number in the display window matches the value you wish to program, select the return arrow to lock in the value and turn on the function.

Display Screens

The basic receiver displays include the locate mode screen, the depth mode screen, and the predicted depth screen. These are presented below. For more information regarding these screens and for detailed locating instructions, please see the *Locating* section.

Locate Mode Screen

When the receiver is detecting a signal from a transmitter, the locate mode screen provides real-time data about the transmitter's location, temperature, pitch, roll, and signal strength. The roll/pitch meter shows the quality of the signal from the transmitter.



Receiver Locate Mode Screen with Transmitter in Range (Trigger Out)

The roll/pitch update meter displays the quantity of roll/pitch data being received from the transmitter. When the meter is empty, no roll/pitch data is being received, and all information will disappear on both the receiver and remote display. Depth and predicted depth readings may still be taken, but the receiver will assume the transmitter has a pitch of zero, as indicated by the following image appearing on the depth or predicted depth mode screen.

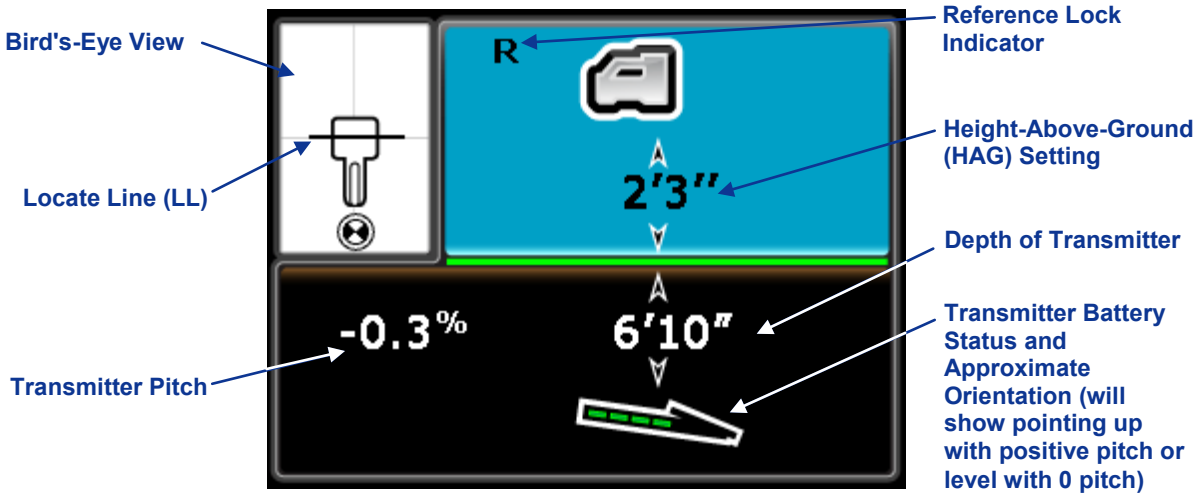
Pitch Assumed Zero

When the roll offset function is used (an electronic compensation to match the transmitter's 12 o'clock position to the drill head's 12 o'clock position), the roll indicator will show as below. For more information on the roll offset, see "Roll Offset Menu" above.

Roll Offset Is Activated

Depth Mode Display Screen

The depth mode screen displays when the trigger is held in with the receiver at the locate line. See the locating section for information on how to position the receiver at the locate line.

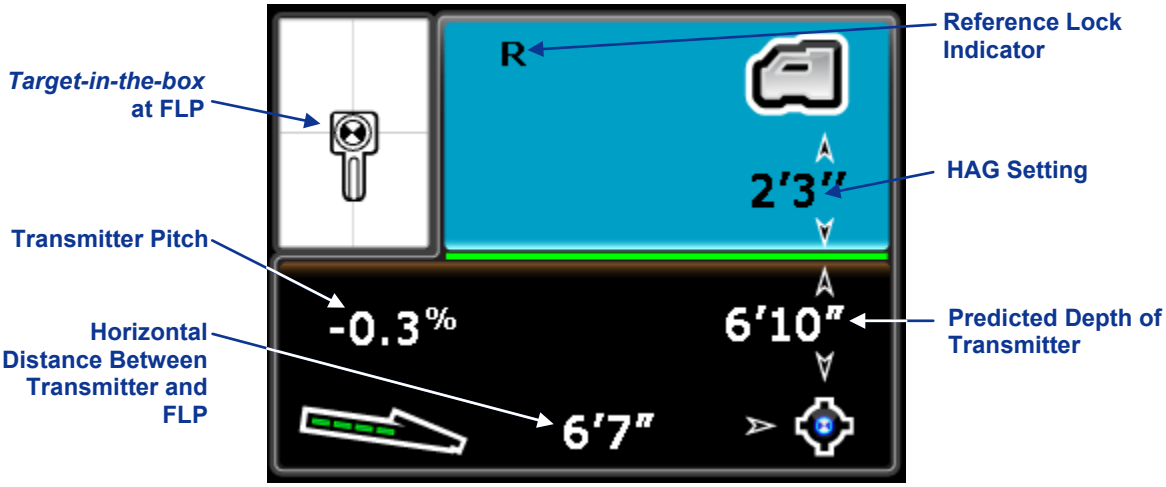


Receiver Depth Mode Screen at LL with HAG on (Trigger In)

When the HAG setting is disabled, the receiver is shown on the ground. The receiver must be placed on the ground for depth readings.

Predicted Depth Display Screen

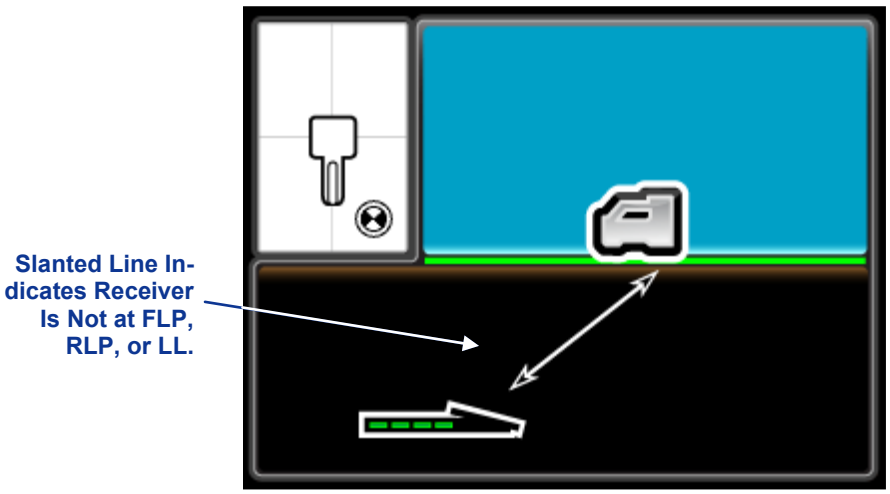
Predicted depth is the depth the transmitter is calculated to be at when it reaches the front locate point (FLP) if it continues on its current trajectory. When the receiver is positioned at the front or rear locate point (FLP or RLP) and the trigger is held in, you will see the predicted depth screen. See the *Locating* section for more information regarding the locate points and the predicted depth function.



Receiver Predicted Depth Screen at FLP with HAG on (Trigger in)

Depth Display Screen, No Data

The depth screen can be accessed at any time during locating by holding in the trigger. However, depth or predicted depth data will only be displayed when the receiver is at the locate line or locate points, respectively. The depth screen will display as follows when the receiver is not positioned at a locate point or the locate line.



Receiver Depth Screen (when not at the LL or LP)

If HAG were enabled, the receiver would be shown elevated above the ground and the HAG value would display below the receiver.

Locate Mode Screen with Pressure Transmitter

When a pressure transmitter is used, the locate mode screen has an additional field as shown below.

Transmitter

Types of F5 Transmitters

DCI manufactures several different transmitters with a total of five frequency options (1.3 kHz, 8.4 kHz, 12 kHz, 18.5 kHz, 19.2 kHz) for use with the F5 system. All F Series and F5 transmitters provide pitch readings in 0.1% or 0.1° increments (from 0% to 100% or 0° to 45°). This section presents information for operating the battery-powered F Series and F5 transmitters. For information on operating the FC cable transmitter, see the *DigiTrak Multi-Function Cable Box (MFCB) Operator's Manual*.

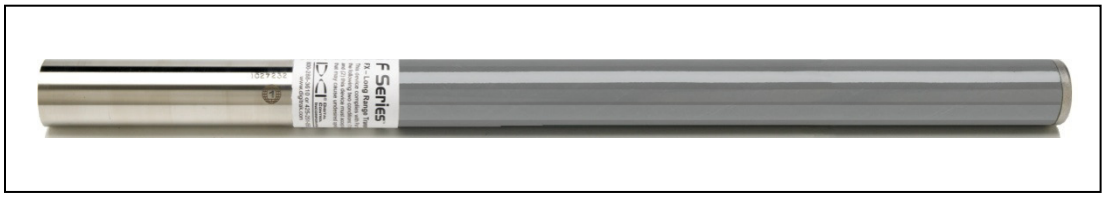
The transmitter fits inside the drill housing and emits electromagnetic signals of a particular frequency. The F5 receiver must be programmed to detect the specific frequency of the transmitter. See "Verifying Signal" later in this section the "Transmitter Selection Menu" in the *Receiver* section for more information. Be sure the receiver is calibrated to the transmitter being used and verify depth data before drilling.

The transmitter and receiver must have matching regional designation numbers to ensure that they can communicate and comply with local operating requirements. The transmitter's regional designation number is located inside the globe icon ( ) near the serial number on long-range and extended long-range transmitter battery compartments and on the front end cap of the short-range transmitter. This number must match that of your receiver for proper communication (see *Receiver* section).

Long-Range FX Transmitter

The long-range F5 and F Series transmitters all measure 15 in. (38.1 cm) long and 1.25 in. (3.175 cm) in diameter and have a depth range of approximately 65 ft (19.8 m).

Options for the long-range transmitter include the FX in 12 kHz (grey) or 19 kHz (black), the 5XD 12/1.3 (blue) which operates in dual-mode at 12 kHz and 1.3 kHz (reduced signal strength in this mode) or in single mode at 12 kHz, the 5XD 19/12 (blue) which operates at either 12 kHz or 19 kHz, the 8.4 kHz model 5X 8.4 (blue), and the 18.5 kHz model 5XD 18.5 (blue).



Extended Long-Range FXL Transmitter

The extended long-range transmitters provide a depth range of approximately 85 ft (25.9 m). They measure 19 in. (48.26 cm) long and 1.25 in. (3.175 cm) in diameter. They have an extended transmitting range and are available in 12 kHz (grey) or 19 kHz (black).

The short-range FS transmitter provides a depth range of approximately 15 ft (4.6 m). It measures 8 in. (20.32 cm) long and 1.00 in. (2.54 cm) in diameter.

Short-Range FS Transmitter with Closeup of Front End Cap

The FC cable transmitter provides a depth range of approximately 90 ft (27.4 m). It measures 19 in. (48.26 cm) long and 1.25 in. (3.175 cm) in diameter.

FC Cable Transmitter

This transmitter requires a special rear-load housing with an end plug that allows the transmitter's cable to exit the housing. The end plug requires a compression fitting to seal the transmitter from the drilling fluid. For operational information on the FC cable transmitter, please see the *DigiTrak Multi-Function Cable Box (MFCB) Operator's Manual*.

NOTE: The range of any transmitter is largely dependent upon the amount of interference at a job site. The range decreases as interference increases. More transmitter frequency options an power options means more options for overcoming jobsite interference.

Batteries and Power On/Off

The long-range transmitters each require two C-cell alkaline batteries or one DCI SuperCell Lithium Battery. The extended long-range transmitters require one DCI SuperCell battery. Do not use alkaline batteries in the FXL transmitter; they would last only a few hours. The short-range FS transmitter requires one AA alkaline battery.

NOTE: Never use damaged or non-DCI lithium batteries. DCI SuperCell batteries are manufactured to military specifications. The use of damaged or lower-quality lithium batteries may damage the transmitter and/or housing and will void the DCI warranty.

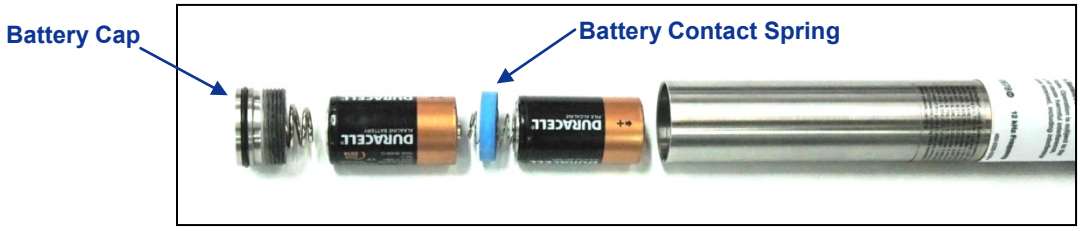
Installing Batteries / Power On

The transmitter is powered on once the batteries are installed properly. To install the batteries:

1. Remove the battery cap from the transmitter by rotating it counter clock wise. A large flathead screw driver is required.

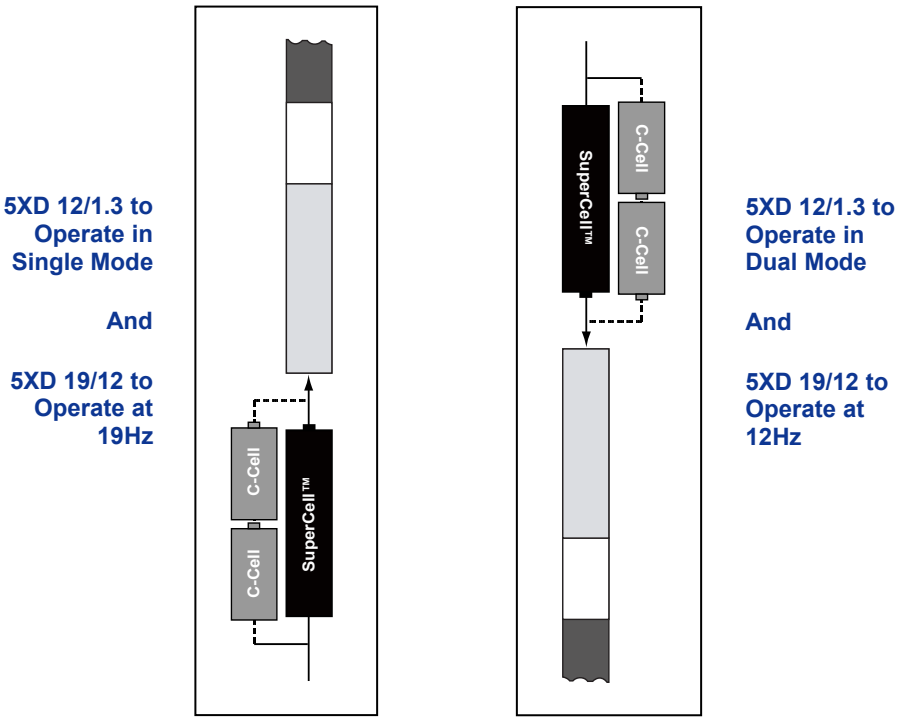
2. Insert battery or batteries positive terminal first.

When using two C-cell batteries in the long-range transmitters, performance is improved by placing a spring between the batteries, as shown below.



Install Transmitter Batteries with Battery Contact Spring

3. Replace the batter cap. Dual frequency transmitters must be in the appropriate orientation for the desired frequency when the battery cap is installed, see below.



Pointing Up *Pointing Down*

Verify Signal

In order for the receiver to detect the signal from the transmitter, the receiver and transmitter must have matching regional designation numbers as discussed earlier in this section and in the *Receiver* section. The receiver must also be programmed to detect the frequency of the transmitter being used. The frequency that the receiver is programmed to detect is displayed at the top of the menu screens.

To change the frequency the receiver is programmed to detect, you must select your transmitter type and frequency from the Transmitter Selection menu in the receiver's main menu. See the "Transmitter Selection Menu" in the *Receiver* section and the table below for more information.

Transmitter Selection Menu Options

Menu Option	Transmitter Model	Frequency	Clock Positions
F5 **19** / 12	5XD 19/12	19.2 kHz	24
F5 19 / **12**	5XD 19/12	12 kHz	24
F5 **12** / 1.3 **SH**	5XD 12/1.3	Single Mode – 12 kHz	24
F5 **12** / 1.3 **DH**	5XD 12/1.3	Dual Mode – 12 kHz	24
F5 12 / **1.3 DL**	5XD 12/1.3	Dual Mode – 1.3 kHz	24
F **12**	FX or FXL	12 kHz	12
F **19**	FX 19 or FXL 19	19 kHz	12
F5 **18.5**	5X 18.5	18.5 kHz	24
F5 **8.4**	5X 8.4	8.4 kHz	24

Transmitter Battery Status 

When using alkaline batteries, the battery status symbol at the bottom of the receiver's depth mode screen will indicate the battery life remaining. When using a DCI SuperCell battery, the battery status symbol will appear full until just before the battery dies.

