

CenterLine (Draft User's Guide)

A lightbar guidance system with wireless remote control.

Software Version 1



Introduction

About CenterLine

CenterLine is a low-cost lightbar guidance system controlled by a wireless remote. CenterLine provides accurate straight-line and curved guidance, for use in spraying, seeding and other related jobs at a cost that rivals foam markers. The CenterLine product comes with a WAAS DGPS receiver providing sub-meter pass to pass positioning accuracy. The wireless remote control is used to set-up and operate the system through menus and options displayed on the lightbar.

CenterLine's attractive design combines a compact size with easy to see LEDs that are fully adjustable using dedicated buttons on the wireless remote. The lightbar can be dimmed to efficiently run at night and brightened to be easily seen in full sunlight.

Straight or Curved Guidance

CenterLine will guide you along swaths of all kinds with sub-meter pass to pass accuracy. You select the driving pattern and CenterLine determines the closest swath to guide you next to. There's no need to decide a guidance pattern ahead of time, or to commit to a pattern for the entire job. Centerline allows you to switch patterns in real-time. Centerline determines when you are using a new pattern and keeps you informed of your current status.

Wireless Remote Control Unit

CenterLine's ergonomic, handheld remote control is easier to use than most TV remotes. Seven easy to read keys allow you to scroll through menus displayed on the lightbar. The remote keypad is backlit for night-time operation, and one set of AA batteries (included) will power the unit for an entire season.

The small, powerful remote permits mounting the weather-resistant lightbar outside on the hood or in the cab. When mounted outside, wireless communication permits easy operation while the cab stays clean and sealed from dust and contaminants.

Lightbar Shows you the Information You Want

A text display on the lightbar reports the guidance information of your choice. It also warns you when you enter an area of the field that has been already applied. Guidance text information can be turned off, if you choose not to see this data. You choose two of these guidance messages to monitor progress in real-time:

- Cross-Track Error,
- Current Swath Number,
- Vehicle Speed,
- Applied Area,
- Vehicle course on the ground.

About this User's Guide

This is the CenterLine user's guide version 1 and will cover CenterLine software versions 1.00 to 1.99. Some software versions may come with a supplement to this user's guide.

Menu Items and Pick List Text

Throughout this user's guide, menu item text will be displayed between the <> characters. EG <START>. Keys on the remote, (Figure 4) will be denoted in bold italics, such as ***Enter***.

Most of the figures in this user's guide are of menu items that would be displayed in the text window of the lightbar (Figure 5). This text will represent either a menu item such as <GUIDANCE> or a pick-list item, such as <METRIC>. The lightbar text window can only display a single line of text up to ten characters long. Figure 1 shows an example of a single text line that would be displayed on the lightbar.

The enter symbol on the right hand side of the text window means that you can press the ***Enter*** key on the remote and move to a sub-menu or a pick-list. The up and down arrows on the left hand side of the text display indicate that there are menu items or pick-list values above and below the currently shown menu or pick-list item, and they can be accessed by using the ***Up*** and ***Down*** arrow keys on the remote.



Figure 1: Example of Text Displayed on Lightbar

Figures with multiple menu items are depicting the menu items that are above, below, left and right of the text line currently in view. Figure 2 shows several menu items. The current menu item in view is <SETUP> and is denoted with a black arrow to the right side of the text. This figure is showing that if you use the ***Up*** and ***Down*** arrow keys you can scroll between <START>, <SETUP> and <TOOLS>. If you press the ***Enter*** key on the remote, you will move to the <GUIDANCE> setup menu item. This figure also shows you that if you are at the <GUIDANCE> menu item, you can scroll between the <GUIDANCE>, <LIGHTBAR> and <SYSTEM> setup menus using the ***Up*** and ***Down*** arrow keys.

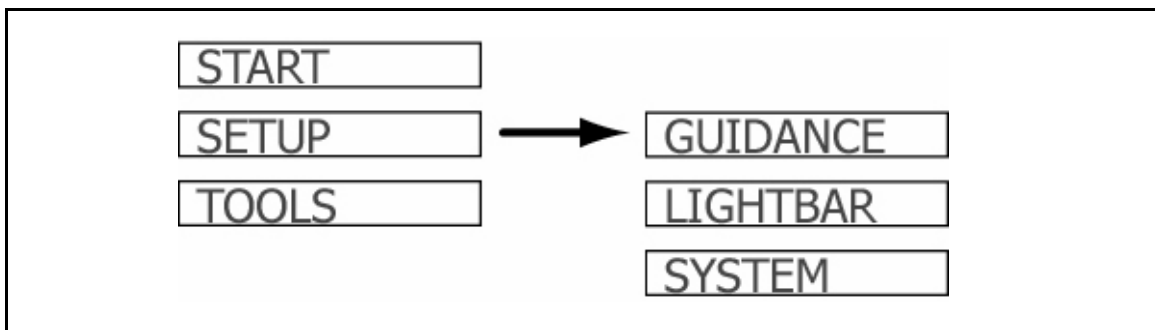


Figure 2: Displaying Multiple Text Lines

Menu Items Back and To Start

There are two additional menu items that are found in almost every menu, <BACK> and <TO START>. Figure 3 shows the <BACK> and <TO START> menu items in the System Setup menu list. Selecting <BACK> will take you back a menu heading. In this example pressing back would take you to <SETUP>. Selecting <TO START> will automatically take you to the <START> menu; from here you can begin real-time guidance. Using <TO START> is useful when you need to quickly change one setting and then go right back into real-time operation.

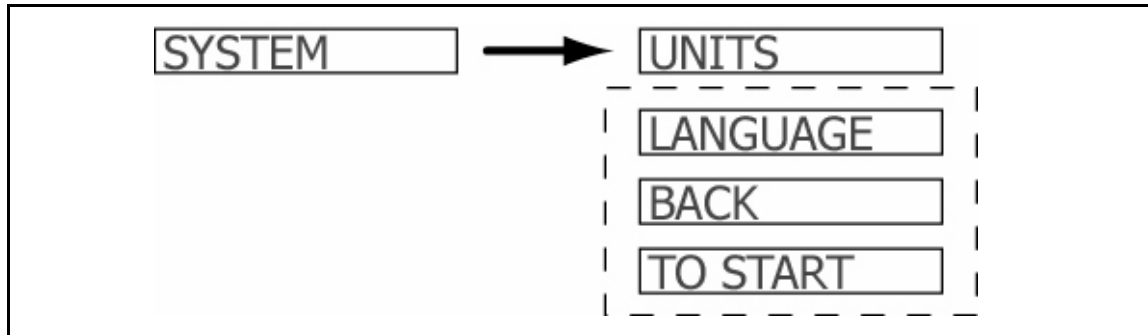


Figure 3: Back and To Start Menu Items

Software Components

CenterLine software can be broken into three components, Setup (“CenterLine Setup” on page 12), Real-Time (“CenterLine Real-Time Operation” on page 27) and Tools. Setup will allow you to configure the CenterLine to best suit their requirements and the Real-Time component will handle all of the real-time guidance operations. The Tools component will provide basic diagnostics for the lightbar and also the attached GPS receiver.

Wireless Remote Control

General Operation

Operation of CenterLine software is via remote keypad input and menu items displayed in the text display area, (Figure 5), of the CenterLine lightbar. The **Up** and **Down** arrow keys will be used to scroll through menus, sub-menus and pick lists. The **Enter** key will be used to enter menus, sub-menus and accept a desired pick-list entry. The **ESC** key acts as cancel.

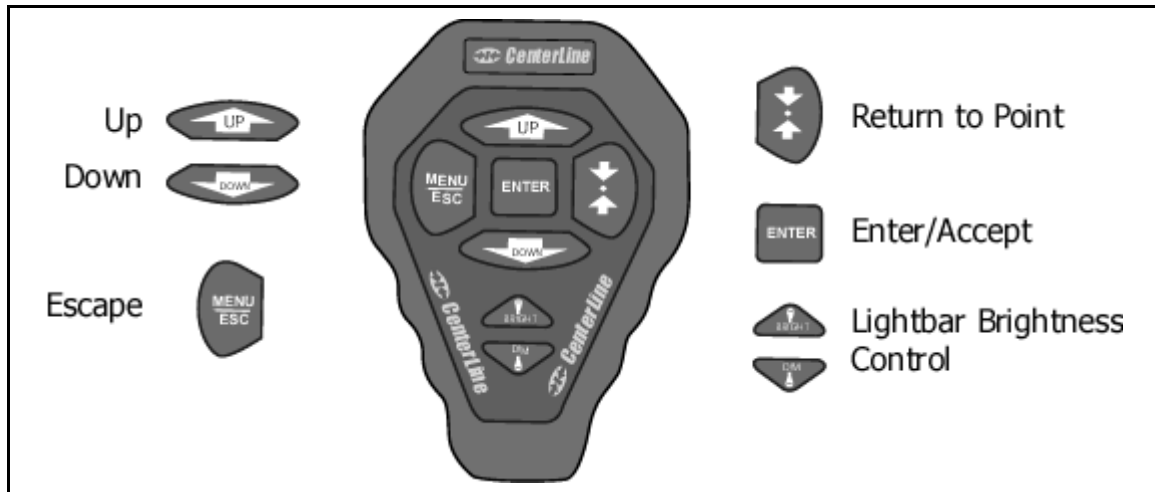


Figure 4: The Wireless Remote Control Unit

FCC Statement

This device complies with part 15 of the FCC Rules. 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.

QS7CL7850094

QS7CL7850107

TR19JN96.008

Changes or modifications to the product, not expressly approved by Midwest Technologies Illinois, LLC, could void the user's authority, as granted under Part 15 of the FCC Rules, to operate the equipment.

CenterLine Lightbar

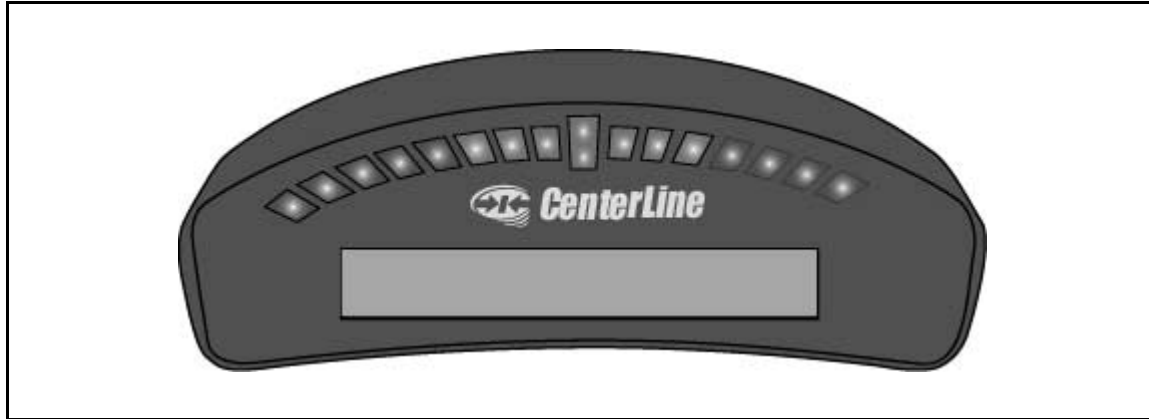


Figure 5: The CenterLine Lightbar

Lightbar Specifications

Housing Material:	ABS/Polycarbonate alloy construction.
Dimensions:	3.70"H x 9.40"W x 3.80"D (95 mm x 240 mm x 100 mm)
Weight:	0.8 lbs (0.36 kg)
Processor:	Intel StrongARM
RAM:	16 MB, 2 MB Flash
LEDs:	High-lumen red and green radial light pattern and 10 character LED alpha-numeric text display. Full brightness control adjustment using wireless remote.
Operating Temp:	32 to 160 F (0 to 70 C)
Storage Temp:	-40 to 185 F (-40 to 85 C)
I/O to DGPS:	1 asynchronous RS 232
I/O to Control Unit:	Wireless link operating at 418 MHz. FCC part 15 and Industry Canada RSS-210 certified. Other certifications pending.
Mounting:	Mounting bracket supplied. Magnetic and suction mounts are optional.