NOTE: Because the SuperCell battery will appear full until just before it dies, you must track the hours of use for the SuperCell battery.

Sleep Mode (Automatic Shutdown) / Power Off

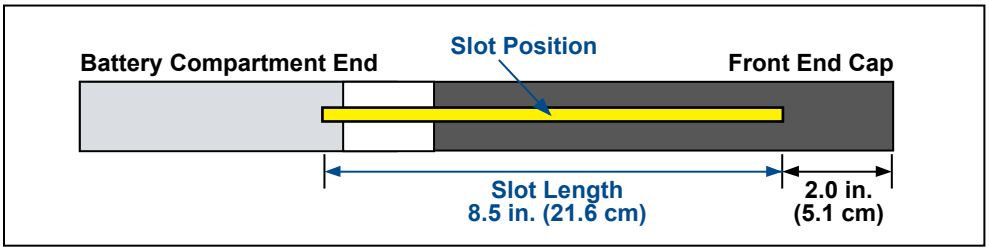
All battery powered DigiTrak transmitters will go into sleep mode and stop transmitting to conserve battery power if they are stationary for longer than 15 minutes. To "wake" the transmitter, rotate the drill string.

A small amount of charge will continue to drain from the batteries while the transmitter is in sleep mode. To conserve battery life, do not leave batteries in the transmitter when they can easily be removed, and always remove batteries when the transmitter is not being used.

Transmitter Housing Requirements

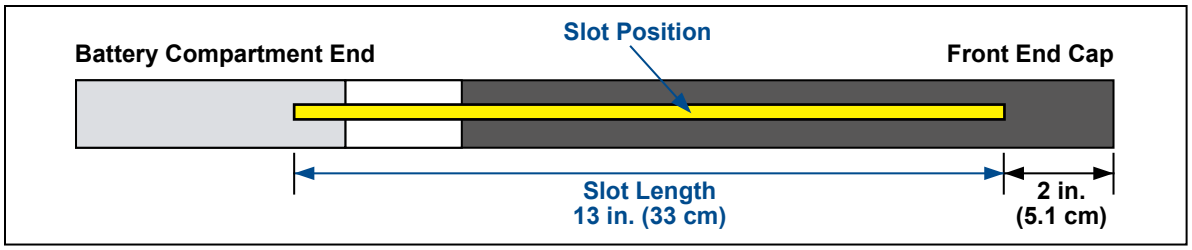
For maximum transmitter range and battery life, the slots in the drill housing must meet minimum length and width requirements and be correctly positioned. DCI recommends at least three slots, each at least 1/16-inch or 0.0625 in. (1.6 mm) wide and equally spaced around the circumference of the housing. For accuracy, slot measurements must be taken from the inside of the housing.

For the long-range transmitters (15 in./38.1 cm long), the slots must be at least 8.5 in. (21.6 cm) long and begin at least 2 in. (5.1 cm) but not more than 3 in. (7.6 cm) from the front of the transmitter, as shown below.



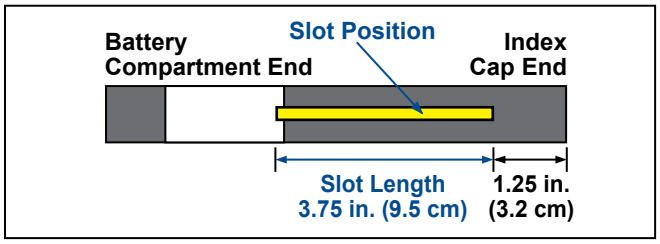
DigiTrak Long-Range Transmitter Housing Slot Requirements

For the extended long-range transmitters (19 in./48.26 cm long), the slots must be at least 13 in. (33 cm) long and begin at least 2 in. (5.1 cm) but not more than 3 in. (7.6 cm) from the front of the transmitter, as shown below.



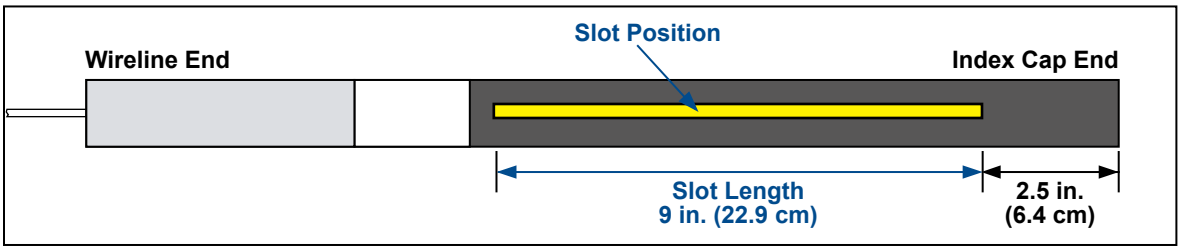
DigiTrak Extended Long-Range Transmitter Housing Slot Requirements

For the short-range FS transmitter (8 in./20.32 cm long), the slots must be at least 3.75 in. (9.5 cm) long and begin at least 1.25 in. (3.2 cm) from the front or index cap end of the transmitter, as shown below.



FS Transmitter Housing Slot Requirements

For the FC cable transmitter (19 in./48.26 cm long), the slots must be at least 9 in. (22.9 cm) long and begin at least 2.5 in. (6.4 cm) from the front or index cap end of the transmitter, as shown below.



FC Transmitter Housing Slot Requirements

The transmitter must fit snugly in the housing. It may be necessary to wrap the transmitter with tape or O-rings and/or use a housing adapter for larger drill housings. Contact DCI for more information.

The index slot in the front end cap of the transmitter should fit onto the anti-roll pin (key) in the housing for proper alignment of the transmitter in the housing. When the drill head's 12 o'clock position does not match that of the transmitter, use the receiver's roll offset function to display appropriate roll values. See "Roll Offset Menu" in the *Receiver* section.

Temperature Updates and Overheat Indicator

All DigiTrak transmitters are equipped with an internal digital thermometer. The internal temperature of the transmitter is sent to the receiver and remote display every 4.4 seconds. This temperature is displayed on the bottom right of the receiver and remote display screens next to the transmitter temperature symbol  .

NOTE: Because the digital thermometer is inside the transmitter, temperature increases due to external drilling conditions will take time to transfer to the transmitter. Any increase in temperature should be dealt with quickly to avoid irreversible damage.

Normal drilling temperatures range from 64°F (16°C) to 104°F (40°C). You should suspend drilling when temperatures exceed 95°F (35°C) to permit cooling. Once the temperature reaches 118°F (48°C) the thermometer icon will change to show that the transmitter is reaching a dangerous temperature,  .

When the thermometer icon begins to flash, the transmitter has become dangerously hot and must be cooled immediately or it will be damaged. The transmitter will shut down at 176°F (80°C).

To cool the transmitter, stop drilling and/or add more drilling fluid.

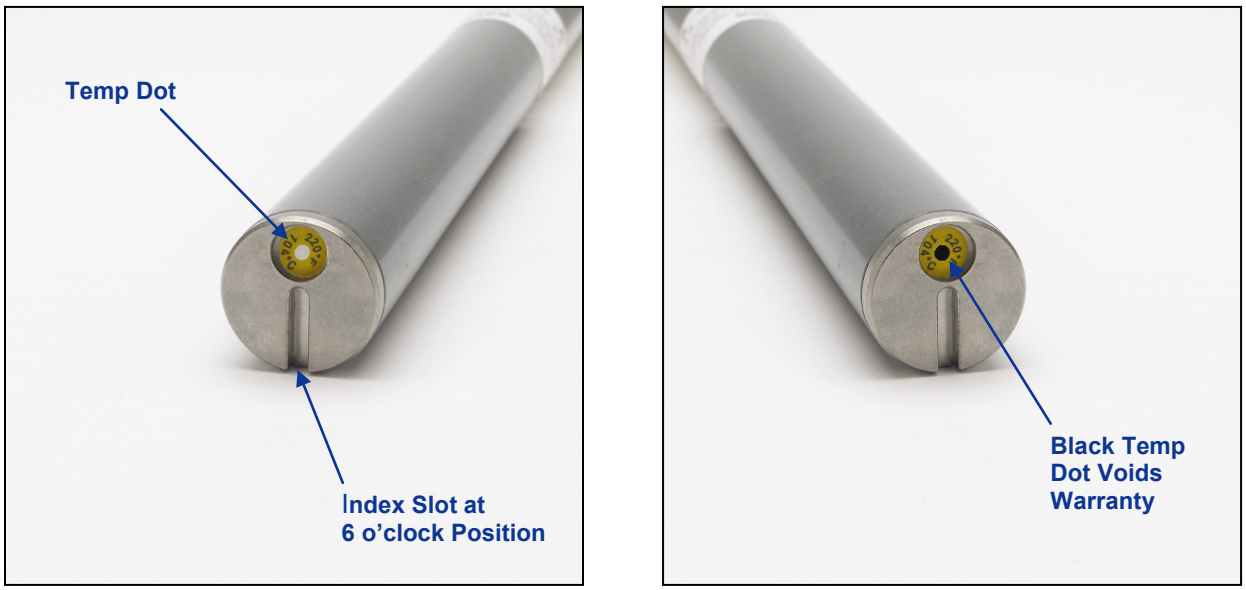
Transmitter Temperature Warning Tones

The audible tones emitted by the F5 receiver and remote display to indicate increases in the transmitter temperature are summarized in the table below.

Temperature	Warning Tones
Below 61°F (16°C)	No tones for temperature increases.
61–97°F (16–36°C)	Double-beep sequence (beep-beep) for every 4°C increase in temperature.
104–111°F (40–44°C)	Two double-beep sequences (beep-beep, beep-beep) for every 4°C increase in temperature. **NOTE**: Action is required to cool the transmitter.
118–133°F (48–56°C)	Three double-beep sequences (beep-beep, beep-beep, beep-beep) for every 4°C increase in temperature. **NOTE**: Cooling is critical to avoid irreversible damage.
Above 140°F (60°C)	Three double-beep sequences every 5 seconds on the remote display, and every 20 seconds on the receiver. **NOTE**: Warning signifies dangerous drilling conditions; irreversible damage may have already been done.
Above 176°F (80°C)	Transmitter shuts down.
180°F (82°C)	FS and FC transmitter overheat indicator (temp dot) turns black (see below).
220°F (104°C)	Long-range and extended long-range transmitter overheat indicator (temp dot) turns black (see below).

Transmitter Overheat Indicator (Temp Dot)

The transmitter has a temperature overheat indicator (temp dot) on the front end cap. The temp dot has an outer yellow ring with a 1/8-inch (3-mm) white dot in the center. The white dot will change color if the transmitter is exposed to excessive heat.



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

If the temp dot changes to silver or gray, then the transmitter has been exposed to heat but not in excess of the specifications. If the temp dot is black, then the transmitter has been exposed to temperatures in excess of 220°F (104°C) for long-range and extended long range transmitters and 180°F (82°C) for an FS or FC transmitter and can no longer be used. The DCI warranty will be void for any transmitter that has been overheated (black dot) or 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 overheating of a transmitter.

Remote Display

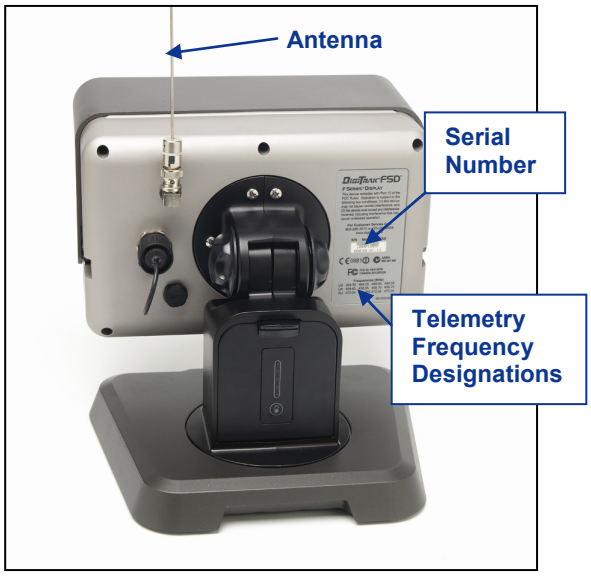
DigiTrak F Series Display (FSD)

General Description

The DigiTrak F Series Display (FSD) is a multifunction display that can be used with a variety of DCI receivers. It provides the drill rig operator with information from the receiver about the depth, orientation, and status of the transmitter. The FSD remote can be powered through either a DC cable source or an F Series battery pack.

An external 13 in. (33 cm) telemetry antenna is supplied with your DCI equipment. It mounts onto the remote display to enhance signal reception up to 1800 ft (550 m) with line of sight to the receiver. For bore lengths greater than this or when line of sight is compromised, contact DCI to purchase one of the optional telemetry antennas.

To meet regional requirements and for proper communication, one of the frequency designations shown on the remote's serial number label (see photo to the right) must match that shown on the receiver. The receiver's frequency designation is located on the serial number



Serial Number Label on Back of FSD

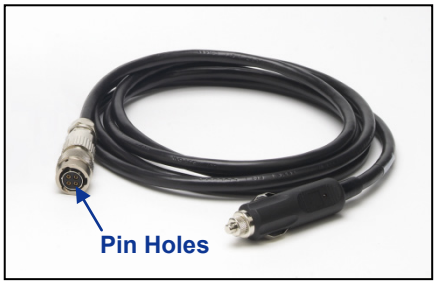
label inside the receiver's battery compartment (see "General Description" discussion in the *Receiver* section).

Power Options

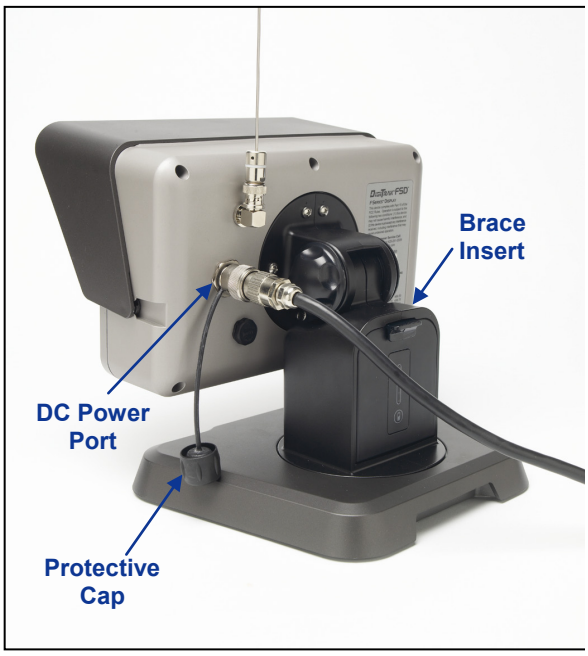
The FSD remote can be powered by either an F Series battery pack or a 14.4 V DC power source using the DC power cable. If both a battery pack and the DC cable are installed, the remote will draw power from the battery until the battery voltage is below the DC source voltage. Install the brace insert as you would the battery when using the DC cable source (see "Installing and Removing the Battery Pack or Brace Insert" below).

Connecting the DC Power Cable

To connect the DC power cable, remove the protective cap from the DC power port on the back of the remote. Then align the four pin holes in the DC cable with the four pins in the DC power port. Push in and rotate the cable connector clockwise until the cable is secure. Install the other end of the DC cable into the DC power source.



DC Power Cable



DC Power Cable Installed in FSD Remote

Installing and Removing the Battery Pack or Brace Insert

The F Series battery pack is installed in the FSD remote's battery compartment for battery power. When the remote is powered by a DC cable source, the brace insert must be installed in place of the battery pack. The brace insert is the same size as the battery pack, and it is installed and removed in the same manner as the battery pack.

To install the battery pack or brace insert, with the tab facing up and away from the FSD remote, insert the battery/brace insert into the battery compartment and push it in until the tab latches in place.

To remove the battery pack or brace insert, push down on the battery tab and pull it away from the remote until the tab is released.

Power On/Off

Once you have provided power to the FSD remote, either using the battery pack or a DC power source, then you can operate the unit. The power on and off functions are as follows.

Power On – Press the execute button  for a half-second or more to turn on the FSD unit. You will hear a tone and the main display screen will appear.