CenterLine Quick Start-up

The following section assumes that you CenterLine hardware has been properly setup. See “CenterLine Product Kits” on page 8 for information on how to configure your system.

General Start-up Sequence

- Apply power to CenterLine.
- Lightbar performs a start up sequence..
- Lightbar text display will display current software version.
- Lightbar will display <START>.
- Software should stay at current location until you press **Enter** to start real-time guidance or scroll the Start menu using **Up** or **Down** to move to another menu option, <SETUP> or <TOOLS>.

First Time Start-up Sequence

- Apply power to CenterLine.
- Lightbar performs a start up sequence..
- Lightbar text display will display current software version.
- Lightbar will display <START>.
- Using **Up** or **Down**, scroll until <SETUP> is displayed on the lightbar. Press **Enter**.
- Run through the three setup sub-menus <GUIDANCE>, <LIGHTBAR> and <SYSTEM>. It is important to have the correct swath width entered.
- Return to the <START> location and press Enter to begin real-time guidance.

CenterLine Product Kits

CenterLine Kit without DGPS Receiver

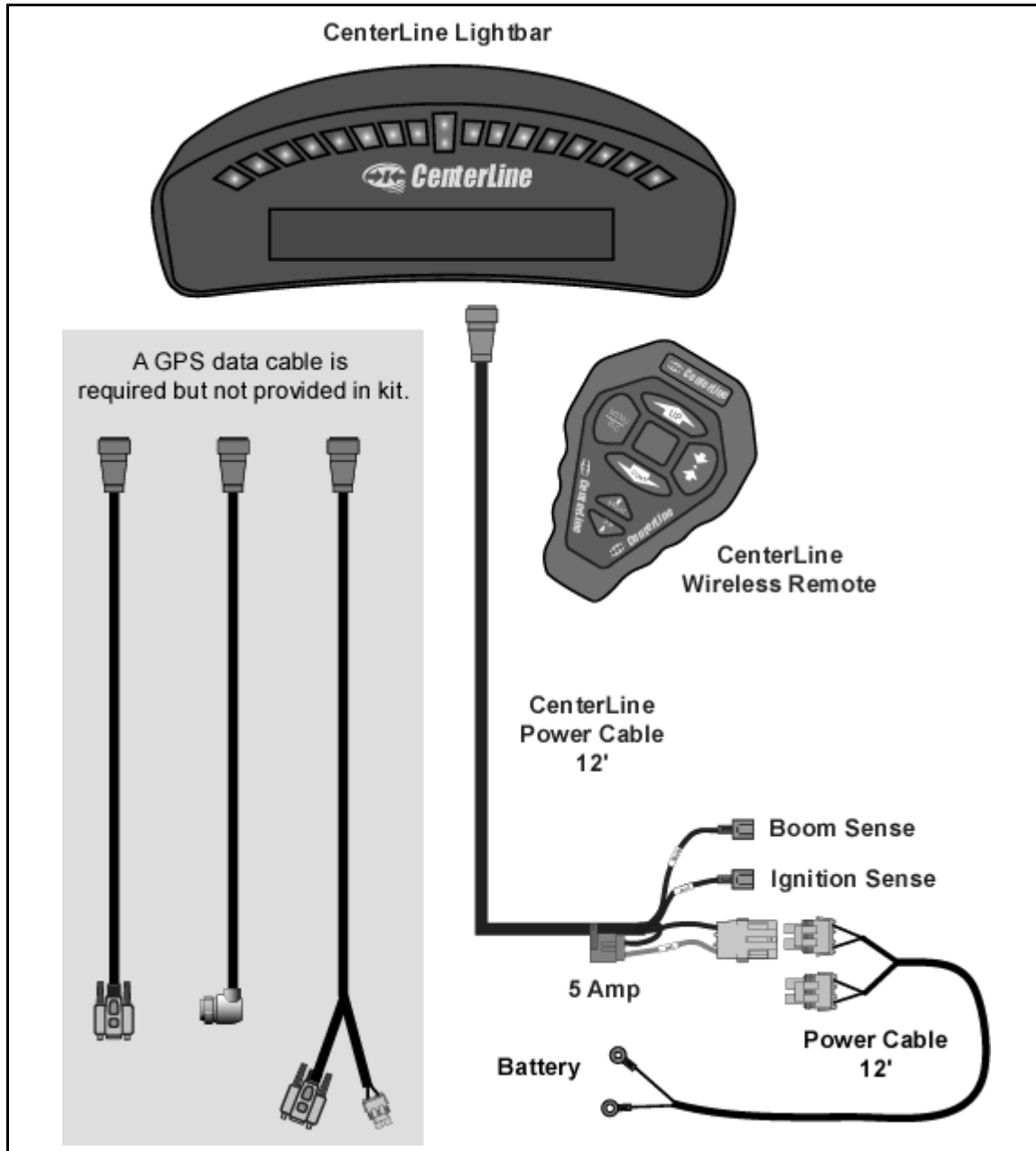


Figure 6: CenterLine without DGPS Receiver

CenterLine Kit with RX 360p WAAS DGPS Receiver

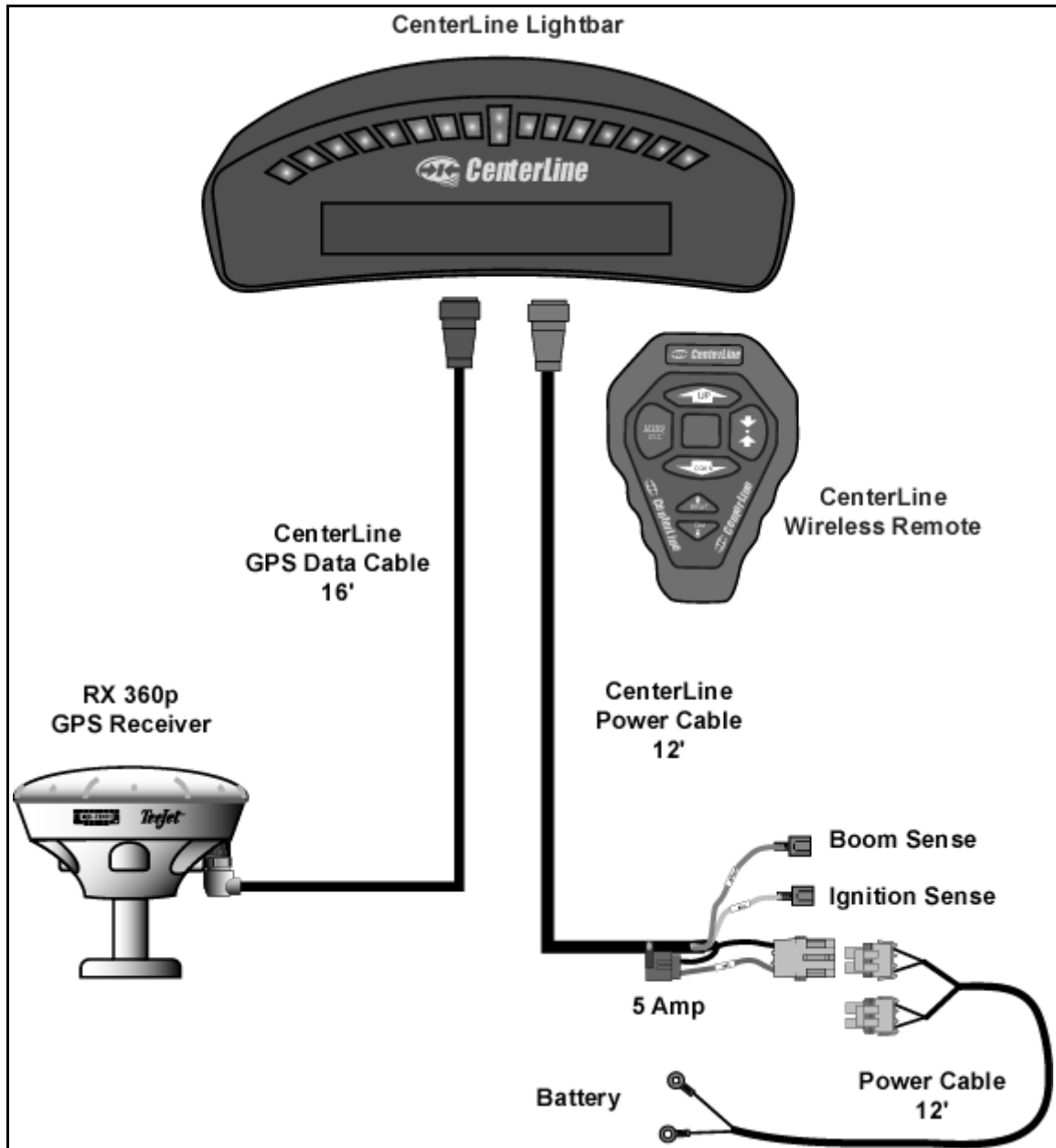


Figure 7: CenterLine Kit with RX360p WAAS DGPS Receiver

CenterLine Kit with RX 350p WAAS DGPS Receiver

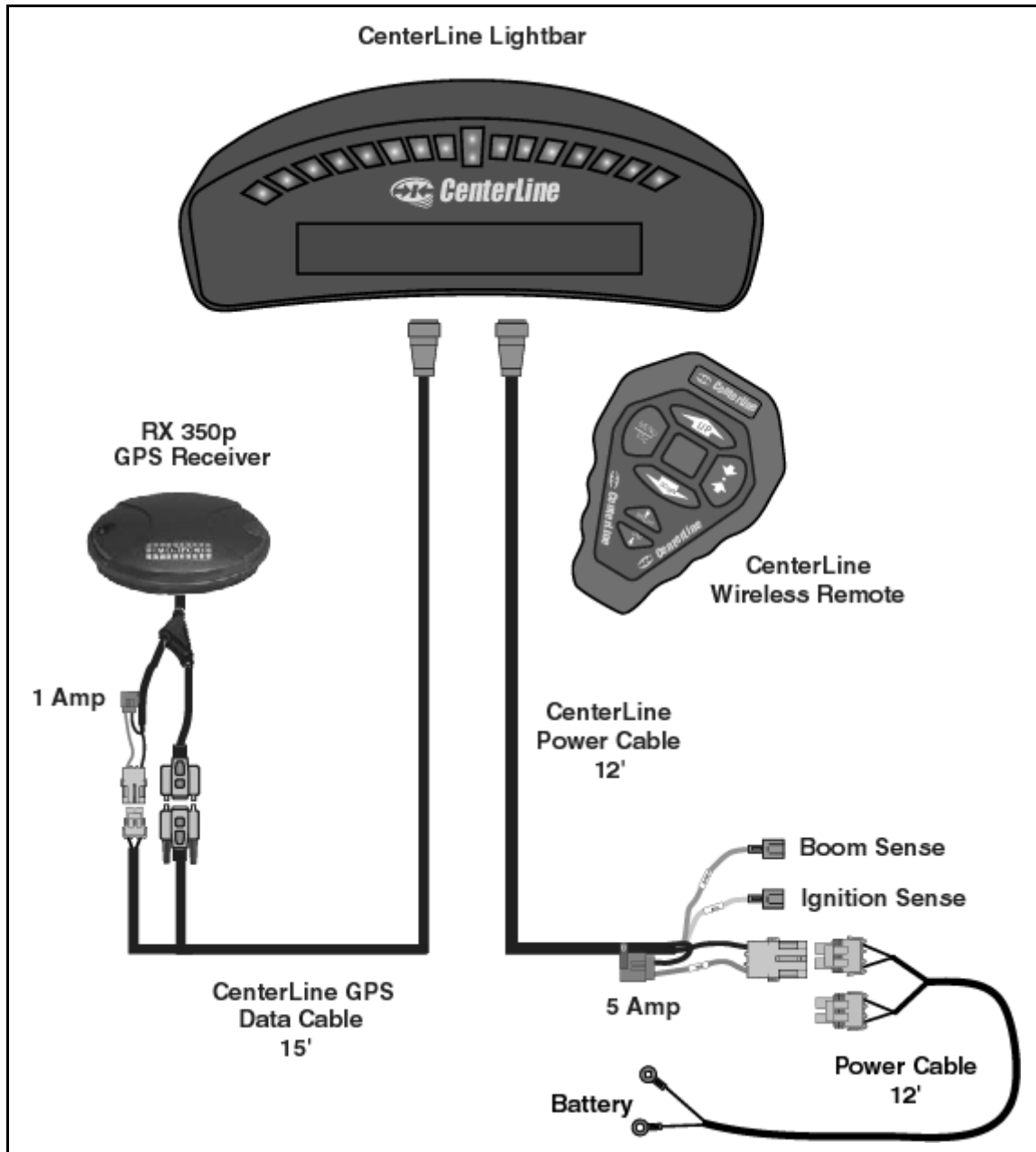


Figure 8: CenterLine with RX 350p WAAS DGPS Receiver

CenterLine with RX 400p DGPS Receiver

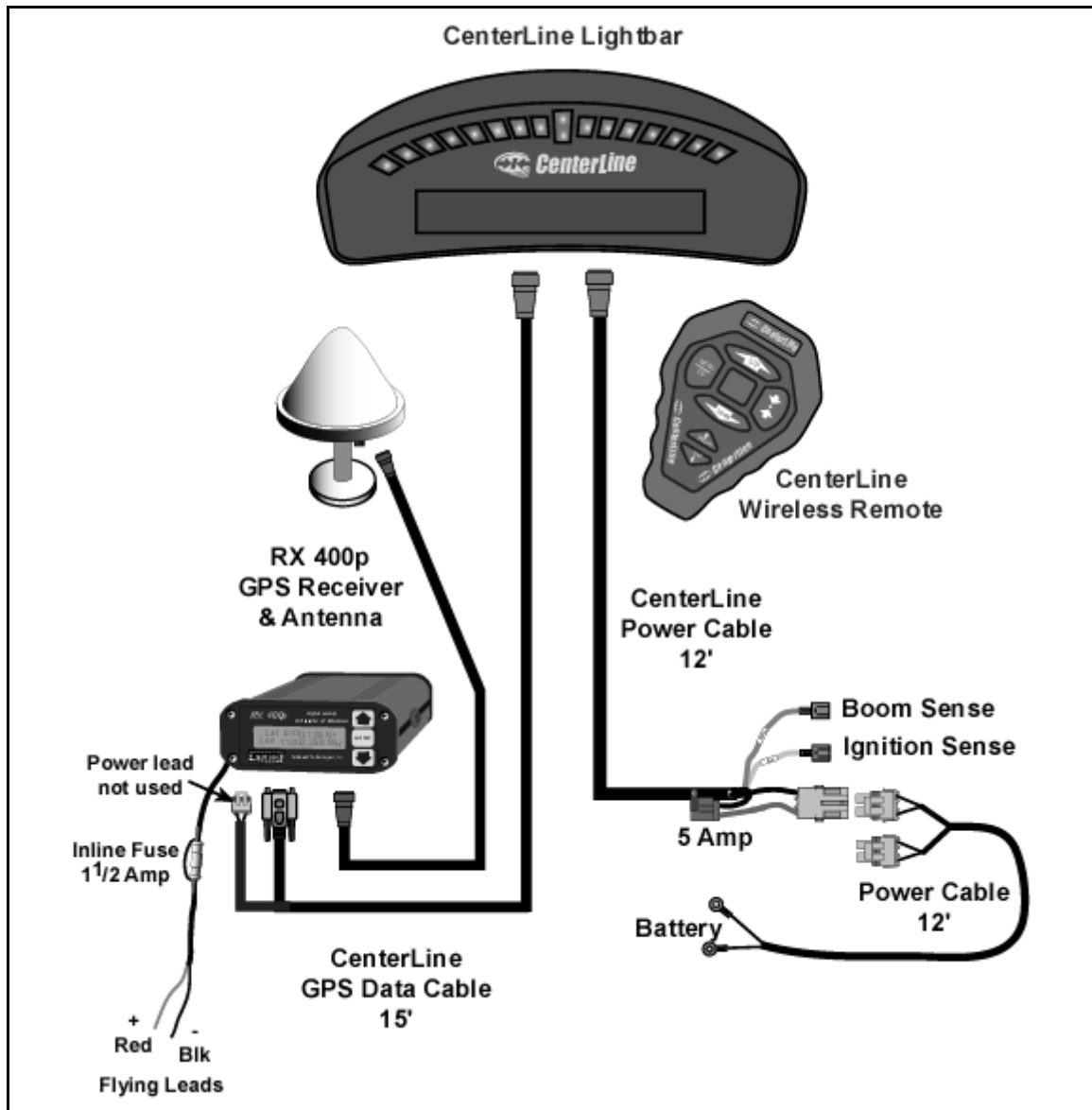


Figure 9: CenterLine with RX 400p DGPS Receiver

CenterLine Setup

CenterLine Setup allows you to configure the CenterLine product to best suit your guidance and mapping requirements. For the complete overview of the Setup process see Section , “CenterLine Setup Flow Diagram,” on page 24. CenterLine Setup will have three sub-menus, <GUIDANCE>, <LIGHTBAR> and <SYSTEM>, each is described in detail below. Figure 10 shows the Setup flow.

The top level of CenterLine software has three menus to choose from, <START>, <SETUP> and <TOOLS>. To enter the setup menus, use **Up** or **Down** to scroll until <SETUP> is visible, then press **enter**. Once in Setup you can scroll through the setup menu list, <GUIDANCE>, <LIGHTBAR> and <SYSTEM>, and select the desired setup menu by pressing **Enter**. See Figure 10.