Power Off – Push and release the execute button  on the front of the remote to access the main menu screen. Push the button again to highlight the power off menu (see "Main Menu" later in this section), and then hold the button down until the unit turns off.

Keypad

The keypad to the right of the display window is used to operate the FSD remote.

Execute Button – The execute button (curved arrow) turns on the FSD unit and selects a highlighted menu option. It is also used for adjusting contrast and for executing menu options. It functions like the trigger switch on the receiver. 

Direction Buttons – The up/down, left/right arrow buttons are used to navigate through menu options. The down button also can be used to access the main menu from the remote mode (see "Main Menu" later in this section). 

Audible Tones

The FSD remote has an internal speaker that emits a tone at startup and emits warning tones when the transmitter temperature increases. See "Transmitter Temperature Warning Tones" in the *Transmitter* section for a complete listing of the warning tones and what they signify.

Adjusting Screen Contrast

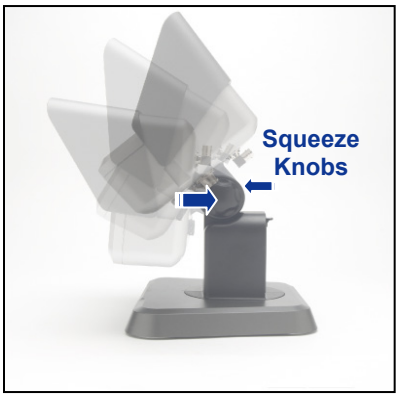
There are two ways to adjust the screen contrast. The easiest method is to hold in the execute button while pushing the right arrow (to lighten the display) or the left arrow (to darken the display). The other way is by using the contrast adjustment option in the main menu (see "Main Menu" later in this section).

Adjusting the Viewing Angle

The FSD remote allows you to adjust the viewing angle through a range of 180° left/right, 90° up/down, and 270° about the display's center.

Up/Down – Loosen and squeeze the two knobs on the back of the remote display, then adjust the screen as desired and tighten the knobs. If the knobs are loose, the display will hold its vertical position only until the knobs are squeezed together or the display is vibrated. Thus, DCI recommends tightening the knobs before drilling.

Loosen Display Knobs



Adjust Viewing Angle

Tighten Display Knobs

Left/Right – When the FSD remote's magnetic base is secure, you can adjust the left-right viewing angle by rotating the display about the base.

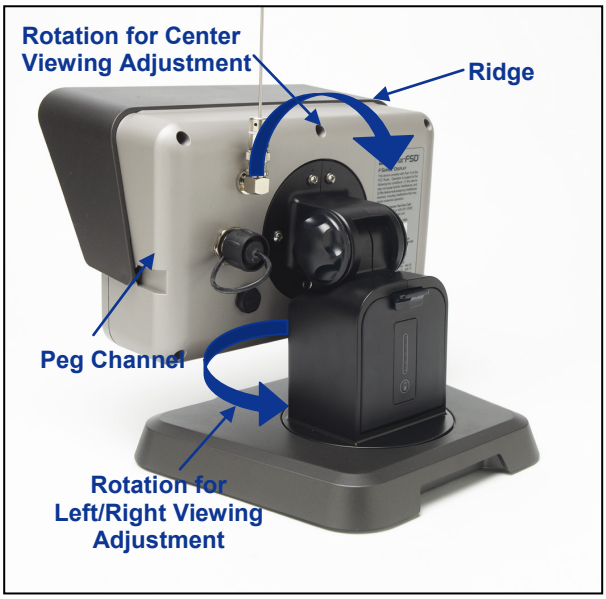
Center – With the magnetic base secure, take hold of the display and rotate it to the desired orientation.

Attaching and Removing Visor

The removable visor on the FSD remote shields the screen from environmental conditions such as rain and sun. The visor is held in place by a ridge on the top of the display and channels on the sides of the display.

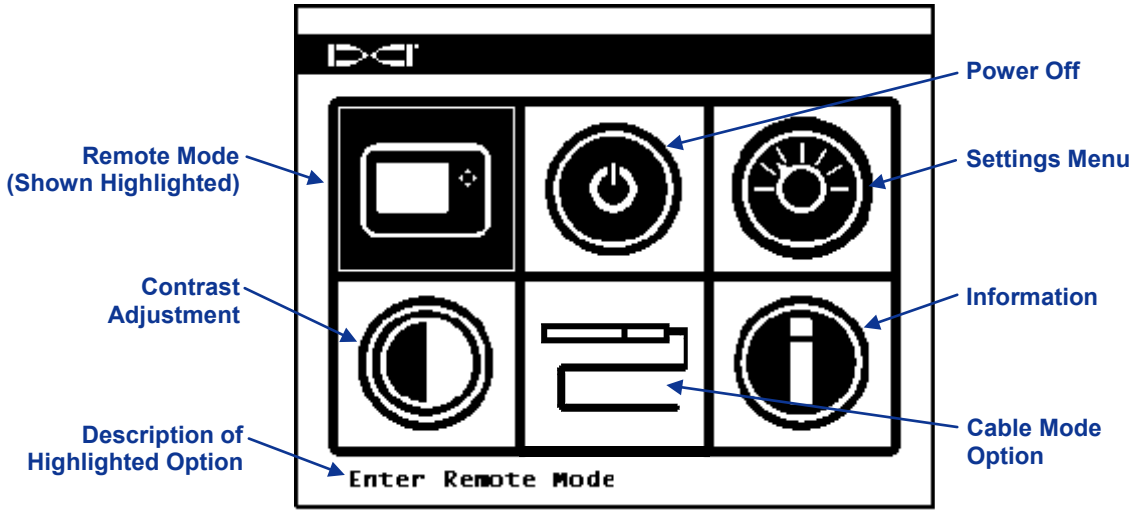
To install the visor, slide the pegs on the visor along the peg channels on the sides of the display until the visor locks over the ridge.

To remove the visor, push the visor back over the ridge and along the channels.



Main Menu

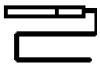
The main menu is accessed by pushing the down arrow button. It displays the menu options with the remote mode option automatically highlighted for selection.



FSD Main Menu Screen

Use the arrow buttons to highlight an option, and press the execute button to select that option. The table below lists the main menu options and the result of selecting each item.

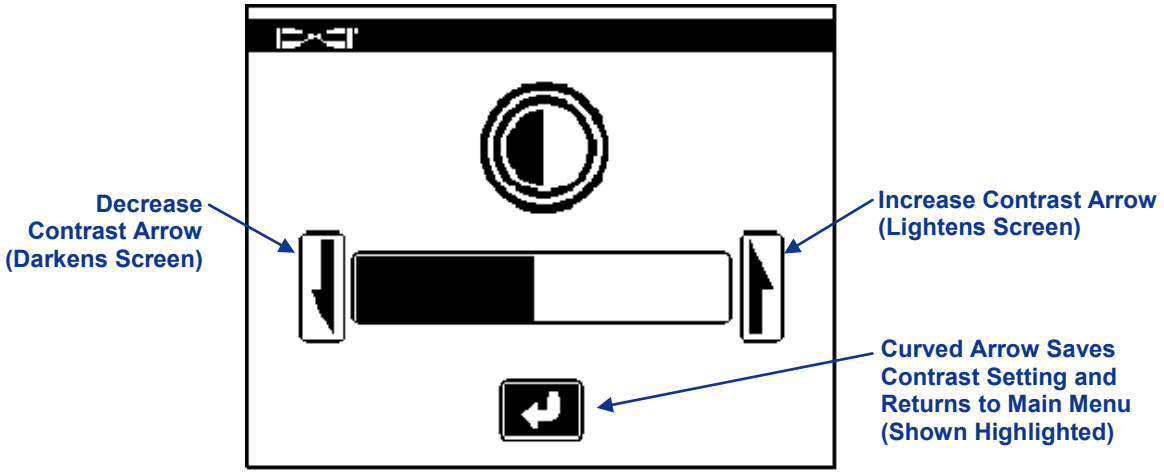
FSD Main Menu Options

	**Remote Mode** – Puts the FSD unit into remote radio mode. It will then display information from the receiver, including transmitter pitch, roll, temperature, battery status, depth, predicted depth, and *Target Steering* data.
	**Power Off** – Turns off the unit with no audible signal.
	**Settings Menu** – Opens the settings menu allowing you to change telemetry channels, pitch and depth units, and the receiver model. See “Settings Menu” below.
	**Contrast Adjustment** – Allows you to adjust the screen contrast. See below for instructions.
	**Cable Mode Option** – Enables use of the FC cable transmitter. Please see the *DigiTrak Multi-Function Cable Box (MFCB) Operator's Manual* for operating instructions.
	**Information** – Displays system information such as the software version, serial number, and current settings.

Contrast Adjustment

The screen contrast can be adjusted from the main display screen by holding in the execute button on the keypad and pressing the left or right arrow button for the desired adjustment: left for darker, right for lighter.

You can also adjust the screen contrast by using the contrast adjustment option. When this option is selected from the main menu, the following screen appears.

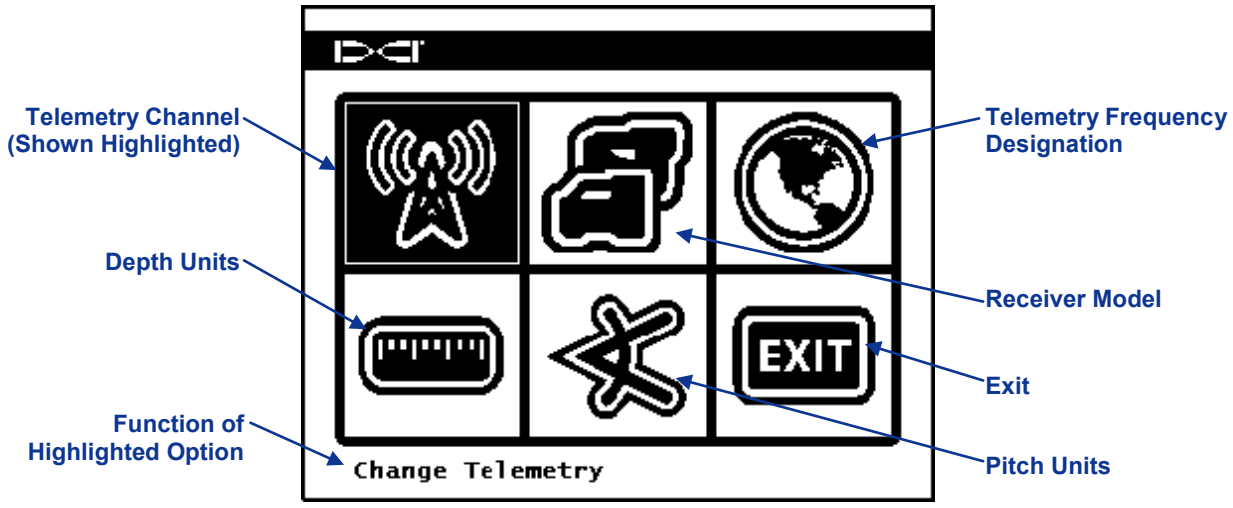


Adjust Screen Contrast

Using the left or right arrow button on the remote, select the desired action: either decrease contrast (left arrow), increase contrast (right arrow), or the curved arrow. Adjust the contrast by pressing the remote's execute button after you have selected the decrease or increase contrast arrow. Each time the execute button is pressed, the contrast will change incrementally. When the contrast is adjusted as desired, use the left/right arrow buttons on the remote to highlight the curved arrow on the screen, and then press the execute button on the keypad to return to the main menu.

Settings Menu

The settings menu, shown below, will appear after selecting the settings menu at the main menu screen.



FSD Settings Menu Screen

The table below shows the menu options as they appear on the display with descriptions of their uses. Any changes that are made to the settings will be saved when the FSD unit is turned off. DCI recommends that you program the FSD settings to match the settings on your receiver.

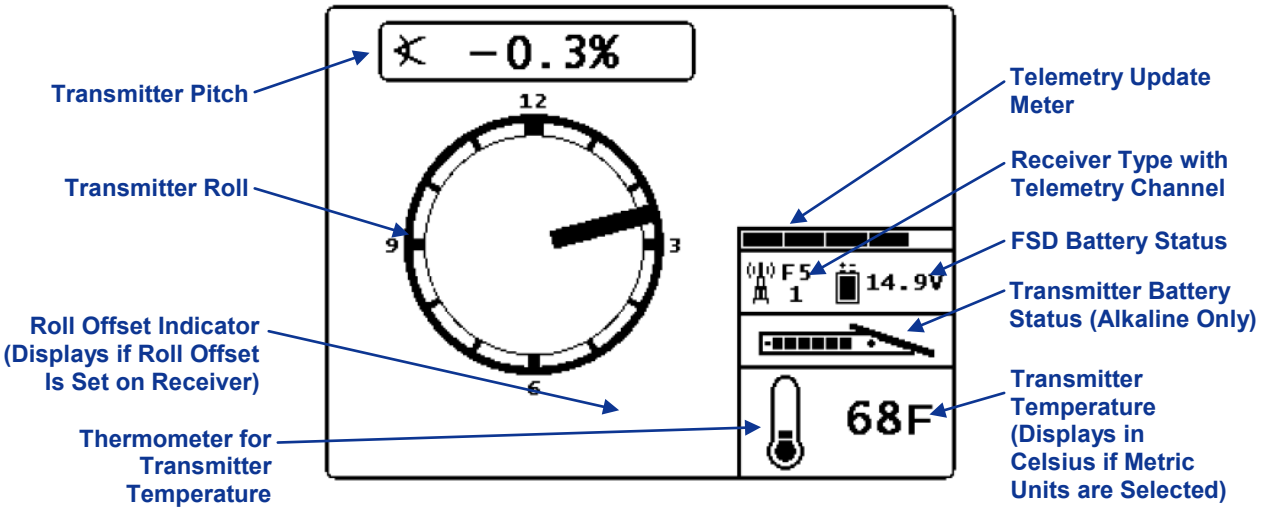
FSD Settings Menu Options

	**Telemetry Channel** – Opens telemetry channel options: 1, 2, 3, and 4. The remote and the receiver must be set to the same channel and must have the same telemetry frequency designation.
	**Receiver Model** – Allows you to program the FSD unit to work with an F5, F2, SE, Eclipse, or Mark Series receiver. If a receiver other than the F5 is to be used, see the *MFD/FSD Operator's Manual*.
	**Telemetry Frequency Designation** – Opens the telemetry region options. If you must change this setting, call DCI to determine which setting is required in your area and to verify that it matches the receiver frequency.
	**Depth Units** – Allows you to select distance units as either English or metric. When English units are selected, the temperature will display in degrees Fahrenheit (°F). When metric units are selected, the temperature will display in degrees Celsius (°C).
	**Pitch Units** – Allows you to select pitch angle units. The options are percent (%) or degree (°).
	**Exit** – Exits the settings menu and returns to the main menu screen. After a setting is changed, the exit option is automatically highlighted for selection.

Display Screens

Main Display Screen

The main display screen is the default screen you will see after turning on the FSD remote. It shows the transmitter pitch, roll, battery status, and temperature. The main screen also shows the FSD battery status, receiver type, telemetry channel, telemetry update meter, and *Target Steering* data (if active). To exit this screen at any time, press the down arrow to access menu options.



FSD Main Display Screen

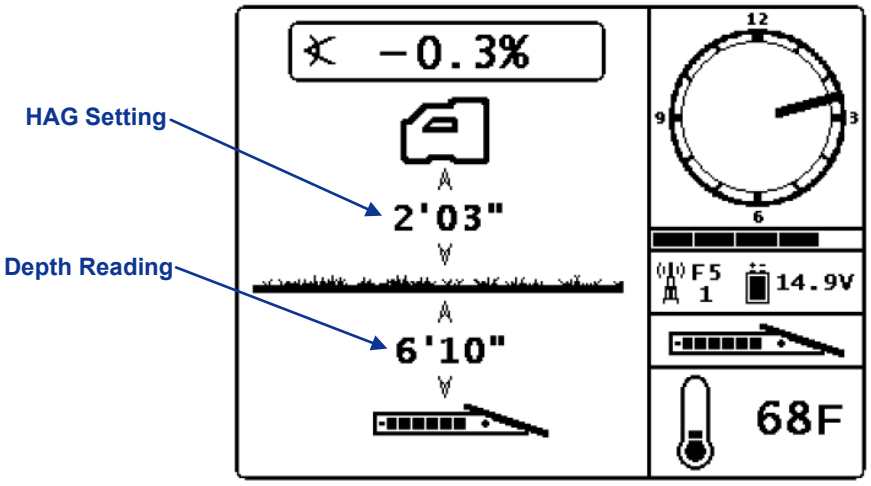
The telemetry update meter displays the amount of signal being received. If less data is being received, then fewer bars are shown on the meter. If the meter is decreasing or low, you should pause before making steering decisions to ensure you have correct data. When the meter is empty, no telemetry data is being received and all transmitter information will disappear.