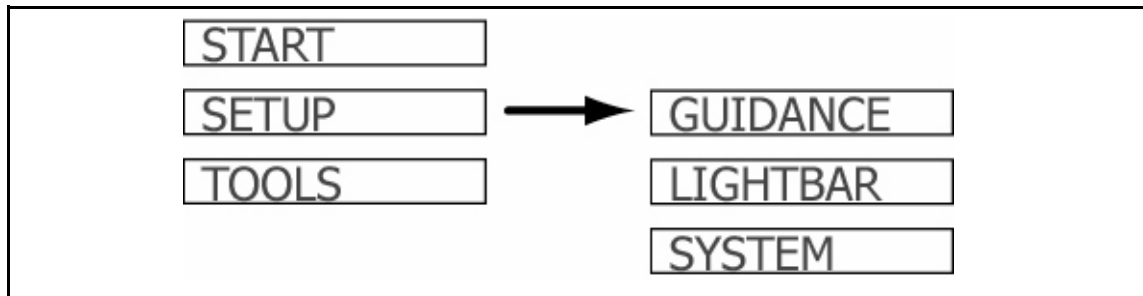


Figure 10: CenterLine Setup Flow

Guidance Setup

Guidance setup allows you to set up several parameters that pertain to guidance functionality. Currently there are four guidance settings, see Table 1.

To access Guidance setup from the Setup menu, scroll until the text window displays <GUIDANCE>, press **Enter**. Menu item <WIDTH> should be displayed in the text window. Use **Up** or **Down** to scroll through the list of Guidance setup menu items.

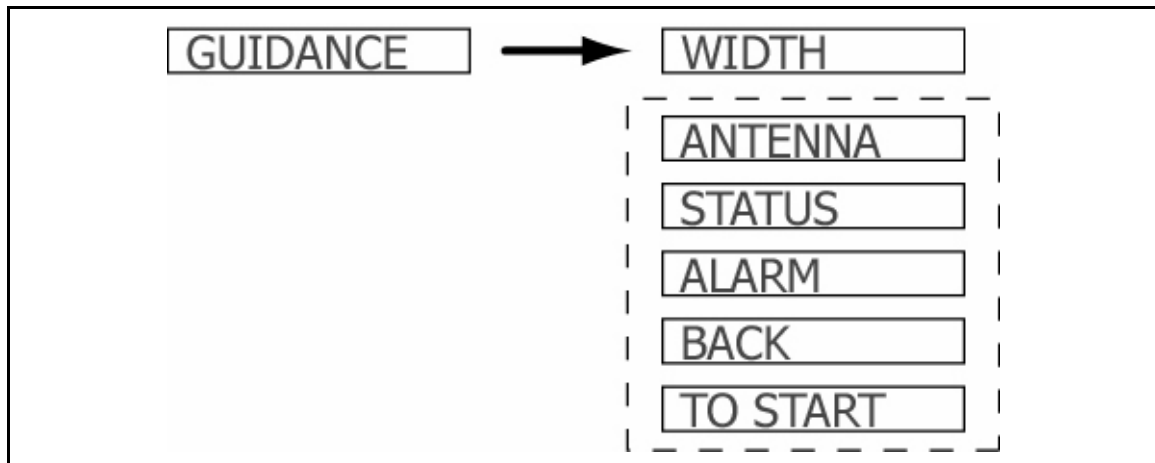


Figure 11: Guidance Setup Flow

Setting Name	Default Value	Change at 1st Time Start Up
Width	30.0 feet (10 meters)	Required
Antenna -Direction	None	Recommended
Antenna - Distance	0.0 ft.	Recommended
Status Detect	Off	Optional
Alarm	Off	Recommended

Table 1: Guidance Menu Item Default Settings

The Guidance menu item <ANTENNA> is a sub-menu of Guidance. The <DIRECTION> and <DISTANCE> menu items will be listed under this Antenna sub-menu. From these menu items you can set the offset distance and direction (Figure 16).

Width

The Guidance setup parameter Width is the distance between guidelines. This width is typically the vehicle implement width or spread area. Setting this width slightly smaller than the actual width will reduce skips. Setting this width slightly larger than the actual width will reduce overlap.

To set the Width setting, go to <GUIDANCE> and scroll with **Up** or **Down** until <WIDTH> is displayed, press **Enter**. To increase the width press **Up**, to decrease the width press **Down**. Press **Enter** once the desired width is set. The width value increments in 0.5 ft. intervals.

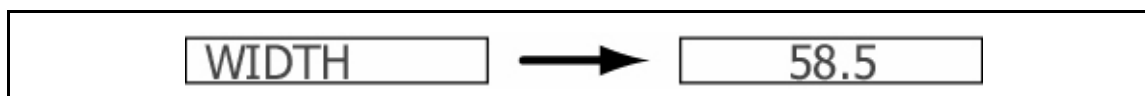


Figure 12: Setting the Guidance Width Value

Antenna

The Antenna sub-menu defines the spatial relationship between the GPS antenna and the vehicle implement or delivery point. The GPS antenna should always be mounted along the vehicle center line (Figure 16). The two Antenna menu setting are Direction and Distance.

To enter the Antenna sub-menu, go to <GUIDANCE> and scroll until <ANTENNA> is displayed in the text window and press **Enter**. As mentioned there are two settings under Antenna, <DIRECTION> and <DISTANCE>. The text window should display <DIRECTION>. Use **Up** or **Down** to move between the <DIRECTION> and <DISTANCE> settings. Press **Enter** once the desired setting is in the text window.