If the roll offset function is set on the receiver (an electronic compensation to match the transmitter's 12 o'clock position to the tool's 12 o'clock position), the letters RO for roll offset will display at the bottom right of the clock circle. For more information, see "Roll Offset Menu" in the *Receiver* section.

Depth Display Screen

The depth or predicted depth of the transmitter can be viewed on the remote display, but only when the receiver is positioned at the locate line (LL) or at the front locate point (FLP) with its trigger held in. See "Locate Points (FLP & RLP) and Locate Line (LL)" in the *Locating* section for information on correctly positioning the receiver.

When the receiver is positioned at the LL with the trigger held in, the FSD display will change to show the depth reading with arrows pointing to the ground and drill head. When the height-above-ground function is turned on, the receiver icon is shown elevated above the ground with the HAG setting displayed. In the figure below you can see that the HAG setting is 2' 03" to indicate that the receiver is being held that distance above the ground. For more information on the HAG settings, see "Height-Above-Ground (HAG) Menu" in the *Receiver* section.



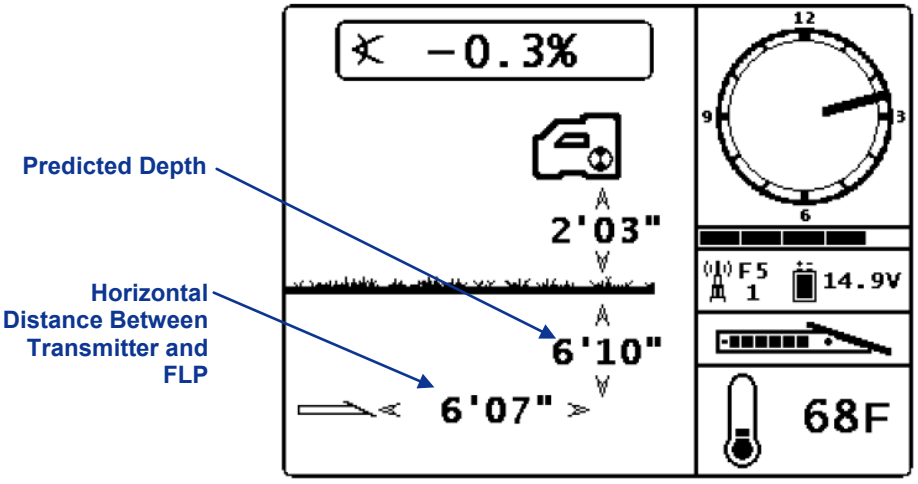
FSD Depth Display at Locate Line with HAG On

The depth will display for 10 seconds after the trigger on the receiver is released, and then the display will return to the main display screen.

When a roll offset is set at the receiver, the letters RO will display at the bottom right of the clock circle on the depth display and on the predicted depth display. For more information, see “Roll Offset Menu” in the *Receiver* section.

Predicted Depth Display Screen

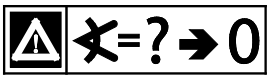
The predicted depth display screen appears when the receiver is positioned at the FLP or the RLP (rear locate point) and the trigger is held in. However, the predicted depth is only valid at the FLP. The predicted depth display will show arrows pointing to the receiver and the predicted depth point ahead of the transmitter. For more information about the predicted depth, see the *Locating* section.



FSD Predicted Depth Display with HAG On

As on the depth display, when a roll offset is set at the receiver, the letters RO will display at the bottom right of the clock circle on the FSD predicted depth display. The example shown above does not have the RO, which indicates that a roll offset has not been set.

When the transmitter pitch information cannot be obtained at the receiver due to range restrictions or interference, the remote will assume the transmitter has a pitch of zero for depth and predicted depth readings. In this case, the remote will show the transmitter pitch as illustrated below.



Pitch Assumed Zero

Locating

Locating in High-Interference Area with the F5 Receiver

Introduction

Locating with the F5 system is relatively easy and intuitive, but you must understand some locating basics first. This section describes the locate points and locate line; the geometry of these elements with respect to the transmitter; the display screens encountered during locating; and the proper method for marking locate points once they are found. You are then given the standard locating procedure, including tracking "on-the-fly," and a method for tracking the transmitter when you cannot walk over it, called off-track locating.

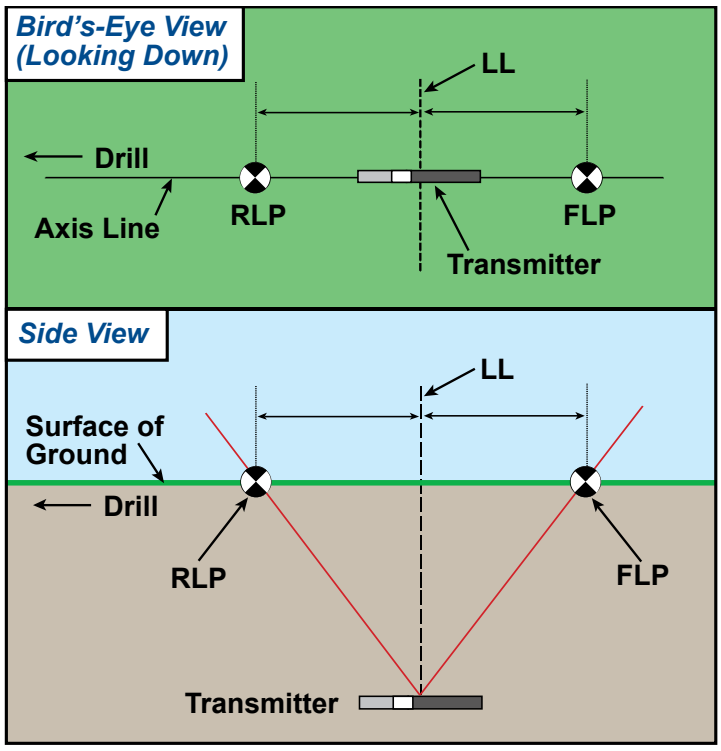
For a detailed explanation of how to track the transmitter when it is steep and deep, please read the information provided in *Appendix B: Projected Depth Versus Actual Depth and the Fore/Aft Offset*.

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

The F5 receiver locates the transmitter by detecting three specific places in the transmitter's magnetic field: the locate points and the locate line. The locate points are indistinguishable from one another by the receiver. They represent similar points in the transmitter's field in front of and behind the transmitter. The front locate point (FLP) is ahead of the transmitter, and the rear locate point (RLP) is behind the transmitter. (See *Appendix B* for more information about the transmitter's magnetic field.)

The locate line (LL) extends 90° to the left and right of the transmitter and represents the location of the transmitter between the FLP and RLP.

The most accurate tracking requires the use of all three locations to determine the position, heading, and depth of the transmitter. Aligning the FLP and RLP reveals the heading and left/right position of the transmitter. The LL determines the central position and depth of the transmitter when the receiver is properly aligned between the FLP and RLP. The full procedure for tracking is given later in this section under "Standard Method for Locating the Transmitter."



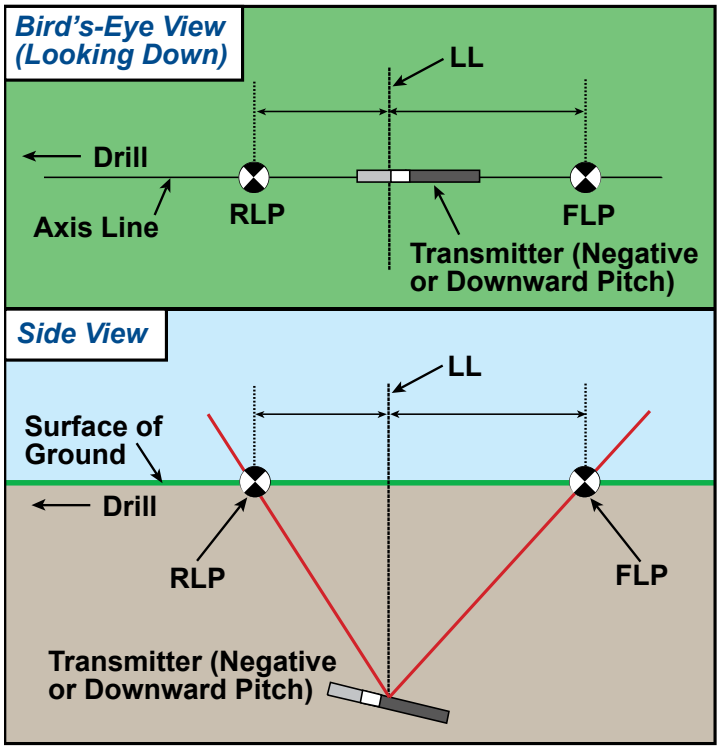
Geometry of FLP, RLP, and LL from Top (Bird's-Eye) and Side Views
Note how the RLP and FLP are equal distances from the LL when the transmitter is level.

NOTE: If the transmitter pitch exceeds ±30% (or ±17°) and/or the transmitter depth exceeds 15 ft (4.6 m), the position of the locate line will be somewhat ahead of or behind the transmitter's actual position. In these cases, the depth displayed on the receiver is referred to as the projected depth (see *Appendix B* for more information regarding this situation).

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

In general, 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 topography. (For more information, see *Appendix B*.)

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 if the transmitter itself is level.



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

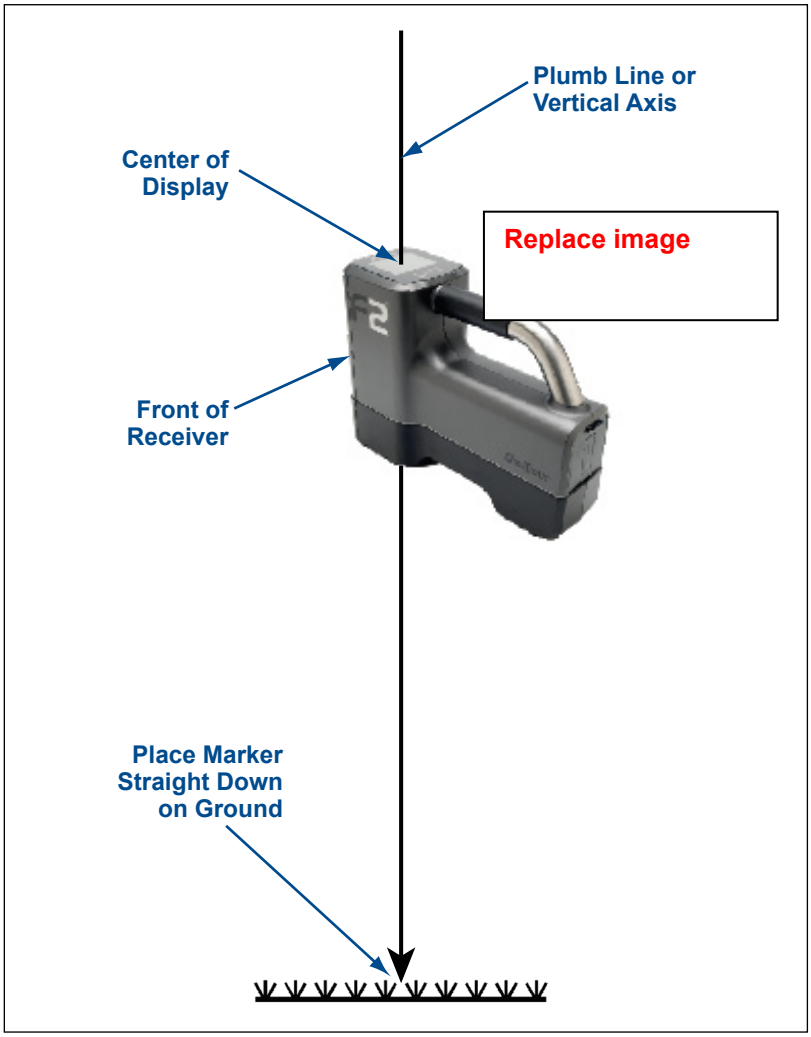
Note how the RLP and FLP are at different distances from the LL when the transmitter is at a negative pitch (compare with figure on previous page in which the transmitter is level).

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

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

Marking Locate Points

The locate points (FLP and RLP) and the locate line (LL) must be found and accurately marked during the locating procedure. To mark a locate point after you have found it, stand with the receiver level and 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 (see figure below). 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 (HAG) distance** that matches the value set on the receiver (see "Height-Above-Ground (HAG) Menu" in the *Receiver* section).

Interference: What It Is and How to Check for It

Before drilling (preferably before bidding on a project) the interference potential at your site should be evaluated. Interference can reduce the transmitter's range or cause variable readings and possibly result in job slowdowns. Interference comes from two different types of sources: active and passive.

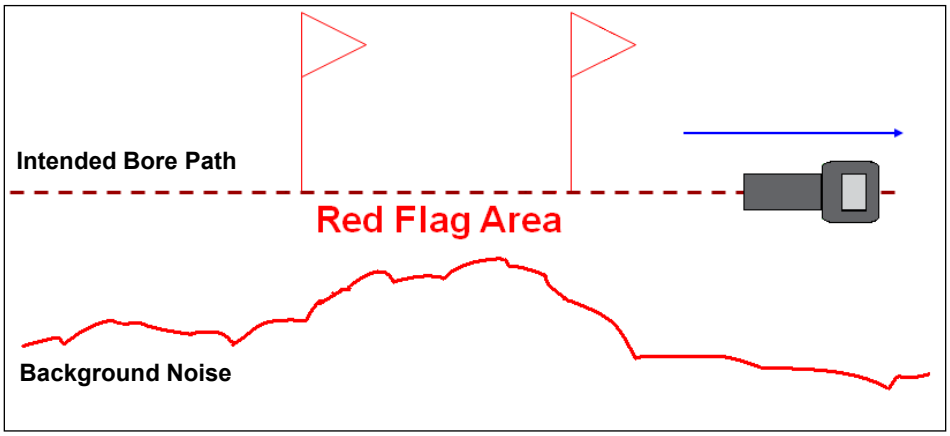
Active interference is also known as electrical interference or background noise and can have varying effects upon the F5 locating equipment. Most electrical devices emit signals that can affect your ability to locate the tool accurately or to get good pitch/roll readings. Some examples of active interference are traffic signal loops, buried dog fences, cathodic protection, radio communications, microwave towers, cable TV, fiber-trace lines, utility data transmissions, security systems, power lines, and phone lines, to name a few. You can conduct a test for the presence of active interference with your F5 system; see "Conducting a Background Noise Check" below.

Passive interference can reduce the amount of signal received from the transmitter, which results in deeper than expected depth readings or a completely blocked signal. Some examples of passive interference are metal objects (such as pipes, rebar, trench plate, chain-link fence, or vehicles). Two other examples of passive interference are saltwater/salt domes and conductive earth, such as iron ore. You cannot conduct a test for the presence of passive interference with your F5 system. Conducting a thorough site investigation prior to drilling is the best method of identifying passive interference sources.

The first step in familiarizing yourself with the interference potential along your intended bore path. The next step is to conduct an electrical interference/background noise check.

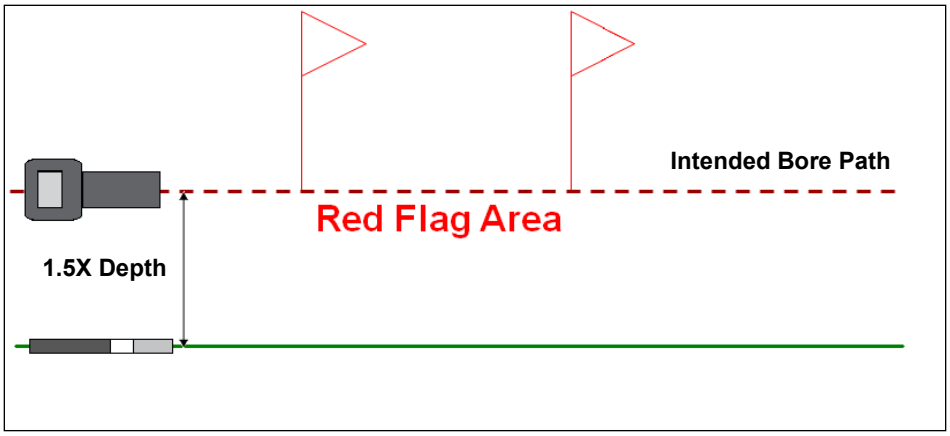
Conducting a Background Noise Check

With the transmitter off, power up the receiver and walk the bore path while monitoring the signal strength on the receiver's screen, noting any locations where it changes. A general rule is that the background noise should be at least 150 points less than the transmitter's signal strength when measured at the maximum depth for that bore. In the figure below, the red flag area denotes an increase in background noise.