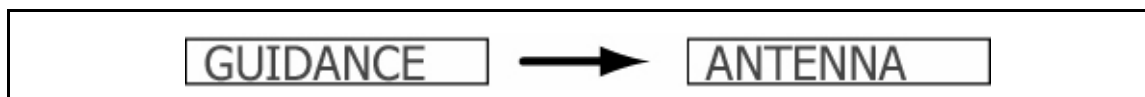


Figure 13: Accessing the Antenna Sub-Menu

Direction

The Direction setting is the direction from the GPS antenna to the swath or delivery point (Figure 16).

To set the Direction setting go to the Antenna sub-menu of Guidance setup and scroll until <DIRECTION> is displayed in the text window, press enter. Using **Up** or **Down** scroll through the direction pick list (see Table 2) until the desired direction is displayed in the text window. Press **Enter** to save the setting and return to the Guidance setup menu.

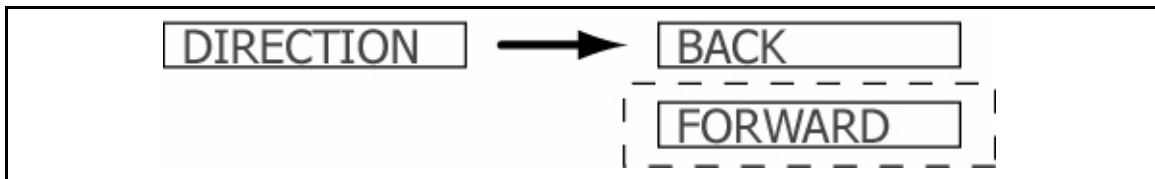


Figure 14: Setting the Direction to Swath

Setting	Description
Back	The swath or delivery point is behind the GPS receiver on the vehicle along the vehicle center line.
Forward	The swath or delivery point is forward of the GPS receiver on the vehicle along the vehicle center line.

Table 2: Direction to Swath Settings

Distance

The Distance setting is the distance from the GPS antenna to the swath or delivery location (Figure 16).

To set the Distance setting go to the Antenna sub-menu of Guidance setup and press **Enter**, scroll until <DISTANCE> is displayed in the text window, press **Enter**. To increase the distance press **Up**, to decrease the distance press **Down**. Press **Enter** once the desired distance is set.

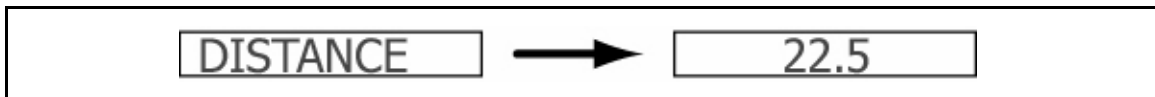


Figure 15: Setting the Distance to the Swath

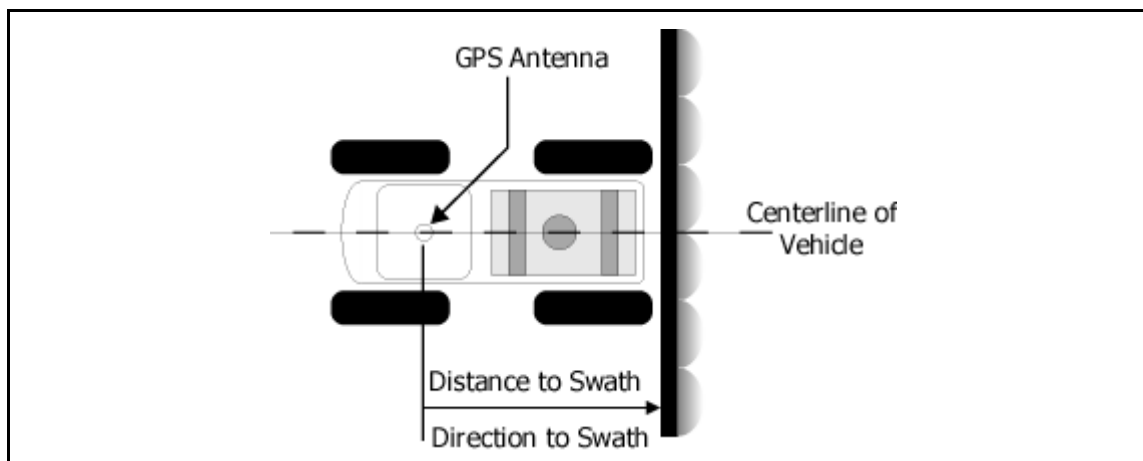


Figure 16: Direction and Distance to Swath from DGPS Receiver

Status

The <STATUS> setting is used to auto detect implement status. When the status detect is properly implemented the CenterLine will detect when product delivery is on or off based the vehicles spray on or spray off switch. See “CenterLine Product Kits” on page 8 for location of status connect wiring.

To set the Status setting go to Guidance setup and scroll with **Up** or **Down** until <STATUS> is displayed in the text window, press **Enter**. Using **Up** or **Down** scroll between the <ON> and <OFF> settings until the desired setting is displayed in the text window. Press **Enter** to save the setting and return to the Guidance setup menu.

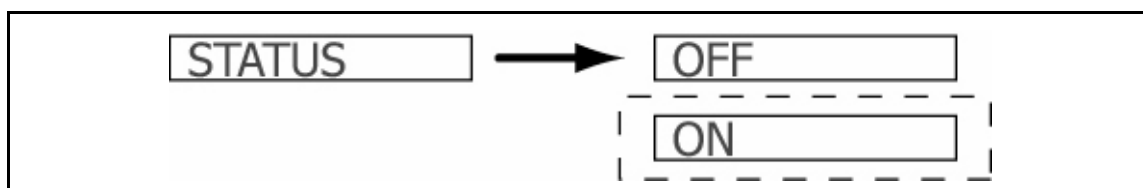


Figure 17: Selecting the Status Setting

Setting	Description
OFF	No Status Detect implemented. Default setting.

Table 3: Status Settings

Setting	Description
ON	Status detect will assume a single swath centered on the vehicle.

Table 3: Status Settings

Alarm

The <ALARM> setting, when set to ON, will notify you when approaching and entering a previously applied area. The text window will display <APPLIED> when the implement swath is in a previously applied area of the field.

To set the Alarm setting go to Guidance setup and scroll until <ALARM> is displayed in the text window, press enter. Using **Up** or **Down** scroll between the <ON> and <OFF> settings until the desired setting is displayed in the text window. Press **Enter** to save the setting and return to the Guidance setup menu.

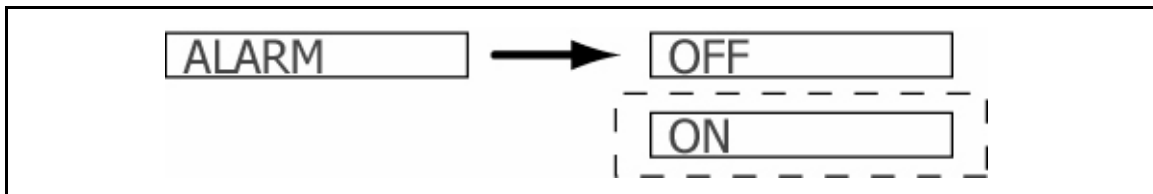


Figure 18: Setting the Alarm

Setting	Description
Off	No applied area detection.
On	Applied area detection alarm.

Table 4: Status Detect Settings

Lightbar Setup

Lightbar setup allows you to set several parameters related to the lightbar. There are four lightbar settings, Drive Sensitivity <SPACING>, Display Mode <MODE> and two selectable messages <TEXT 1> and <TEXT 2>, see Figure 19 and Table 5.

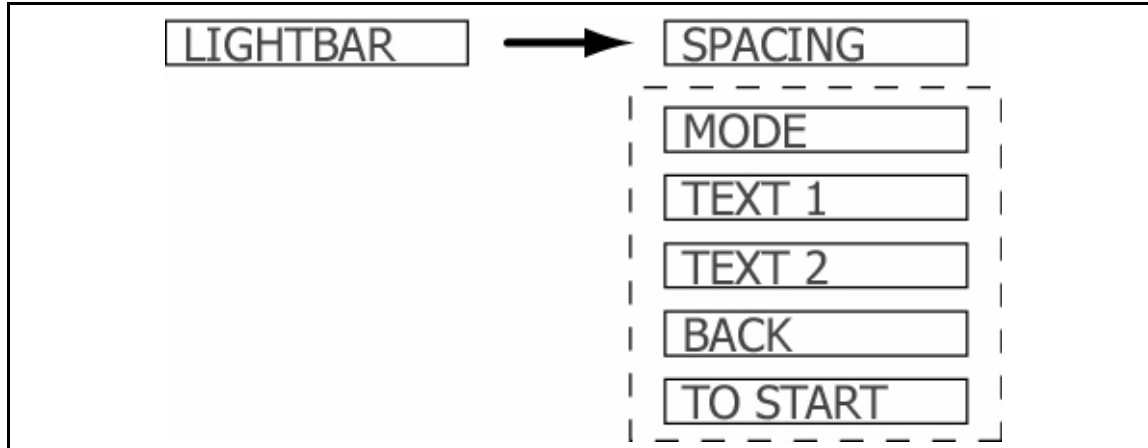


Figure 19: The Lightbar Setup Flow

Setting Name	Default Value	Change at 1st Time Start up
Spacing	1.5 ft.	Optional
Mode	Vehicle	Optional
Text 1	X-Track Error	Optional
Text 2	Applied Area	Optional

Table 5: Lightbar Menu Item Default Settings

Spacing

The Spacing setting allows you to set the distance you would like a single light on the lightbar LEDs to represent.

To change the Spacing setting go to Lightbar setup and scroll until <SPACING> is displayed in the text window and press **Enter**. To increase the spacing distance press **UP**, to decrease the spacing press **Down**. Press the **Enter** key once the desired spacing is set. The Spacing range is 0.5 ft. to 9.5 ft., in 0.5' increments.

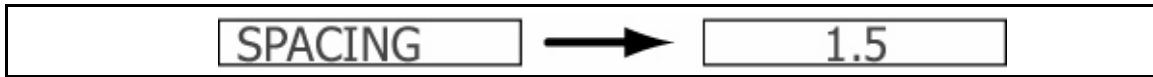


Figure 20: Setting the LED Spacing

Mode

The Mode setting defines how you will interpret the row of LED's. The center stack of Green LEDs can represent either the current guideline or the vehicle, see Table 6.

To change the Mode setting go to Lightbar setup and scroll until <MODE> is displayed in the text window, press **Enter**. Using **Up** or **Down**, scroll through the Mode pick list until the desired setting is displayed in the text window. Press the **Enter** key to save the setting and return to the <TEXT 1> menu item.

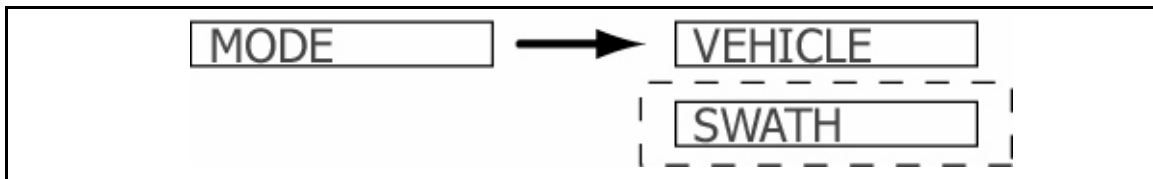


Figure 21: Setting the Mode

Setting	Description
Swath	When Display Mode is set to Swath, the center stack of Green LEDs will represent the current guideline. In this mode, steer the vehicle to bring the moving LED back to center
Vehicle	When Display Mode is set to Vehicle, the center stack of Green LEDs will represent the vehicles position. In this mode, steer the vehicle to bring the center lights towards the moving LED.

Table 6: Display Mode Settings

Text 1

The Text 1 setting allows you to select a text message from a set of predetermined guidance information messages. These messages will be displayed in the lightbar text window during guidance operations. A maximum of two text messages can be displayed.

To set the Text 1 setting go Lightbar setup and scroll using **Up** or **Down** until <TEXT 1> is displayed in the text window, press **Enter**. Using **Up** or **Down** scroll through the Text 1 pick list until the desired message is displayed in the text window. Press **Enter** to save the setting and advance to the <TEXT 2> menu item.

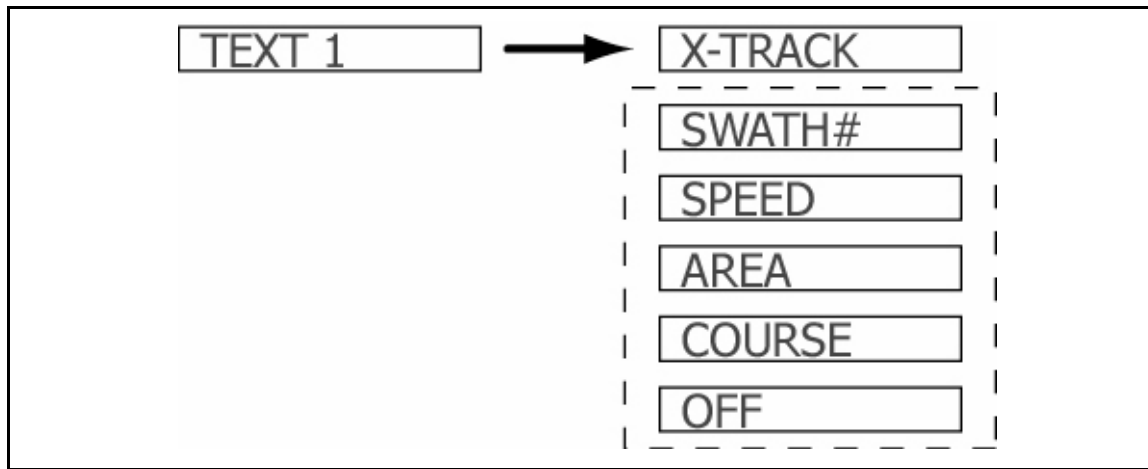


Figure 22: Selecting the Text 1 Message

Message	Description
X-Track	Displays the error (in distance) between the current guideline and the vehicle position.
Swath #	Displays the current guideline number.
Ground Speed	Displays the vehicle ground speed.
Area Applied	Displays the amount of area covered, sprayed or spread in acres or hectares.
COG	Course on Ground, displays the vehicle heading in degrees.
Off	When Off is selected no message will be displayed in this message slot.

Table 7: Text 1 Options

Text 2

The Text 2 setting allows you to select a text message from a set of predetermined guidance information messages. These messages will be displayed in the lightbar text window during guidance operations.

To set the Text 2 setting go Lightbar setup and scroll using **Up** or **Down** until <TEXT 2> is displayed in the text window, press **Enter**. Using **Up** or **Down** scroll through the Text 2 pick list until the desired message is displayed in the text window. Press **Enter** to save the setting and return to the Lightbar setup menu.

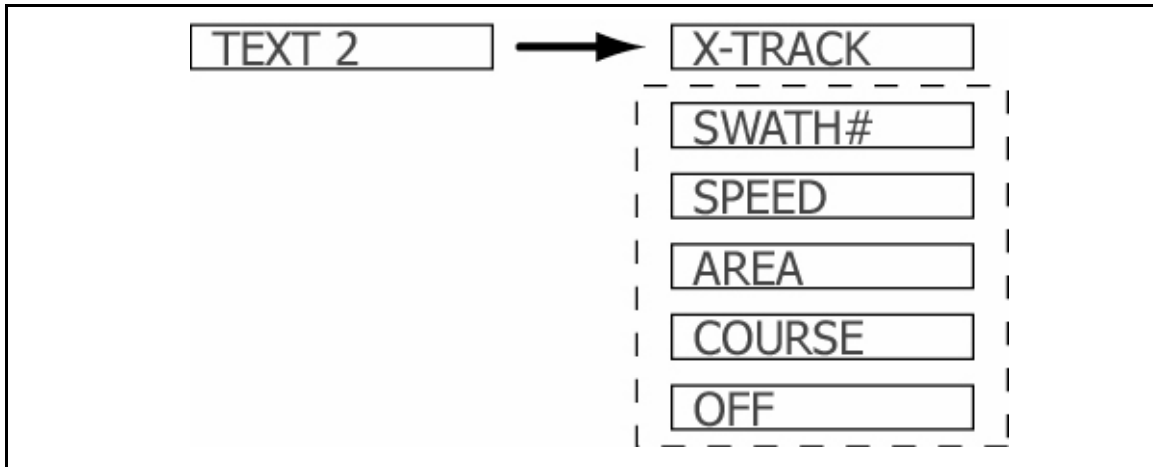


Figure 23: Selecting the Text 2 Message

Message	Description
X-Track	Displays the error (in distance) between the current guideline and the vehicle position.
Swath #	Displays the current guideline number.
Ground Speed	Displays the vehicle ground speed.
Area Applied	Displays the amount of area covered, sprayed or spread in acres or hectares.
COG	Course on Ground, displays the vehicle heading in degrees.
Off	When Off is selected no message will be displayed in this message slot.

Table 8: Text 2 Message Options

System Setup

System setup allows you to configure settings that effect the entire CenterLine product. There are only two settings, Units and Language (Table 9).

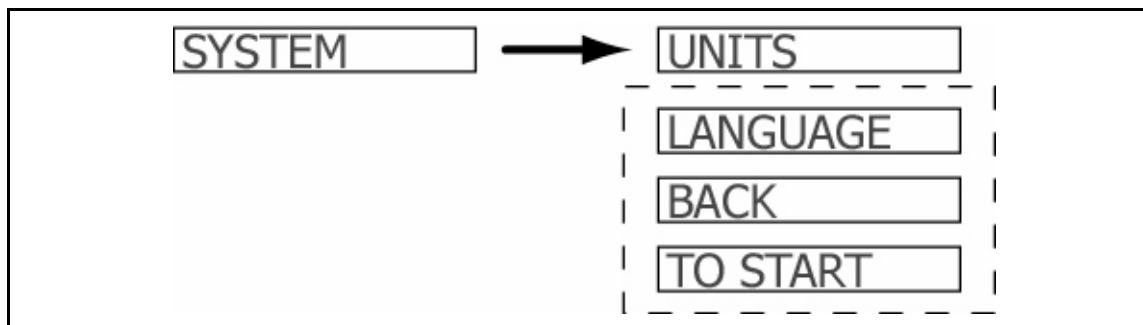


Figure 24: System Setup

Setting Name	Default Value	Change at 1st Time Start Up
Unit	US	Optional
Language	English	Optional

Table 9: System Menu Item Default Settings

Units

System Units allows you to select between US and Metric units (Table 10).

To change the system units, enter System Setup and scroll through the sub-menu list until <UNITS> appears in the text window, press **Enter**. Next scroll between the two units choices, <METRIC> or <US>. When the desired unit is displayed press the **Enter** key. The software should bring you back to <UNITS>.

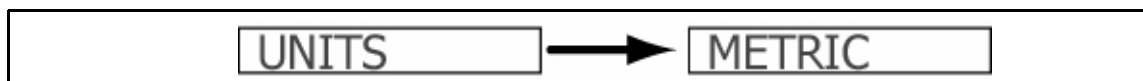


Figure 25: Setting System Units

Pick List	Description
US	All units will be entered and displayed in Feet, Miles, Acres and US volumes. This is the default setting.
Metric	All units will be entered and displayed in Meters, Kilometers, Hectare and Metric volumes.

Table 10: The Unit Menu Item Settings

Language

CenterLine comes pre-loaded with several languages. To change the system language, enter System Setup and scroll through the sub-menu list until <LANGUAGE> appears in the text window, press **Enter**. Next scroll to the desired language using **Up** or **Down**. When the desired language is displayed press the **Enter** key. The software should bring you back to <LANGUAGE>

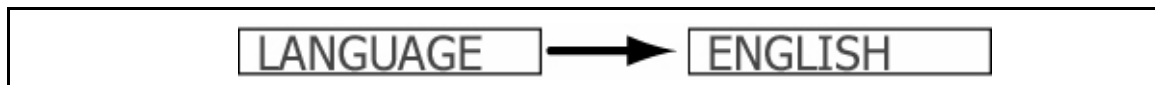


Figure 26: Setting the System Language

CenterLine Setup Flow Diagram

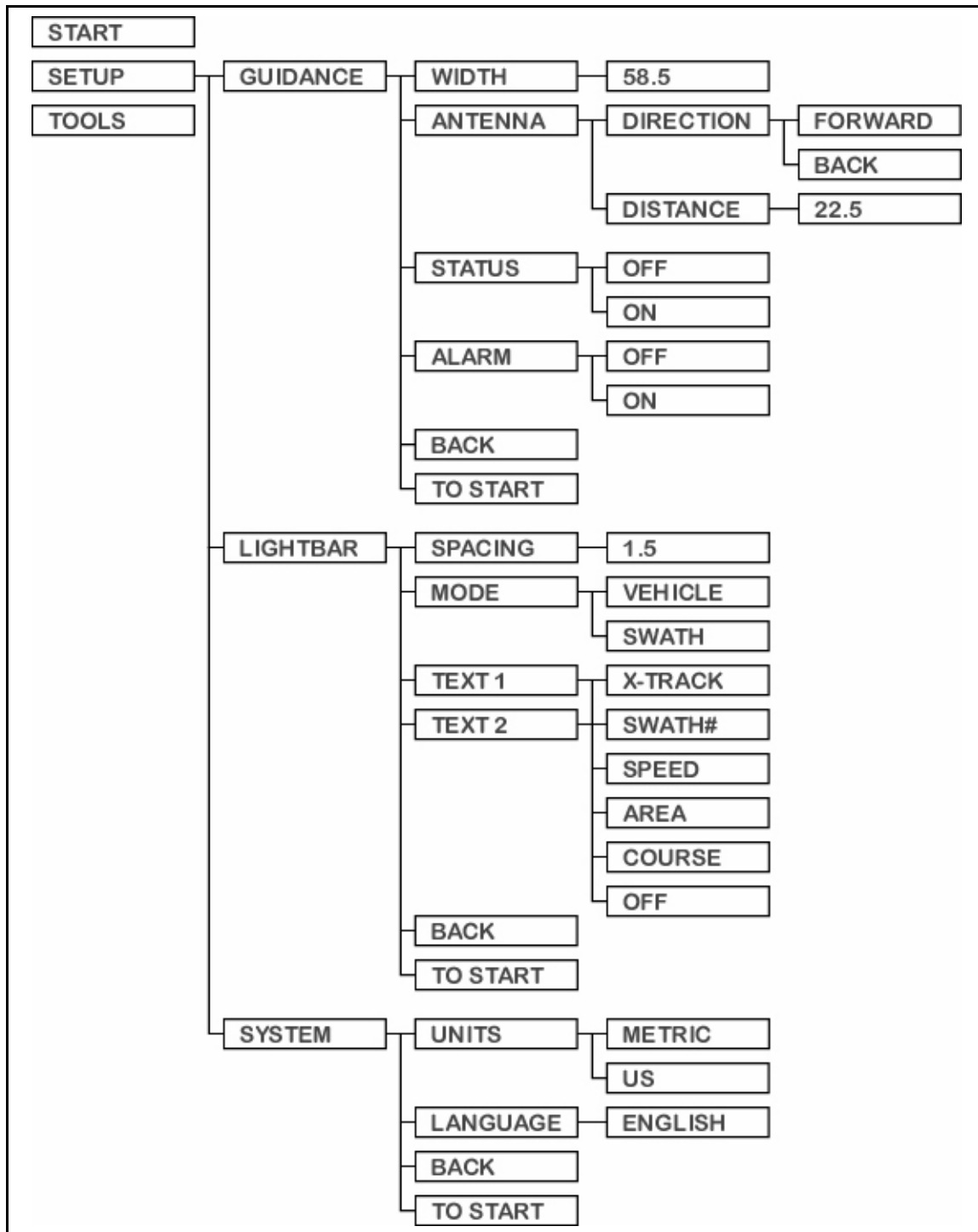


Figure 27: CenterLine Setup Flow Diagram

Tools

The Tools menu is intended to provide some basic system diagnostics. Tools contains two diagnostic tools, Receiver and Lightbar (see Table 11).