One-Person Background Signal Strength Check (No Transmitter)

At the end of the bore path, have a coworker install batteries in the transmitter to power it up. With the receiver positioned on the intended bore path, have the coworker with the transmitter step off to your side approximately 1.5 times the maximum depth of your intended bore. You will now walk back toward the launch end in tandem, maintaining this distance of 1.5X the max depth while periodically stopping to change the transmitter's pitch and roll orientation to verify the speed and accuracy of these readings on the receiver.



Two-Person Roll/Pitch Test with Transmitter

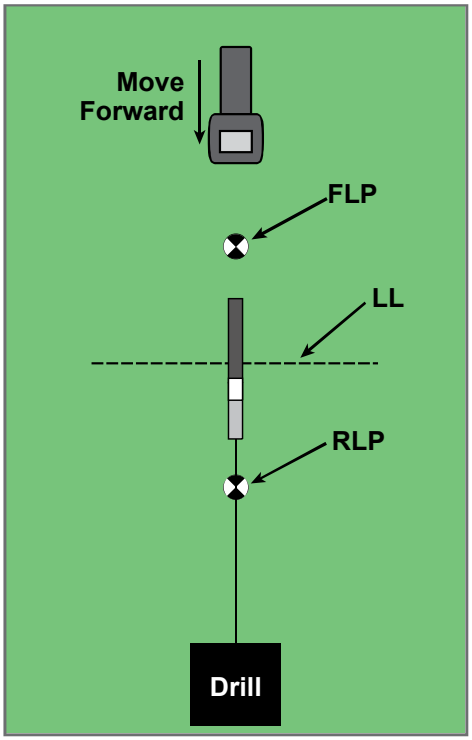
Suggestions for Dealing with Interference

Every job site warrants an interference/background noise check no matter how remote and interference-free your job site appears to be. If the pitch/roll information becomes erratic or is lost, move the receiver away from the interference source while staying within range of the transmitter. Separation (use of the HAG function) may also help when drilling under metallic objects, because the greater the separation between the receiver and the metal objects, the better the receiver's antenna will read the signal. Another solution is to use a transmitter with a stronger signal strength that may be able to overcome the interference/background noise.

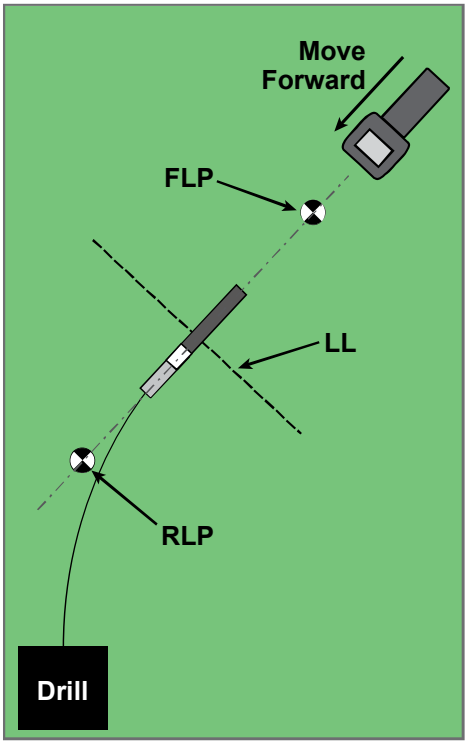
Standard Method for Locating the Transmitter

With the F5 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

Depth readings and data points for the Log While Drilling (LWD) function may be taken at the FLP or at the LL. It is necessary to hold the trigger in to view the depth or predicted depth, to send the depth reading to the remote display, and to log data points for the LWD function.

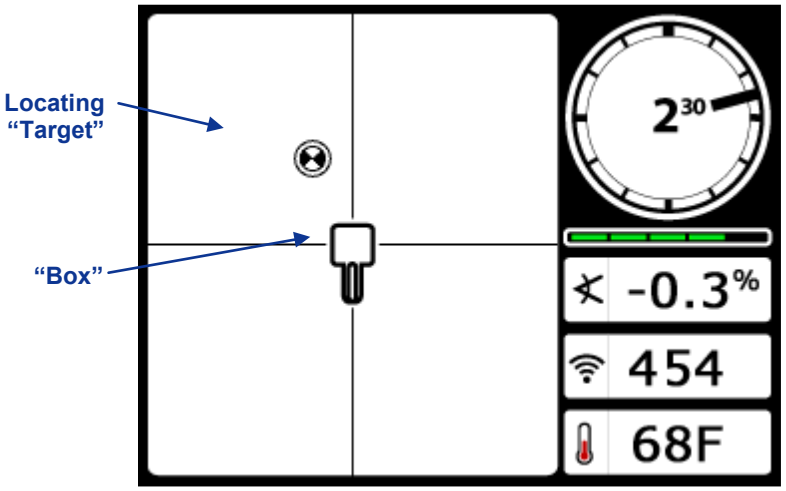
Finding the Front Locate Point (FLP)

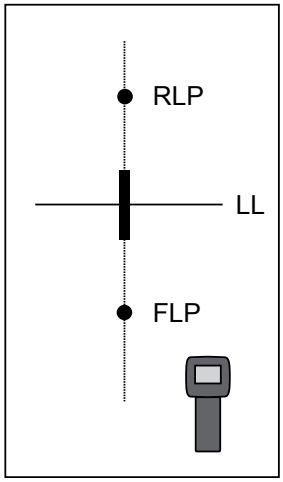
The locating procedure described here assumes you are facing the drill with the transmitter below ground and between you and the drill.

1. Start with the receiver on and in locate mode.
2. Stand out in front of the drill head at a distance of approximately one rod length.

NOTE: The FLP will be found further out in front of the drill head as the drill head gets deeper.

3. Holding the receiver level, observe the position of the locating target ( ) relative to the receiver box on the display. The figures below illustrate what you might see on the display and the actual position of the receiver, transmitter, and locate points. Note that the FLP is ahead of and to the left of the receiver, as shown in the receiver display.





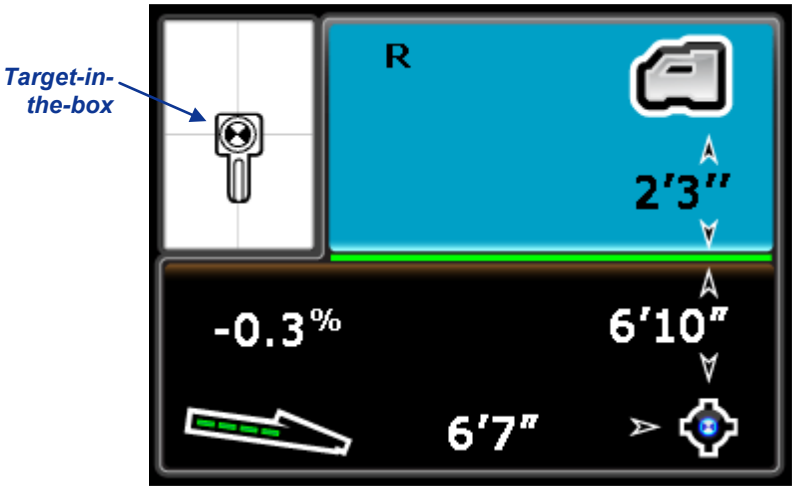
Receiver Locate Mode Screen

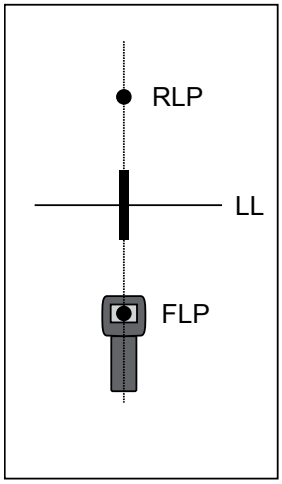
Actual Position of Receiver and Transmitter

4. Walk in the direction indicated by the picture on the screen to center the target in the box, which is forward and to the left in this example.

5. When the target is centered in the box, hold the trigger in for one second so the receiver can get a "lock" on the reference signal. The "R" symbol will appear at the top of the depth screen.

WARNING: Do not hold the trigger in unless you are precisely at the FLP (target centered in box). If you are ahead of the FLP, you will set an incorrect reference that causes a ghost locate line. In this case, you must reference again at the FLP.





Receiver Depth Mode Screen (at FLP with HAG on)

Actual Position of Receiver and Transmitter

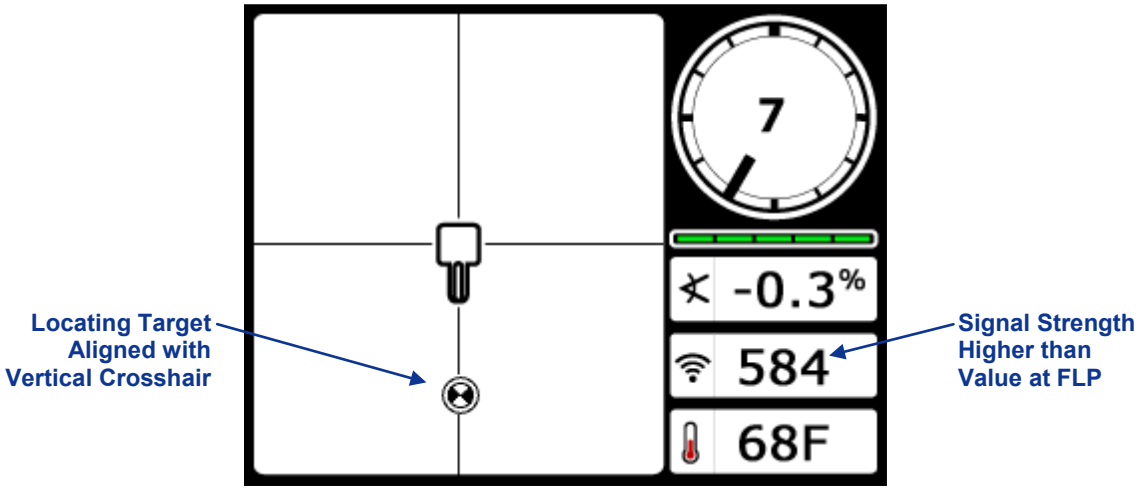
The depth value given at the FLP is the depth the transmitter will be at when it reaches its predicted location if no steering adjustments are made.

> **NOTE:** To verify that the signal is balanced through the receiver's antenna, carefully rotate the receiver 360° about the center of the display keeping the receiver level. The locating target should stay centered in the box. If it does not, do not continue to use the receiver and contact DCI's Customer Service Department.

6. With the target centered in the box, mark the location directly below the receiver's display screen on the ground as the FLP.

Finding the Locate Line (LL)

7. Continue to walk in the direction of the drill or the last known transmitter location. Keep the locating target on the vertical crosshair and observe that the signal strength is increasing.

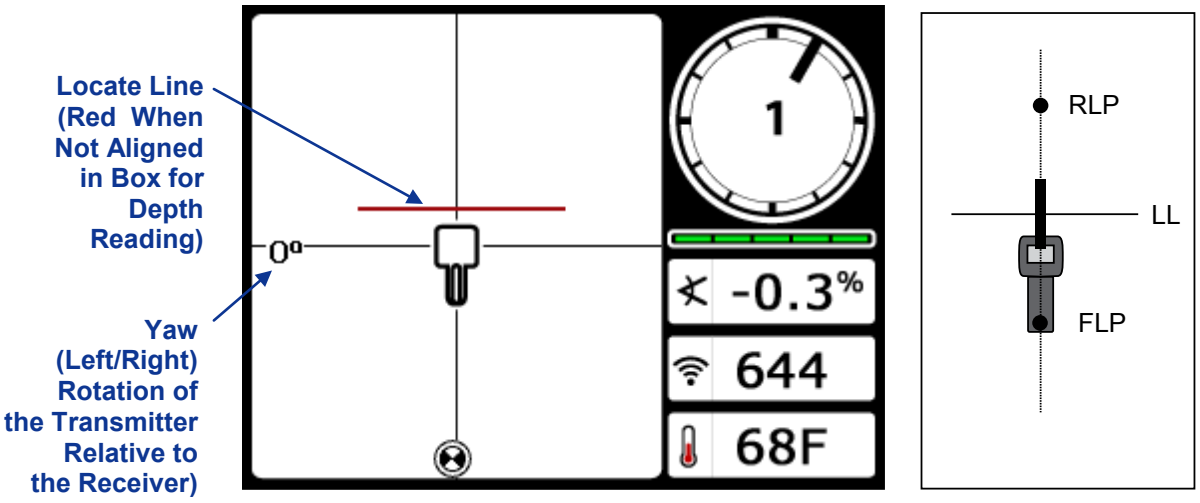


Receiver Locate Mode Screen
(FLP Behind Receiver, Which Is Moving Toward LL)

If the signal strength decreases, you may actually have just located the RLP. Position yourself further away from and facing the drill to locate the FLP.

8. When the target reaches the bottom of the screen, the locate line should appear.

> **NOTE:** If the locate line does not appear and the ball flips to the top of the screen, move the receiver in a forward/aft direction over where the ball flips. Then hold in the trigger; this should re-reference the receiver to the transmitter's signal and bring up the locate line.

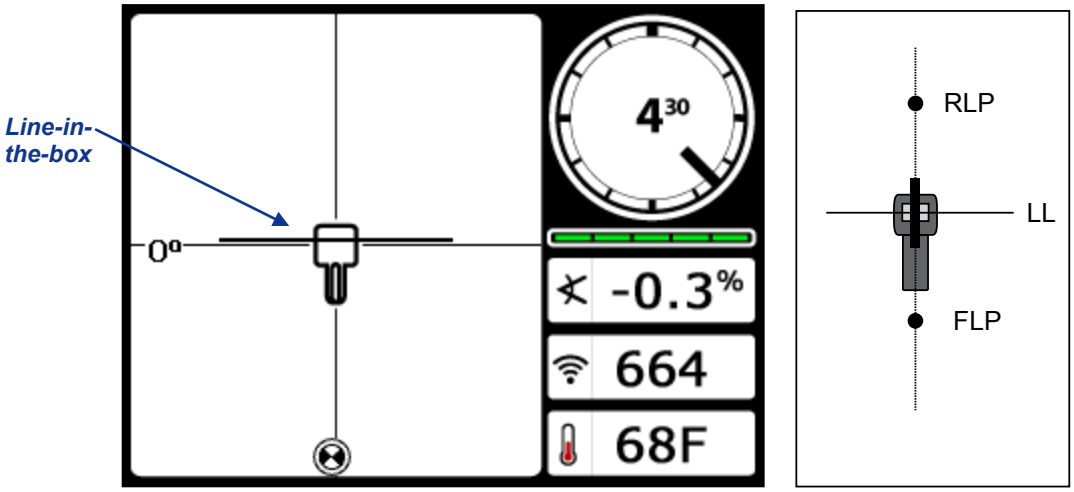


Receiver Locate Mode Screen (Approaching LL)

Actual Position of Receiver and Transmitter

NOTE: Do not rely on the alignment of the ball with the vertical crosshair to identify the left/right position of the transmitter. The front and rear locate points must be accurately found to determine the transmitter's lateral position (heading) and to take accurate depth readings.

9. Position the receiver so that the LL aligns with the horizontal crosshair.



Receiver Locate Mode Screen (at the LL)

Actual Position of Receiver and Transmitter

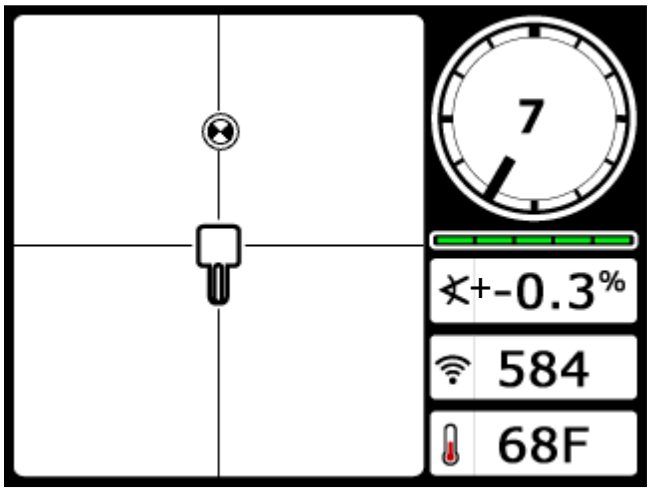
10. Mark the location directly below the receiver's display screen on the ground as the LL. You can take a depth reading here by holding in the trigger. However, to be certain you are directly above the transmitter, and your depth reading is accurate, you should first find the RLP.