To access Tools from the Setup menu, scroll until the text window displays <TOOLS>, press **Enter**. <RECEIVER> should be displayed in the text window. Use **Up** or **Down** to scroll through the Tools menu.

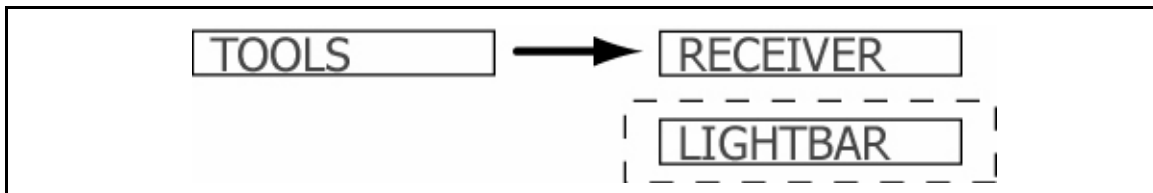


Figure 28: The Tools Menu Flow

Menu Item	Description
Receiver	Allows you to check status of a connected GPS receiver.
Lightbar	Allows you to test the functionality of the CenterLine Lightbar LEDs and text window.

Table 11: Tools Menu Items

Receiver

The Receiver diagnostic test will query the attached GPS receiver and return its current configuration and status. This information will be displayed in the text window on the lightbar.

To start the Receiver check go to Tools menu and scroll until <RECEIVER> is displayed in the text window, press **Enter**. The lightbar will display the following diagnostic message sequence in Table 12.

Diagnostic	Description
GPS Status	Returns Yes if the lightbar is receiving GPS data from the receiver. Returns NO if the lightbar is not receiving GPS data. The text window message will appear as <GPS:YES> or <GPS:NO>.

Table 12: Receiver Diagnostic Messages

Diagnostic	Description
DGPS Status	Returns Yes if the lightbar is currently receiving differentially correct GPS positions. Returns No if the GPS positions are not differentially corrected. Text window messages will appear as <DGPS:YES> or <DGPS:NO>.
NMEA Strings	Returns the name of each NMEA string currently being sent from the receiver. As an example if the NMEA GPGGA string is being sent from the receiver to the CenterLine then the text window will display <GPGGA>.
Data Rate	Returns the current receiver data rate. This is typically 5 Hz. The rate will be displayed in the text window, e.g. <5 HZ> will be displayed for the 5 Hertz data rate.

Table 12: Receiver Diagnostic Messages

Lightbar

The Lightbar diagnostic test will initiate an illumination sequence of all of the LEDs and text window, followed by a brightness control sequence. This will allow you verify if all lights are working properly on the CenterLine lightbar.

To start the Lightbar check go to <TOOLS> and press **Enter**. Scroll with **Up** or **Down** until <LIGHT-BAR> is displayed in the text window, press **Enter**. The illumination sequence should start. When test is completed the lightbar will display <END>.

CenterLine Real-Time Operation

Starting Real-time Operation

This section assumes that you have read the setup section, “CenterLine Setup” on page 12 and have properly setup your CenterLine lightbar.

Start real-time operation by pressing **Enter** when <START> is displayed in the text window. The <START> menu item is at the highest menu level. You can jump to <START> easily from most menu levels by scrolling to <TO START> and pressing **Enter**. This will jump you to the <START> location from where ever you are in the menu structure (Figure 27).

Figure 29 is a flow diagram of the CenterLine real-time operation and menu.

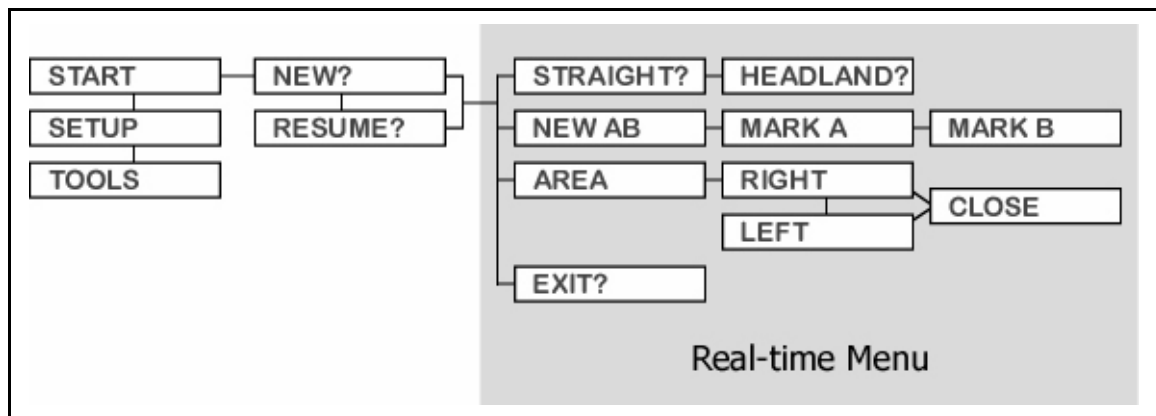


Figure 29: Real-Time Operation Flow Diagram

New? Resume?

Once **Enter** has been pressed at the <START> location, you will be prompted to start a new field or resume working in the current field. During real-time operation CenterLine stores the vehicle's trajectory data. This allows you to stop working in a field before you are finished and return at a later time and continue where you left off. Only the current field is stored.

Use **Up** or **Down** to scroll between the <NEW?> and <RESUME?> menu items. Selecting <NEW?> will clear the current field trajectory data and start a new field in memory. Selecting <RESUME?> will retain the current field trajectory data and allow you to start guidance using the existing data.

Real-time Operation

Once <NEW?> or <RESUME?> has been selected real-time guidance will begin. At this stage you should have your GPS receiver properly connected to the CenterLine lightbar and running. See “CenterLine Product Kits” on page 8 for diagrams on how your DGPS receiver should be connected. The default guidance mode will be Headland. While in Headland mode you will also be able to Mark A and B points for Parallel mode. The current guideline information is stored with the field’s trajectory data and is lost when <NEW?> is selected and retained when <RESUME?> is selected. Only information for a single guideline is stored.

Real-time Menu

During real-time operation you will have access to a real-time menu (Figure 29) that allows you to switch between guidance patterns, mark and A and B points for straight-line guidance, start a new A-B line and exit. The real-time menu is accessed by pressing **Up** or **Down** during guidance operation. Once either of these keys is pressed, the guidance messages displayed in the text window are replaced by the real-time menu (Figure 29). Use **Up** and **Down** to scroll through the menu and press **Enter** to select an item. The real-time menu will time out after 5 seconds has passed and no arrow keys have been pressed.

Marking A and B Locations

The Straight-line guidance mode requires a reference guideline to guide the vehicle along. Establishing a guideline involves marking two points along the reference guideline. To establish this reference guideline using the real-time menu, use **Up** or **Down** to scroll in the menu until <NEW AB?> is displayed in the lightbar (Figure 30). Press **Enter**. The menu item <MARK A> should now be displayed. Mark the A location by pressing **Enter**. The menu item <MARK B> will now be displayed. To mark the B location, press **Enter**. The reference guideline is now established and the lightbar should display <NEW AB?>.

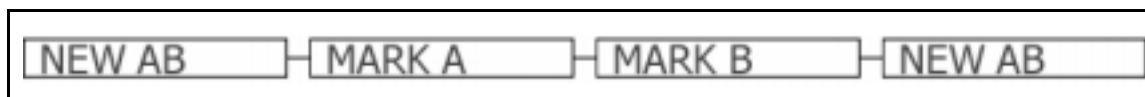


Figure 30: The Mark A Mark B Sequence

Switching between Guidance Modes

There may be situations where you will need to switch between guidance modes. Typically an operator will make one or more passes of the field’s headland area in the Headland guidance mode. While driving the headlands, the operator may mark the A and B guideline points that will be used when switching modes. Once the headlands are completed, the operator will switch to the Straight-line mode, and complete the field in a back and forth fashion.

To switch between guidance modes, scroll the real-time menu (Figure 29) until <HEADLAND> or <STRAIGHT> appear in the text window. If <STRAIGHT> is displayed, this indicates that the current mode is Straight-line guidance. Pressing **Enter** will switch you to the Headland guidance mode and the text window will display <HEADLAND>.

Area Determination

The area of the job or field you are working is important information. CenterLine allows you to determine the area of a field by driving the perimeter of the field. This is conveniently done while driving the first headland circuit in Headland mode.

To determine the area of a field, scroll the real-time menu until <AREA> is displayed (Figure 31). Press **Enter**. Lightbar will display <LEFT> or <RIGHT>. Select the side of your swath or implement that will be closest to the field boundary, using **Up** or **Down**. Press **Enter** when you want to start area calculation. The lightbar will display <CLOSE>. Press Enter when you want to close the boundary and determine the area. Pressing <CLOSE> will insert a line between the starting location and the end location and use that shape to determine area.

The area will be automatically determined when the vehicle drives within 4.5 meters (15 feet) of the starting point.

The bounded area will be displayed on the lightbar as a part of the guidance message stream for three minutes.

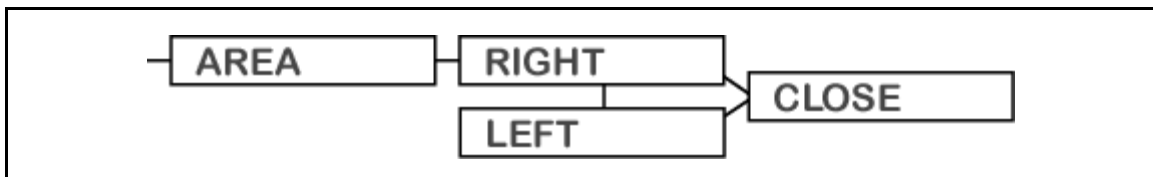


Figure 31: Area Determination Flow Diagram

Return to Point



CenterLine allows you to mark a point in the field that you will want to return to later in time. Typically the Return to Point feature is used to mark where you are stopping guidance and want to start in the same location and in the same direction at a later time. This Return to Point location is stored with the field's trajectory data and is lost when <NEW?> is selected and retained when <RESUME?> is selected.

There is a specific **Return to Point** key located on the wireless remote, see Figure 4. This key works in toggle fashion, press it once to mark the point, press it again to navigate back to the point. You can stop the navigation process by pressing **ESC**. Once **Return to Point** is pressed again (third time) the old location is replaced with the current vehicle location.

Exiting Real-time Operation

To exit guidance scroll with **Up** or **Down** in the real-time menu until <EXIT?> is displayed, (Figure 32), in the text window. Press **Enter**. This will stop real-time operation and take you back to the main menu.

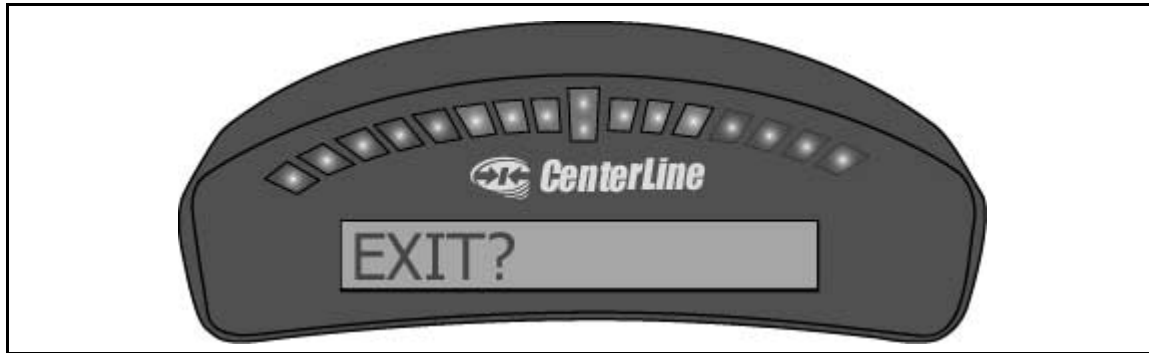


Figure 32: Exit in Display

Headland Guidance Operation

This section describes how to operate CenterLine in the Headland guidance mode. The Headland mode is selected when the operator wants to drive several circuits around the field boundary and be guided around all circuits that occur after the first circuit. Once several headland circuits have been completed, the operator then has the option of switching to the Straight-line mode. The Headland pattern is also selected when a user wants to do product application on terraced fields. In the Headland curved guidance pattern, the operator can pull along side any previous applied swath and be guided parallel to that swath.

To select the Headland Guidance mode, scroll with **Up** or **Down** in the real-time menu until <HEADLAND> or <STRAIGHT> is displayed on the lightbar. If <HEADLAND> is displayed then you are already in Headland mode. If <STRAIGHT> is displayed, press **Enter**. This will switch the guidance mode from Straight-line to Headland.

Reference Guideline

While operating in the Headland mode, the user has the option to mark the A and B points of the reference guideline used in the Straight-line Guidance mode. This feature makes it easier for the operator to Mark the A and B points while in Headland mode applying the headlands. It is always best to mark the A and B points for the Straight-line mode while driving along a straight edge of a field. More detail on how to establish a reference guideline see "Marking A and B Locations" on page 28.

The operator will remain in the Headland mode until the guidance mode is changed using the real-time menu, see "Switching between Guidance Modes" on page 28. The reference guideline is only required for the Straight-line mode.

Headland Pattern Example

In this example the operator wants to apply two headland passes to the field and then switch to Straight-line mode and apply the remainder of the field with straight-line parallel swath guidance. After the first headland circuit the operator will pull parallel to the first circuit swath and begin applying the second circuit while being guided parallel to the first circuit.

Figure 33 shows the operator just finishing the first headland circuit. Once the operator pulls along side the first headland circuit, curved guidance will automatically start. The operator will now be able to drive the second headland circuit parallel to the first circuit by following the guidance information displayed on the lightbar.

Figure 34 shows the operator being guided along side the initial headland circuit. The lightbar automatically supplies guidance information. For more details on how to interpret curved guidance information on the lightbar see "Headland Mode Lightbar Graphics" on page 35.

Figure 35 shows the operator continuing to drive around the second headland circuit.

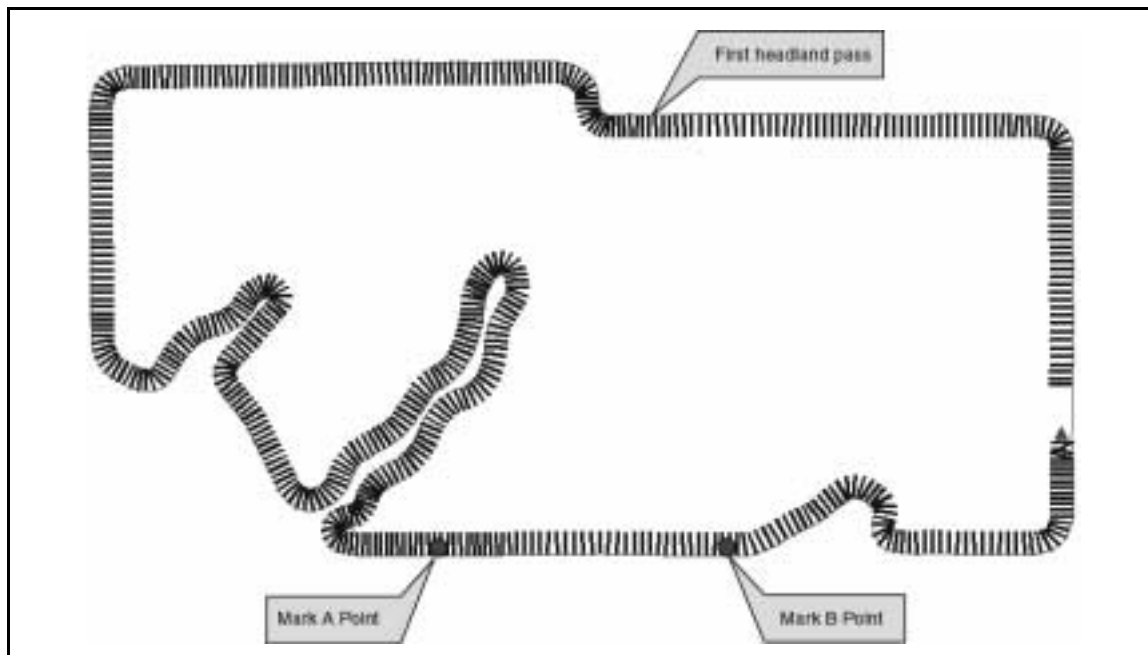


Figure 33: Completing the First Headland Circuit

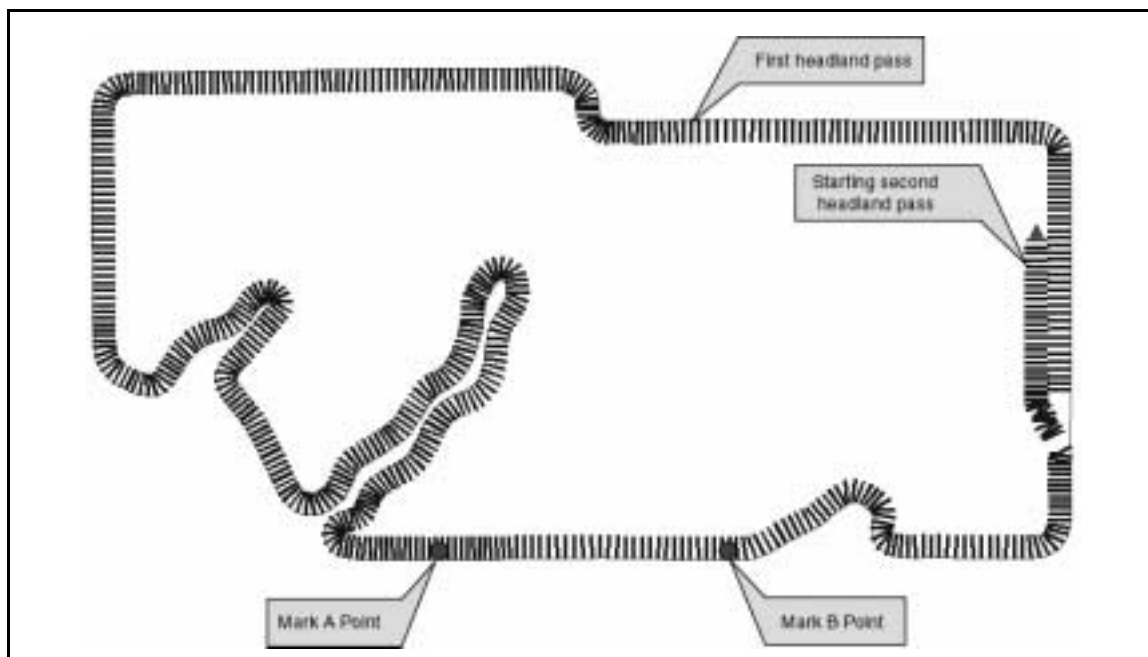


Figure 34: Starting the Second Headland Pass

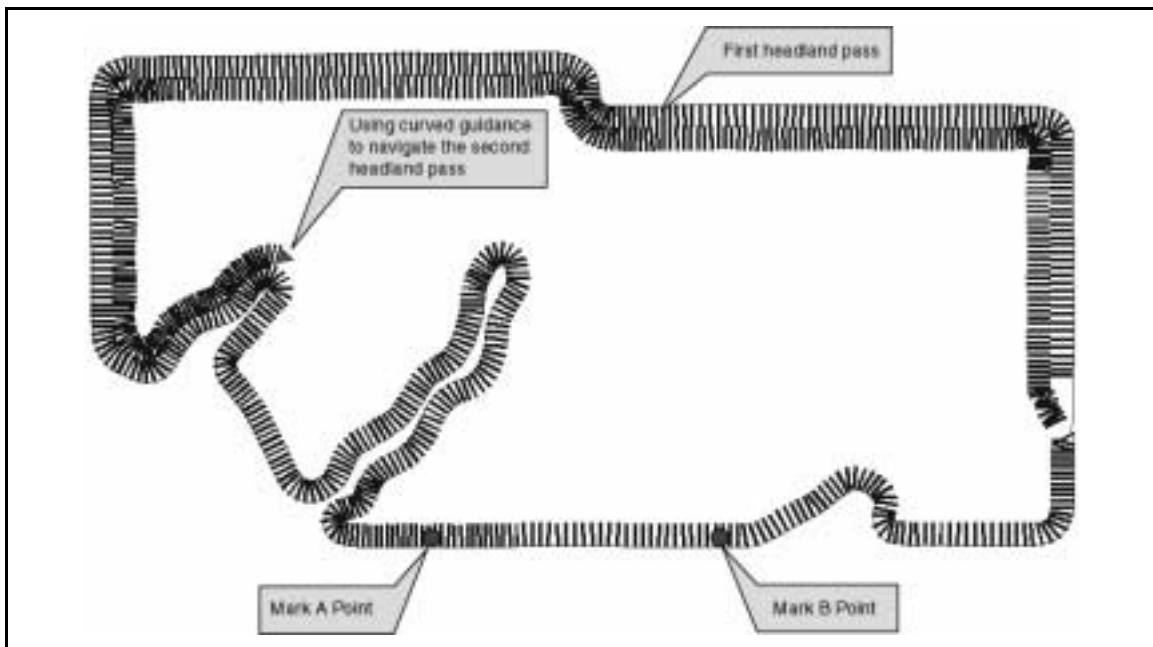


Figure 35: Continuing Around the Second Circuit.

Switching from Headland to Straight-line Mode

Once the operator has completed the desired number of headland circuits, two circuits in our current example, he can switch to the Straight-line Guidance mode and apply the remainder of the field in a straight back and forth fashion.

To switch from the Headland Pattern to another pattern see “Switching between Guidance Modes” on page 28. If the operator is being guided along a curved path when the pattern is switched, the lightbar will no longer guide them along the curved path.

If a reference guideline was established while in the Headland Guidance mode, CenterLine will automatically guide the vehicle along the closest parallel line as soon as the operator switches to the Straight-line mode. If a reference guideline was not established during the Headland mode, then the operator will need to mark the A B points. The lightbar will display the <MARK A> message, indicating that no reference guideline exists.

Figure 36 shows the operator applying product in Straight-line mode. Because a reference guideline was established during the curved guidance process, the user can immediately start straight-line guidance as soon as they press the guidance mode button.