Finding the RLP to Confirm Transmitter Heading and Position

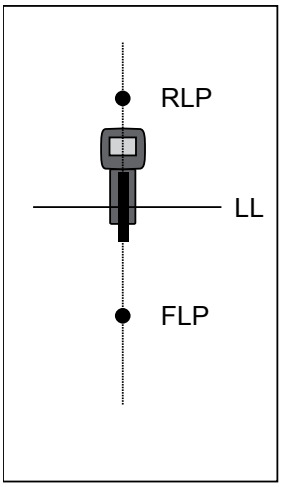
Finding the RLP will allow you to confirm the transmitter's heading and position. Like the FLP, the RLP is represented as a target ( ) on the receiver display. Once the RLP is found, you will connect the RLP to the FLP with a line that represents the exact heading of the transmitter. The transmitter is located at the point where this line intersects the LL.

Continue the locating procedure as follows:

11. From the LL, facing toward the drill or last transmitter location, walk forward keeping the target aligned on the vertical crosshairs.

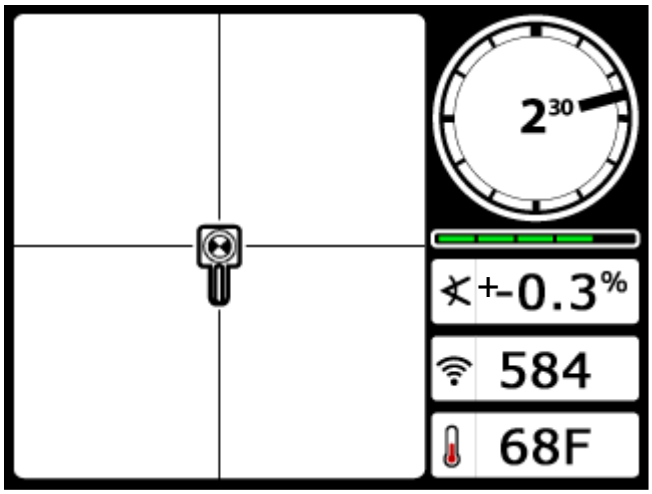


Receiver Locate Mode Screen (Approaching RLP from LL)

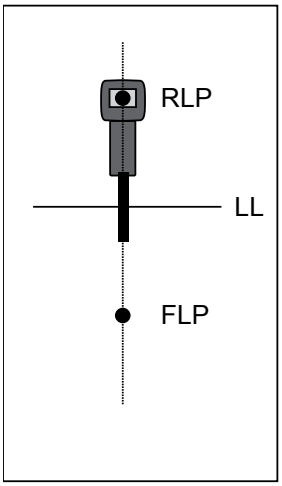


Actual Position of Receiver and Transmitter

12. Position the receiver so that the locating target is centered in the box.



Receiver Locate Mode Screen (at RLP)



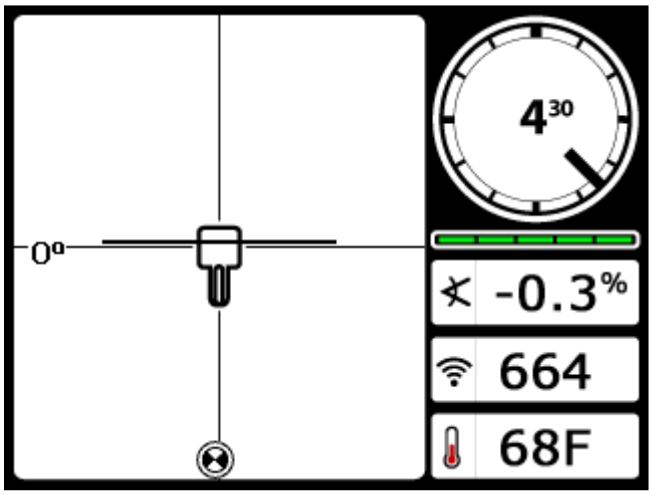
Actual Position of Receiver and Transmitter

13. Mark the location directly below the receiver's display screen on the ground as the RLP.

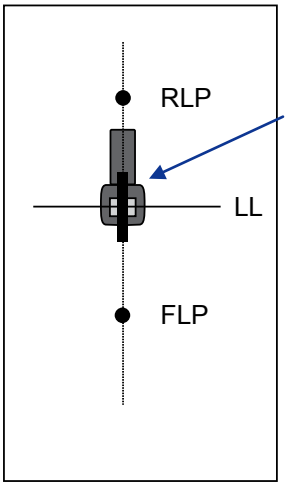
14. Connect the RLP to the FLP with a straight line. This line represents the transmitter's heading. The exact position of the transmitter is located beneath where this line and the LL cross.

15. Position the receiver at the intersection of these lines with the LL passing through the center of the box on the display and hold the trigger in to take a depth reading.

> **NOTE:** To verify the depth reading, turn off the HAG and set the unit on the ground. Take another depth reading. This reading should be very near the depth reading obtained with the HAG on and the receiver lifted. See Appendix B and Appendix C for more information on depth.



Receiver Depth Mode Screen (at LL)



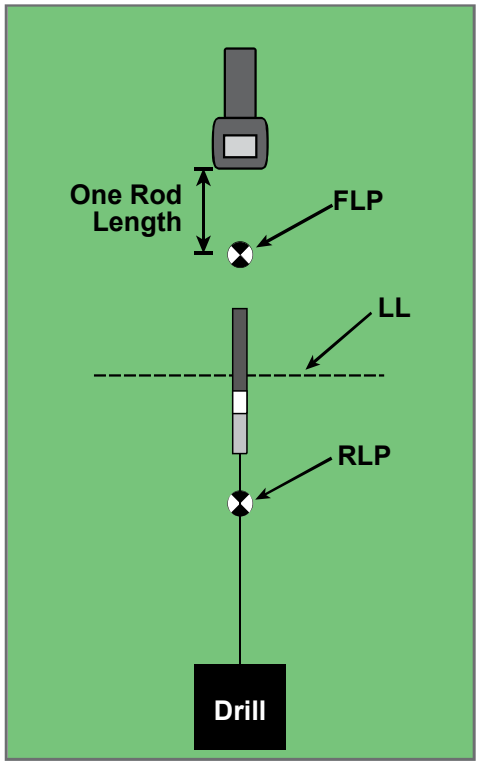
With the LL aligned in the box, the receiver may face toward the RLP *or* FLP during depth readings.

Actual Position of Receiver and Transmitter

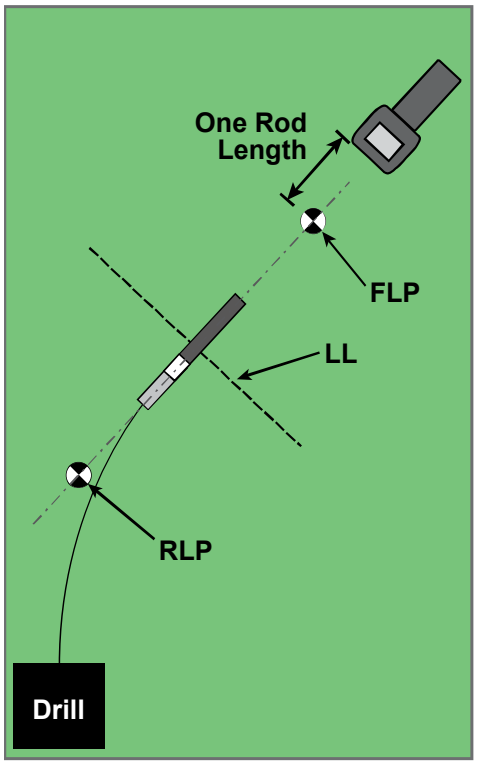
Tracking “On-the-Fly”

If you are running at 0% (0°) pitch over level ground, the predicted depth will be the actual depth. In this case, all locating can be done at the FLP while the tool is moving.

Once the transmitter has been found and its heading is on line, position yourself the distance of one rod length in front of the FLP on the intended bore path with the receiver facing the drill and sitting level on the ground.



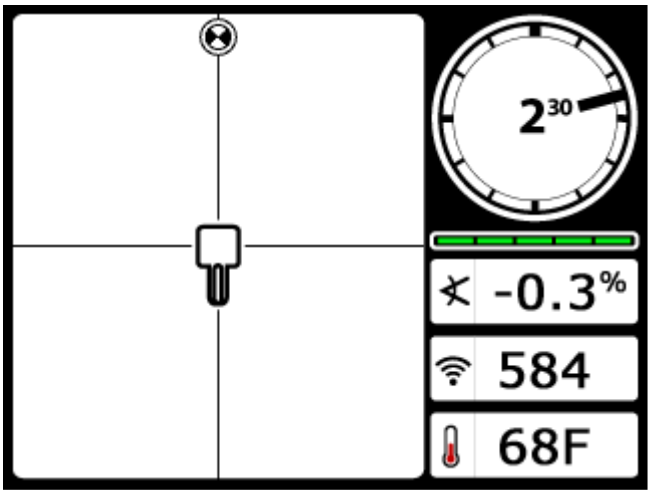
Tracking "On-the-Fly" with a Straight Path



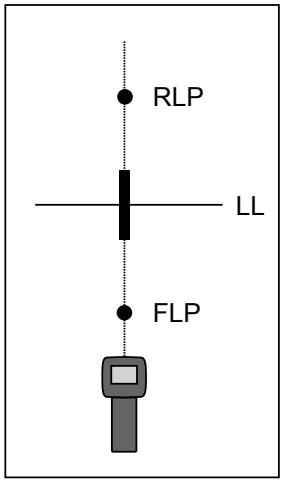
Tracking "On-the-Fly" with a Curved Path

Depth readings and data points for the Log While Drilling (LWD) function may be taken at the FLP or at the LL. It is necessary to hold the trigger in to view the depth or predicted depth, to send the depth reading to the remote display, and to log data points for the LWD function.

WARNING: Do not hold the trigger in unless you are precisely at the FLP (target centered in box). If you are ahead of the FLP, you will set an incorrect reference that causes a ghost locate line. In this case, you must reference again at the FLP.



Receiver Screen Tracking "On-the-Fly"



Actual Position of Receiver and Transmitter

As the tool advances, the FLP should travel along the receiver's vertical crosshairs indicating that the tool is still on line. Once the FLP is in the box, hold the trigger in and confirm that the predicted depth reading is as expected.

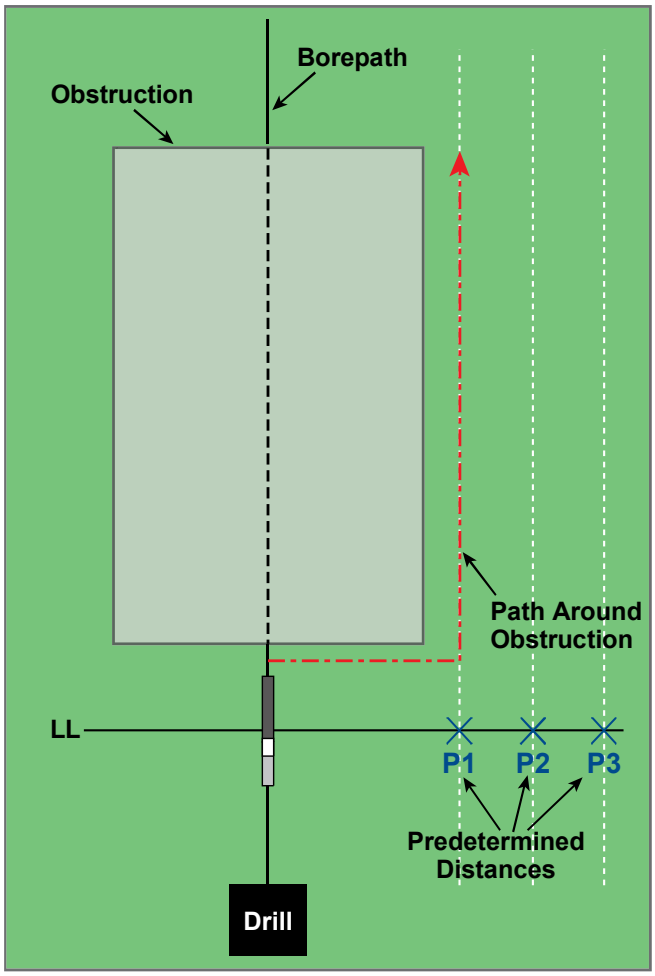
Off-Track Locating

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's heading and also to determine if it is maintaining its intended depth. The off-track locating method is only effective when the pitch of the transmitter matches the pitch of the topography. Ideally, pitch will be 0% (0°) under flat ground.

To explain how the off-track locating method works, we will use the example of an obstruction that is on the intended bore path, as shown in the figure below. The transmitter is about to go under the obstruction.

1. Stop drilling and find the LL of the transmitter by putting the line in the box.

2. While holding the trigger in and keeping the receiver in the same orientation, step to the side of the tool until you reach a predetermined distance (P1) from it. Move the receiver forward and aft until you can see the ball jump from the bottom of the screen to the top of the screen (or vice versa), then mark this location.



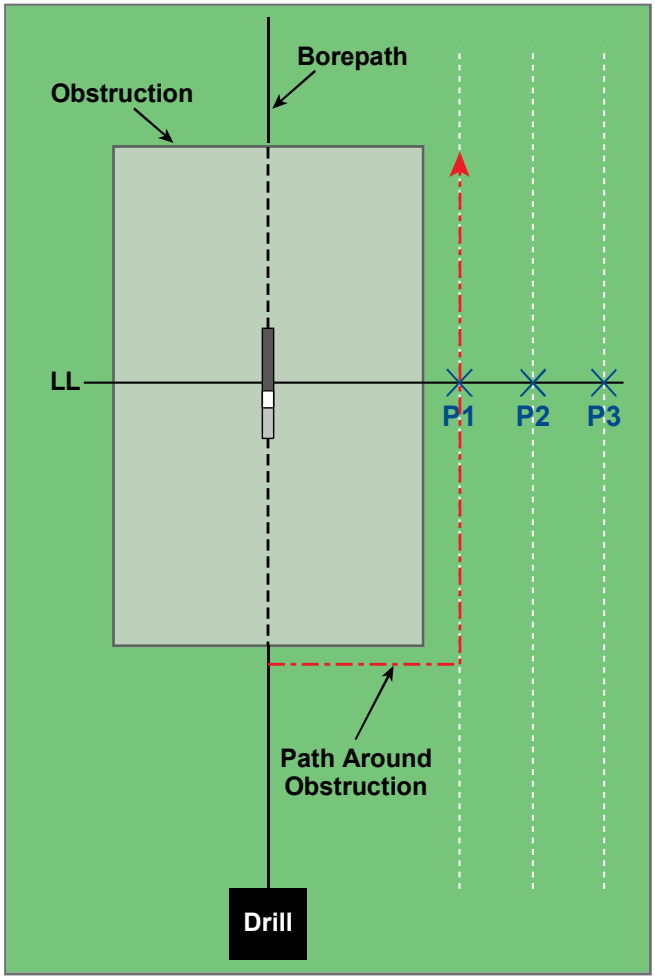
Preparing for Off-Track Locating

3. While still holding the trigger in and keeping the receiver in the same orientation, step to the side of the tool another predetermined distance (P2) further away from it. Move the receiver forward and aft until you can see the ball jump from the bottom of the screen to the top of the screen (or vice versa), then mark this location.

4. While still holding the trigger in and keeping the receiver in the same orientation, step to the side of the tool another predetermined distance (P3) further away from it. Move the receiver forward and aft until you can see the ball jump from the bottom of the screen to the top of the screen (or vice versa), then mark this location.

5. After finding the three locations P1, P2, and P3 to the side of the transmitter, connect these locations with a line. This is the locate line. Because the LL runs perpendicular (at a 90° angle) to the transmitter, it is possible to determine the heading of the tool. By comparing the slant distance or signal strength at the predetermined distances of P1, P2, and P3, as the tool progresses you can verify if the drill head is moving away from or maintaining the intended bore path. It is also important to track the pitch of the transmitter to verify the tool is maintaining the desired path.

6. As drilling continues, the tool should be steered to maintain a constant slant distance at each of the points P1, P2, and P3. If the slant distance increases, the tool is moving away; if the slant distance decreases, the tool is moving toward the side position. Note: Differences in pitch will also affect the signal strength and slant distance as the tool progresses.



Off-Track Locating

The Target Steering *Function*

The *Target Steering* function allows the F5 receiver to be placed out ahead of the drill head and used as a steering target. The receiver is positioned on level ground so that it is facing in the same direction as the drilling. To activate the *Target Steering* function, you must program the receiver with the desired target depth number. The drill head can then be guided to a point directly below where the receiver has been placed using the *Target Steering* screen on the remote display.

The F5 system assumes level topography for the most accurate *Target Steering* results. It also assumes a conservative bend radius. Therefore, in situations with significant pitch changes, such as during the launch/exit ends, the up/down steering information on the remote display may not be accurate. In these situations, only the left/right steering information should be considered accurate.

Feasible Target Depth and Positioning the Receiver as a Target

The maximum distance that the receiver can be placed out ahead of the drill head for *Target Steering* is 35 ft (10.7 m). Beyond 35 ft (10.7 m) the up/down distance information becomes less accurate. Over the 35-ft range, starting with the drill head approximately level, the following parameters apply:

- The maximum depth change is approximately 4 ft (1.2 m).
- The maximum pitch change is approximately 14%.

For the most conservative *Target Steering* operation, we assume that the ideal drill path is a circular arc with a radius that accommodates the bend radius of most drill strings and products being installed. As shown in the diagram below, the feasible steering area is limited to the shaded region bounded by the two circular arcs.

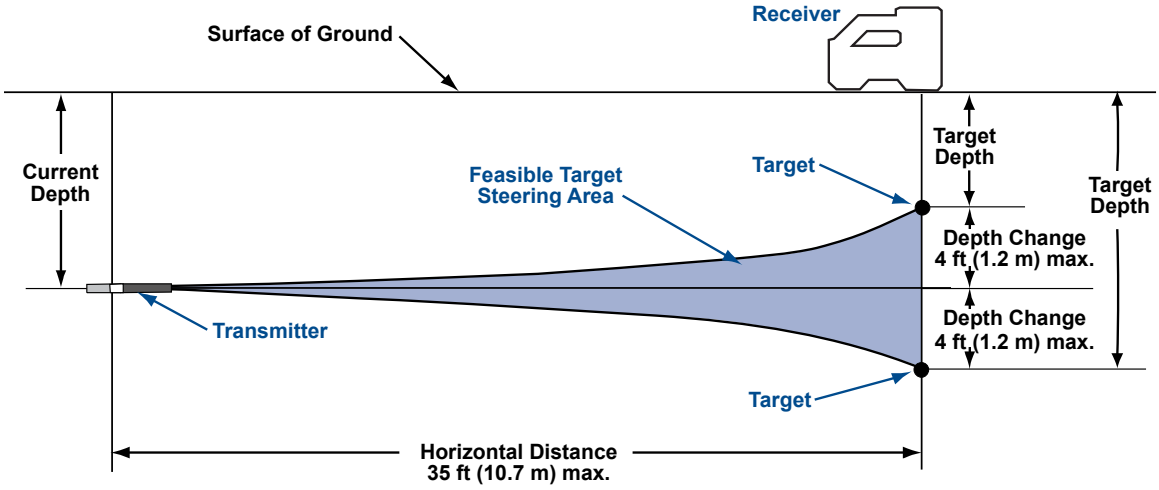


Diagram of Feasible Steering Area

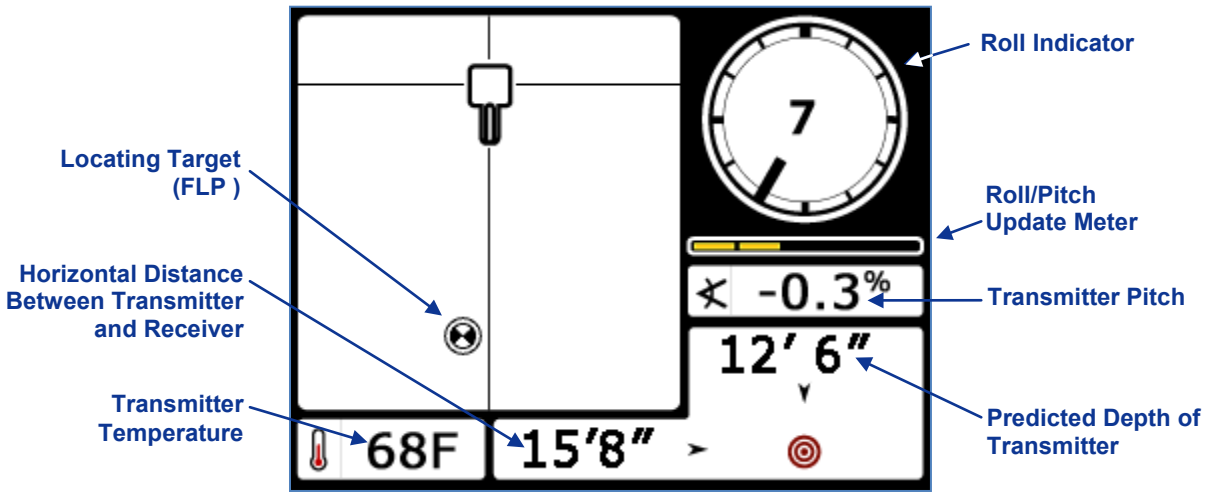
Maximum depth change is *approximately 4 ft (1.2 m) over horizontal distance of 35 ft (10.7 m).*

The *Target Steering* procedure requires correct placement of the receiver. The receiver must be placed out in front of the transmitter on the bore path with its back end (where the battery pack is inserted) facing the drill or the last locate points if drilling a curved path. The maximum horizontal distance from the transmitter that the receiver should be placed is approximately 35 ft (10.7 m). Beyond this distance the up/down information becomes less accurate.

Programming the Receiver for *Target Steering*

The receiver must be programmed with the desired target depth number. To program the receiver, see the instructions under "*Target Steering* Menu" in the *Receiver* section.

The figure below shows the receiver's locate screen with the *Target Steering* distance at the bottom. This number is the horizontal distance that the receiver is from the transmitter. Use this number to help you position the receiver a maximum distance of 35 ft (10.7 m) ahead of the tool.



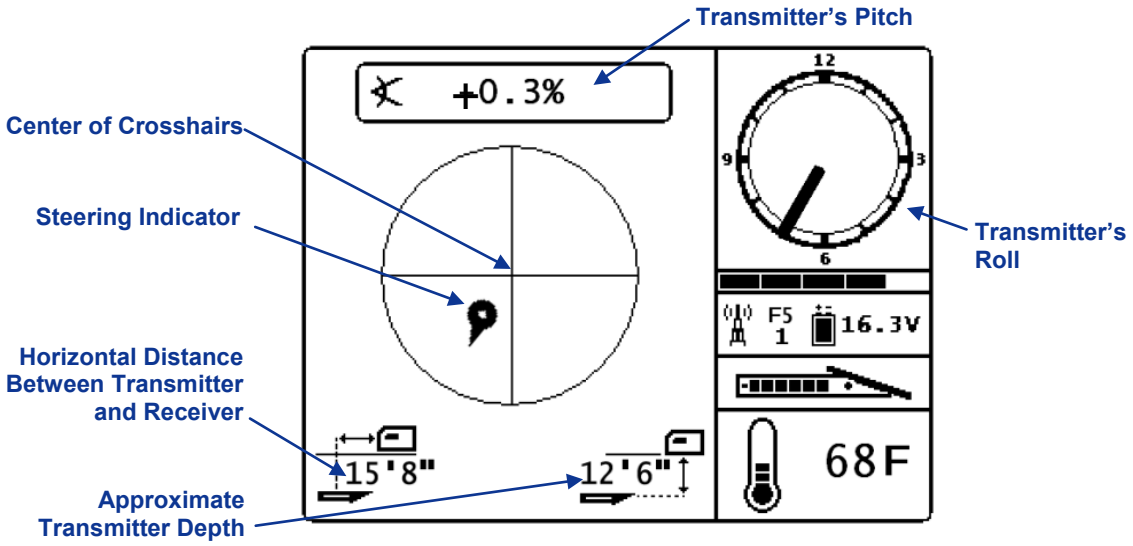
Target Steering Locate Mode Screen

Turn Off Target Steering

To turn off Target Steering, toggle down when the *Target Steering* locate mode screen shown above is displaying. The screen will return to the standard locate mode display and the receiver will stop acting as a steering target.

Steering to the Target

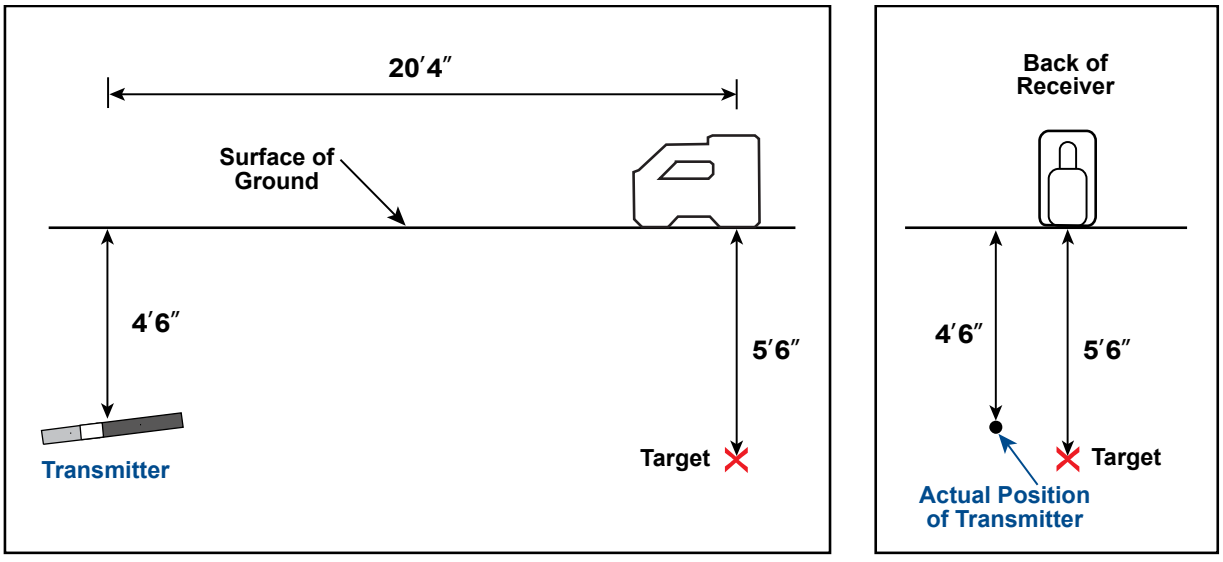
Once the target depth number has been entered on the receiver and the receiver has been positioned ahead of the tool as the target, select remote mode from the remote's main menu (see "Main Menu" in the *Remote Display* section). You will then see the *Target Steering* screen shown below.



Target Steering *on Remote Display*

The steering indicator in this case shows that the drill head is to the left and too high for the intended path. The steering indicator should be dead center in the display if you are correctly heading to your programmed target depth. A steering command of 4 o'clock would bring the drill head toward the target. Note that, for quick viewing and interpretation, the pointed end of the steering indicator corresponds to the clock position of the head. The horizontal distance from the drill head to the receiver is indicated at the bottom left part of the display. At the bottom right, the current depth of the drill head is indicated.

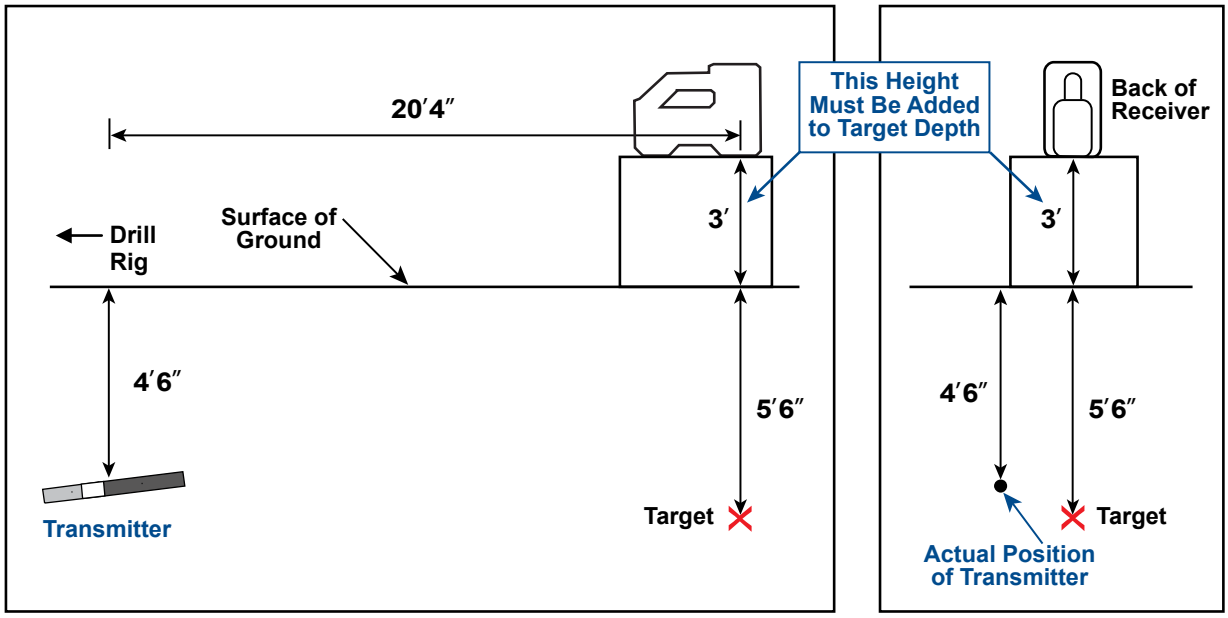
A side view of the position of the receiver and of the transmitter is shown below on the left. An end view of the same setup is shown on the right.



Side and End Views Showing Positions of Receiver, Transmitter, and Target

Target Steering in Interference Areas

In areas of passive and/or active interference, it may be advisable to physically elevate the receiver above the ground. In the example below, the receiver is placed 3 ft (or 1 m) above the ground. To compensate, the target depth value will be set to 8'6" (2.6 m).



Side and Back End Views of Transmitter, Target, and Raised Receiver

3-2200-00-D

Appendix A: System Specifications and Maintenance Requirements

The power requirements, environmental requirements, and equipment maintenance requirements for the DigiTrak F5 Locating System are listed below.

Power Requirements

Device (Model Number)	Operational Voltage	Operational Current
DigiTrak F5 Receiver (F5R)	14.4 V ⎓ (nominal)	350 mA max
DigiTrak F Series Display (FSD)	14.4 V ⎓ (nominal)	220 mA max
DigiTrak F Series Battery Charger (FBC)	Input 12 V ⎓ (nominal) Output 16.8 V ⎓ (nominal)	5000 mA max 1800 mA max
DigiTrak F Series Lithium-Ion Battery Pack (FBP)	14.4 V ⎓	4400 Ah max, 65 Wh
DigiTrak FS Transmitter	1.1–1.6 V ⎓	400 mA max
DigiTrak F Series Transmitters (FX, FXL, 5XD 12/1.3, 5XD 19/12, 5X 18.5, 5X 8.4)	2–3.6 V ⎓	750 mA max

Environmental Requirements

Device	Altitude	Relative Humidity	Operating Temperature
DigiTrak F5 Receiver	<16,404 ft (<5000 m)	<90%	-4° to 140°F (-20° to 60°C)
DigiTrak F Series Display	<16,404 ft (<5000 m)	<90%	-4° to 140°F (-20° to 60°C)
DigiTrak FS Transmitter	<16,404 ft (<5000 m)	<100%	-4° to 180°F (-20° to 82°C)
DigiTrak FX, FXL Transmitters	<16,404 ft (<5000 m)	<100%	-4° to 220°F (-20° to 104°C)
DigiTrak F Series Battery Charger	<13,123 ft (<4000 m)	<99% for 0-10°C <95% for 10-35°C	32° to 95°F (0° to 35°C)
DigiTrak F Series Lithium-Ion Battery Pack	<13,123 ft (<4000 m)	<99% for <10°C <95% for 10-35°C <75% for 35-60°C	-4° to 140°F (-20° to 60°C)

General Transmitter Care Instructions

- Periodically clean the spring and threads inside the battery compartment as well as the spring and threads of the battery cap to ensure a proper power connection with the batteries. An emery cloth or wire brush can be used to remove any oxidation that has built up. Be careful not to damage the battery cap O-ring; remove it while cleaning if necessary. After cleaning, use a conductive lubricant on the battery cap threads to keep the battery cap from binding in the battery compartment.

- Before use, inspect the battery cap O-ring for damage that may allow water to enter the battery compartment. Replace the 2-022 Buna-N70 type O-ring if the one installed becomes damaged.

- Placing tape around the fiberglass tube of the transmitter, if space allows, will keep the fiberglass protected from most corrosive environmental wear.

- Send in the Product Registration Card for the 90-day Limited Warranty.

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.

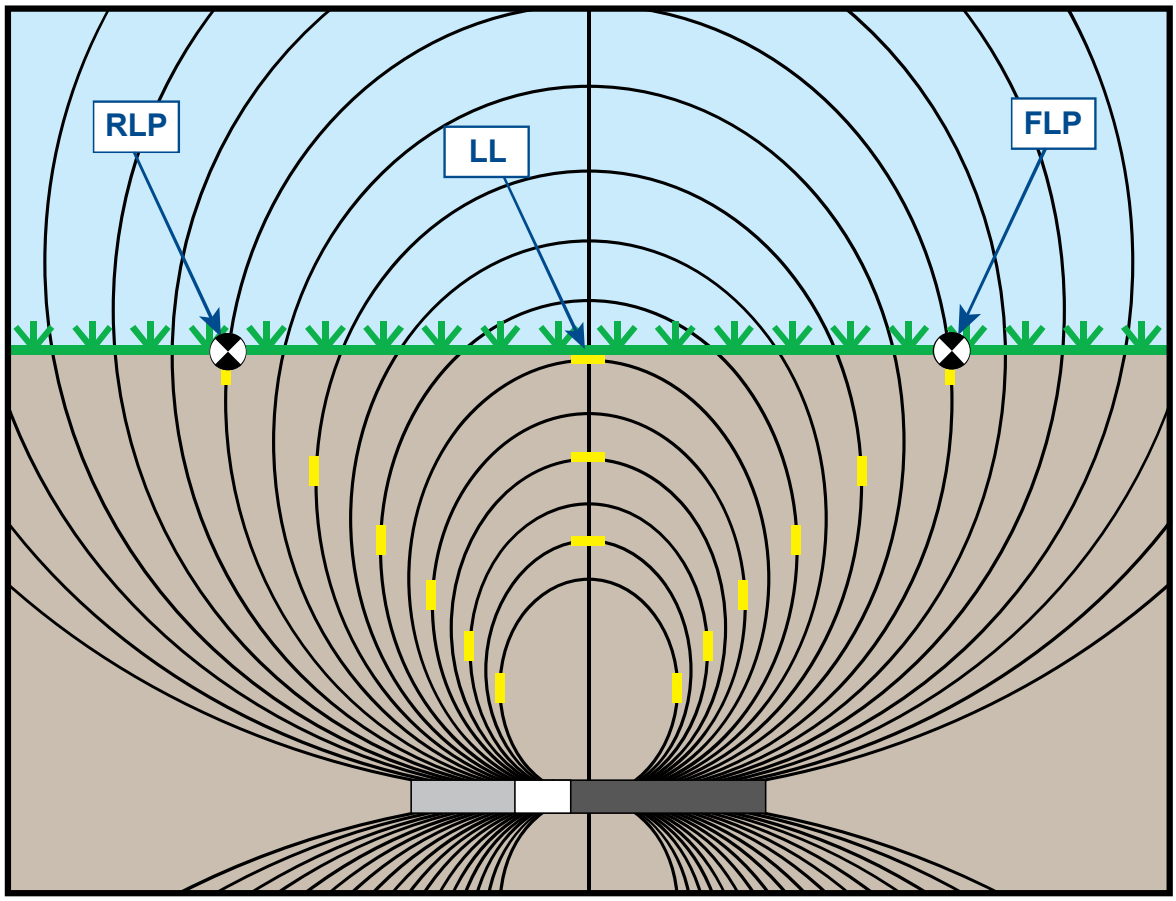


Figure B1. Flux Field and Geometry of FLP, RLP, and LL (side view)

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 (4.6 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 B1 and B2) to determine the actual depth and fore/aft offset when you know the displayed (projected) depth and pitch of the transmitter.

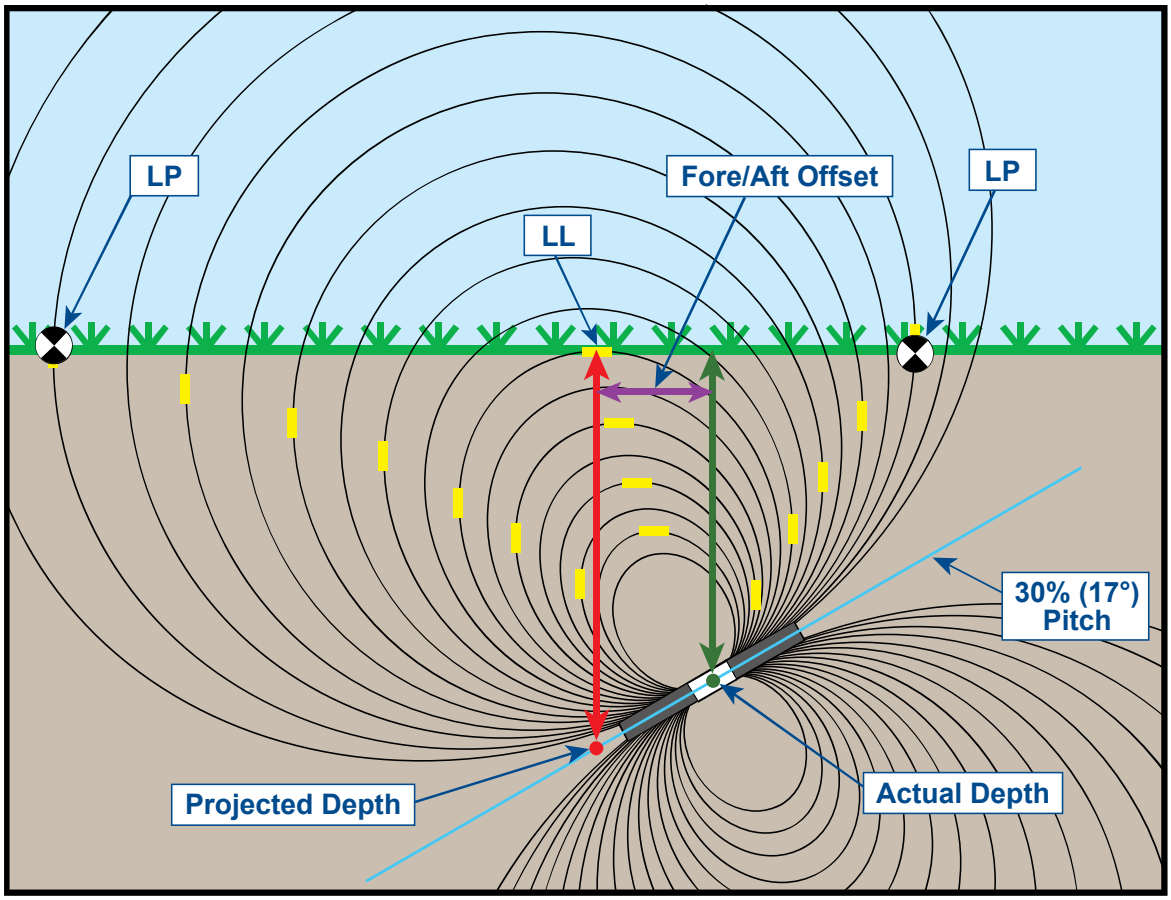


Figure B2. Projected Depth vs. Actual Depth and Fore/Aft Offset When Steep and Deep

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 (FLP and RLP) 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 transmitter 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).

Notes

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:

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

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

Notes

Appendix D: Reference Tables

The information and tables contained in this appendix provide further assistance for confirming the position of the transmitter. The following information is provided:

Depth Increase in Inches (Centimeters) per 10-foot (3-meter) Rod

Depth Increase in Inches (Centimeters) per 15-foot (4.6-meter) Rod

Depth Increase in Inches (Centimeters) per 10-foot (3-meter) Rod

Percent	Depth Increase		Percent	Depth Increase
1	1 (2)		**28**	32 (81)
2	2 (5)		**29**	33 (84)
3	4 (10)		**30**	34 (86)
4	5 (13)		**31**	36 (91)
5	6 (15)		**32**	37 (94)
6	7 (18)		**33**	38 (97)
7	8 (20)		**34**	39 (99)
8	10 (25)		**35**	40 (102)
9	11 (28)		**36**	41 (104)
10	12 (30)		**37**	42 (107)
11	13 (33)		**38**	43 (109)
12	14 (36)		**39**	44 (112)
13	15 (38)		**40**	45 (114)
14	17 (43)		**41**	46 (117)
15	18 (46)		**42**	46 (117)
16	19 (48)		**43**	47 (119)
17	20 (51)		**44**	48 (122)
18	21 (53)		**45**	49 (124)
19	22 (56)		**46**	50 (127)
20	24 (61)		**47**	51 (130)
21	25 (64)		**50**	54 (137)
22	26 (66)		**55**	58 (147)
23	27 (69)		**60**	62 (157)
24	28 (71)		**70**	69 (175)
25	29 (74)		**80**	75 (191)
26	30 (76)		**90**	80 (203)
27	31 (79)		**100**	85 (216)

Depth Increase in Inches (Centimeters) per 15-foot (4.6-meter) Rod

Percent	Depth Increase		Percent	Depth Increase
1	2 (5)		**28**	49 (124)
2	4 (10)		**29**	50 (127)
3	5 (13)		**30**	52 (132)
4	7 (18)		**31**	53 (135)
5	9 (23)		**32**	55 (140)
6	11 (28)		**33**	56 (142)
7	13 (33)		**34**	58 (147)
8	14 (36)		**35**	59 (150)
9	16 (41)		**36**	61 (155)
10	18 (46)		**37**	62 (157)
11	20 (51)		**38**	64 (163)
12	21 (53)		**39**	65 (165)
13	23 (58)		**40**	67 (170)
14	25 (64)		**41**	68 (173)
15	27 (69)		**42**	70 (178)
16	28 (71)		**43**	71 (180)
17	30 (76)		**44**	72 (183)
18	32 (81)		**45**	74 (188)
19	34 (86)		**46**	75 (191)
20	35 (89)		**47**	77 (196)
21	37 (94)		**50**	80 (203)
22	39 (99)		**55**	87 (221)
23	40 (102)		**60**	93 (236)
24	42 (107)		**70**	103 (262)
25	44 (112)		**80**	112 (284)
26	45 (114)		**90**	120 (305)
27	47 (119)		**100**	127 (323)

Notes

Appendix E: EU Required Documentation

Declaration of Conformity for F5 System by DCI

Notice of Telemetry Use Restrictions

Declaration of Conformity (DoC)

We, **Digital Control Incorporated,** 19625 62nd Ave South Suite B103 Kent, WA 98032 USA,

Declare under our own responsibility that the product

DigiTrak F2 System consisting of a receiver (F2R), remote display (FSD), transmitter (FS) or (FX) or (FXL) or (FX 19.2) or (FXL 19.2), battery pack (FBP), and battery charger (FBC)

to which this declaration relates is in conformity with the essential requirements and other relevant requirements of the R&TTE Directive (1999/5/EC). The product is in conformity with the following standards and/or other normative documents:

HEALTH & SAFETY (Art. 3(1)(a)): Based on LVD DoC : 2006/95/EC	**For F2R,FSD,FBP,FXL,FX FX 19.2,FXL 19.2:** IEC 61010-1:2001, EN62311(section 4) **For FBC:** IEC 60335-2-29:2002, IEC 60335-1:2001 **For FS:** EN 60950-1:2006, EN 62311
EMC (Art. 3(1)(b)): Based on EMC DoC : 2004/108/EC	**For F2R, FSD,FX,FXL, FX 19.2,FXL 19.2,FS:** ETSI EN 301 489-01 V1.8.1 (2008), ETSI 301 489-03 V1.4.1 (2002) **For FBC:** EN 55022:2006 +A1:2007 Class A, EN 61000-3-3:1995 (Amended by A1:2001 and A2:2005), IEC 61000-3-3:2005, EN 61000-3-2:2006, IEC 61000-3-2:2005, EN 55024:1998 (Amended by A1:2001 and A2:2003), IEC 61000-4-6:2008, IEC 61000-4-3:2006 (Amended by A1:2007), IEC 61000-4-2:2008, IEC 61000-4-4:2004, IEC 61000-4-11:2004, IEC 61000-4-5:2005, IEC 61000-4-8:2001
SPECTRUM (Art. 3(2)):	**For F2R, FSD:** ETSI EN 300 220-1 V2.1.1 (2006), ETSI EN 300 220-2V2.1.2 (2007) **For FX,FXL,FX 19.2,FXL 19.2 F2R:** ETSI EN 300 330-1 V1.5.1 (2006), ETSI EN 300 330-2 V1.3.1 (2006) **For FS:** ETSI EN 300 330-1 V1.7.1 (2010-02), ETSI EN 300 330-2 V1.5.1 (2010-02) **For F2R:** ETSI EN 301 166-1 V1.3.1 (2008), ETSI EN 301 166-2 V1.2.2 (2008)

Compliance is claimed per reports: From NWEMC of Hillsboro, OR, USA: DIGC0022.1, DIGC0047, DIGC0049, DIGC0051, DIGC0054, DIGC0067, DIGC0071, DIGC0071.1, DIGC0107, DIGC0107.1; From TUV SÜD America, Portland, OR, USA: 231-806497101-200, 231-806497102-000; From EMCC DR. RAŠEK, Ebermannstadt, Germany: EMCC-001910PFB, EMCC-001910PFD, EMCC-001910PFG

Technical file, 555-0001-00-TCF, held by: **Digital Control GmbH**, Kurmainzer Str. 56, D-97836 Bischbrunn, Germany, Tel: +49-9394-990-990

Kent Washington USA, 21 July 2010
(Place, date)

Rudy Zeller, F2 Program Manager
(Name and signature of person responsible)

Unique identification of this DoC: 555-0001-00-DoCE Rev 02

Notice of Telemetry Use Restrictions

DigiTrak F5 receivers and F Series transmitters are classified as Class 2 radio equipment per R&TTE Directive. The following restrictions apply.

Country	Allowed Frequencies (MHz)	Limitations
Austria	458.6, 458.65, 458.7, and 458.75	
Belgium	458.6, 458.65, 458.7, and 458.75	Yes*
Bulgaria	458.6, 458.65, 458.7, and 458.75	
Cyprus	458.6, 458.65, 458.7, and 458.75	
Czech Republic	458.6, 458.65, 458.7, and 458.75	
Denmark	458.6, 458.65, 458.7, and 458.75	
Estonia	449.8, 449.85, 449.9, and 449.95	Yes*
Finland	458.6, 458.65, 458.7, and 458.75	
France	458.6, 458.65, 458.7, and 458.75	
Germany	458.6, 458.65, 458.7, and 458.75	
Greece	458.6, 458.65, 458.7, and 458.75	
Hungary	433.65 and 433.70	Yes*
Iceland	458.6, 458.65, 458.7, and 458.75	
Ireland	458.6, 458.65, 458.7, and 458.75	
Italy	458.6, 458.65, 458.7, and 458.75	Yes*
Latvia	458.6, 458.65, 458.7, and 458.75	Yes*
Liechtenstein	433.65 and 433.70	
Lithuania	458.6, 458.65, 458.7, and 458.75	Yes*
Luxembourg	458.6, 458.65, 458.7, and 458.75	Yes*
Malta	458.6, 458.65, 458.7, and 458.75	Yes*
Netherlands	451.03 and 451.09	Yes*
Norway	458.6, 458.65, 458.7, and 458.75	
Poland	458.6, 458.65, 458.7, and 458.75	
Portugal		Telemetry use not allowed
Romania	458.6, 458.65, 458.7, and 458.75	
Slovak Republic	458.6, 458.65, 458.7, and 458.75	
Slovenia	458.6, 458.65, 458.7, and 458.75	Yes*
Spain	449.8, 449.85, 449.9, and 449.95	
Sweden	458.6, 458.65, 458.7, and 458.75	
Switzerland	433.65 and 433.70	
Turkey	458.6, 458.65, 458.7, and 458.75	
United Kingdom	458.6, 458.65, 458.7, and 458.75	

*Individual user license required – check with your local authority.

There are no restrictions to the use of DigiTrak F Series transmitters that have been identified by DCI. Please check with your local authorities to verify the 12-kHz, 18.5-kHz, and 19.2-kHz radio bands are available for use in the region the transmitter is to be used.

Notes

DIGITAL CONTROL INCORPORATED

19625 62nd Ave. S., Suite B-103 • Kent, WA 98032 USA • (425) 251-0559 or (800) 288-3610 • Fax (253) 395-2800
www.digitrak.com DCI@digital-control.com (E-mail)

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 Warranty 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 user'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 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 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 a 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 a 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.