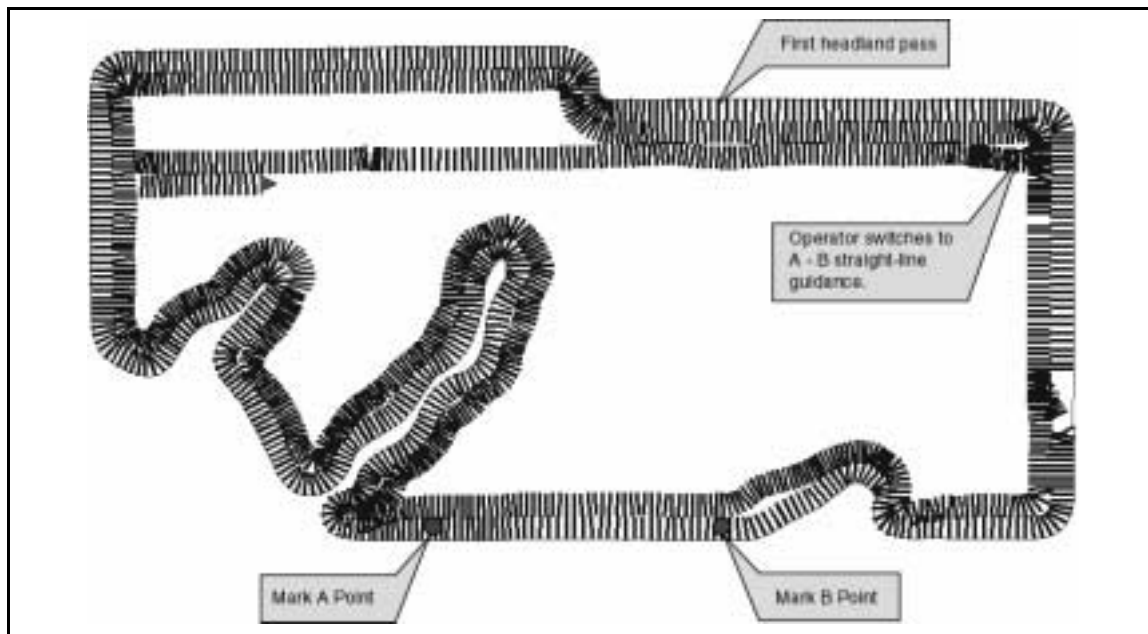


Figure 36: Switched from Headland Mode to Straight-line Mode.

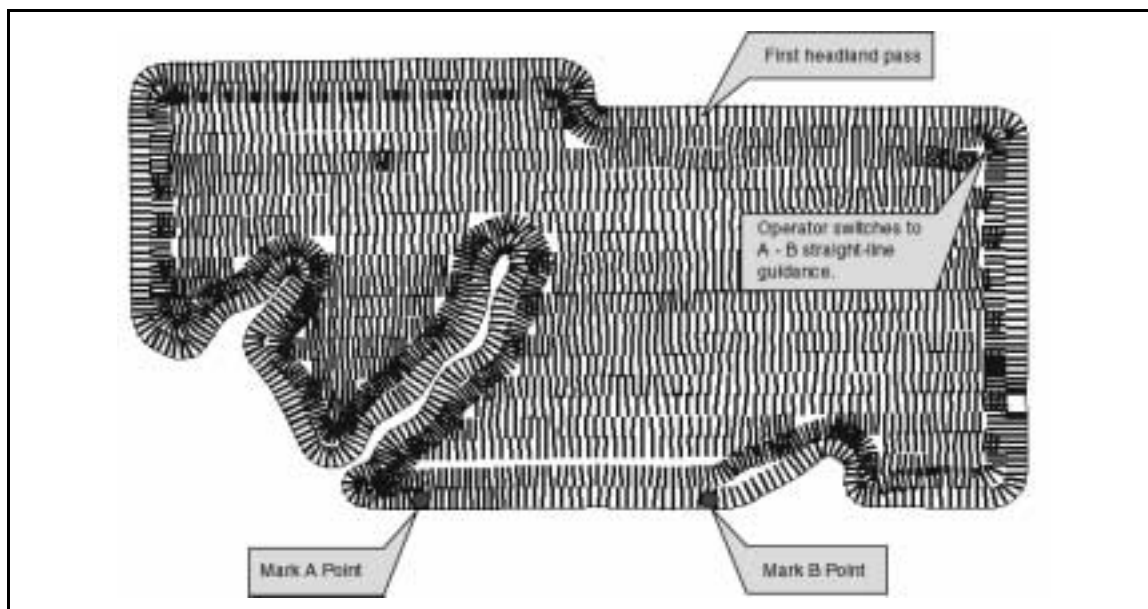


Figure 37: Completed Field Application

Figure 37 shows the completed field, notice there are several areas of the field where the operator turned spray off to avoid double application on previously applied areas.

Headland Mode Lightbar Graphics

CenterLine's Headland mode guidance technique employs a lightbar text display graphic that will aid the operator when navigating parallel to a curved swath. The X-Track LED functionality that is employed in Straight-line mode is also employed when driving in Headland mode.

A projected swath-path graphic is displayed in the text display area of the lightbar, see Figure 38. This projected path is made up of four horizontal bars. The bottom bar is closest to the vehicle and the top bar is the path furthest away. The width of the bars decrease as they move away from the vehicle, this adds a perspective view to the path ahead of the vehicle. The projected distance the first bar is away from the vehicle is based on the vehicle speed. The lightbar in Figure 38 informs the user to drive straight, and there are no turns approaching. In Figure 39 the lightbar indicates the vehicle is approaching a turn to the right. The X-Track LEDs indicate that the vehicle is slightly to the right of the guideline. Lightbar X-Track LEDs were set up in Swath mode, therefore the user will need to correct to the left to get back on line. The X-Track LEDs do not provide any information relating to the curved path ahead of the vehicle, they only indicate where the vehicle is with respect to the guideline at the current vehicle location.

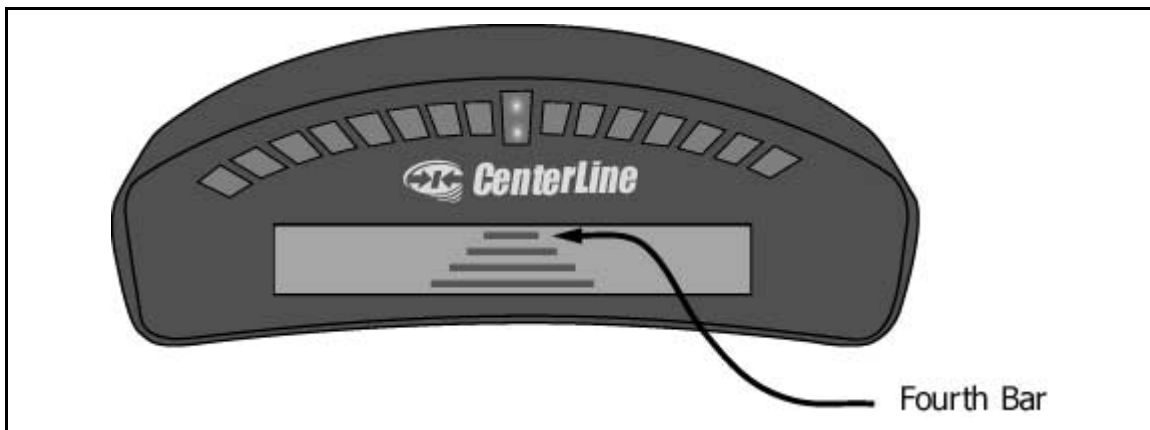


Figure 38: Curved Guidance Lightbar Graphics

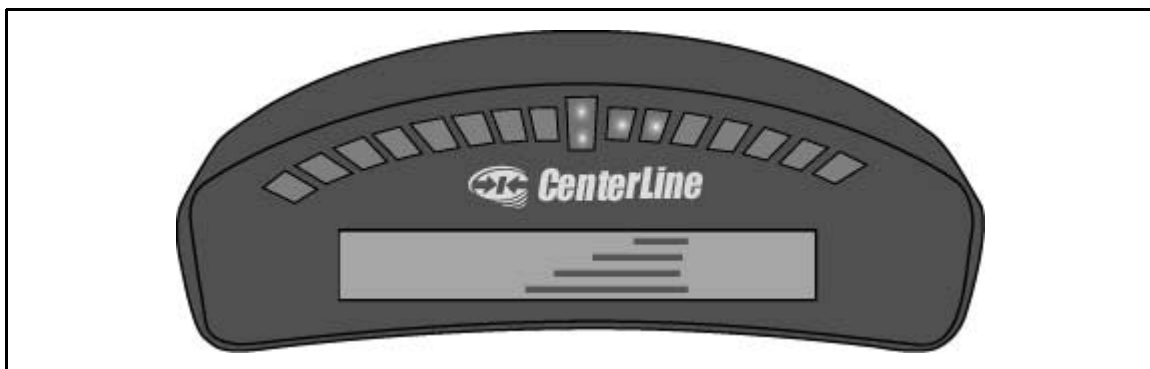


Figure 39: Right-Hand Turn Ahead

Straight-line Guidance Operation

The Straight-line guidance mode will provide vehicle guidance along straight lines based off a reference guideline. The first step is to establish the reference guideline. This reference guideline is used to calculate all other parallel guidelines. See “Marking A and B Locations” on page 28 for more detail on how to establish a reference guideline.

To mark the initial point A, begin driving along the first swath path, typically this would be along a straight edge of a field boundary. While the vehicle is driving along the initial swath, the lightbar will display <MARK A>. Once the center of the vehicle is over the A location, press **Enter**, this will establish the guideline point A.

The lightbar will now display <MARK B>. The next step is to establish guideline point B. To establish guideline point B press **Enter** when the center of the vehicle is over the Mark B location. This establishes the reference guideline. The lightbar will begin displaying LED cross-track guidance information as well as any user selected messages defined in Lightbar setup.

Once the reference guideline is established, the operator can begin driving straight-line guidance. The CenterLine software will detect which guideline is closest to the centerline of the vehicle and provide guide information with respect to that line. As the vehicle works its way across the field, (Figure 40), new guidelines parallel to the reference guideline are established based on the swath width value entered in Guidance setup.

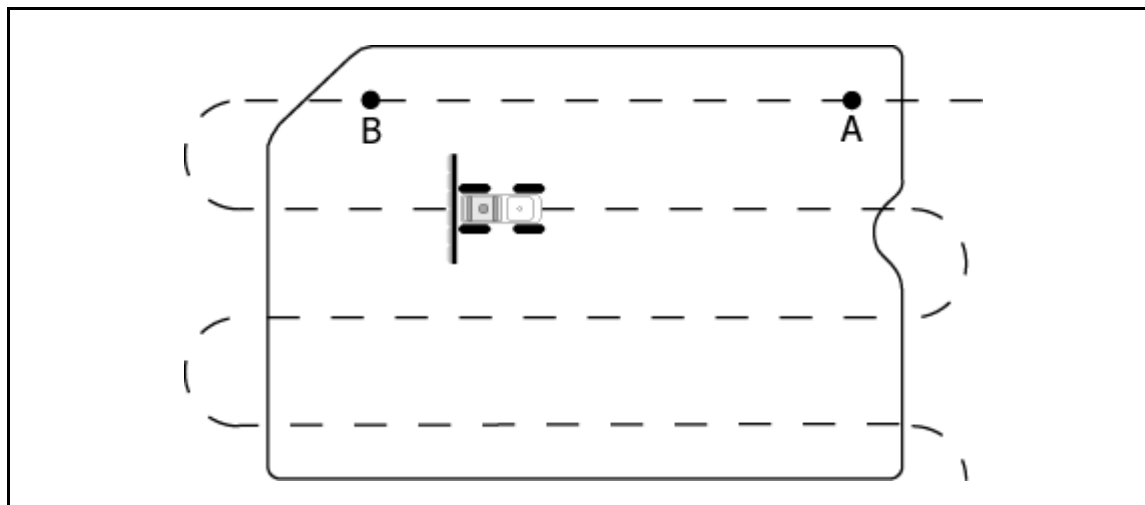


Figure 40: Working a Field in the Straight-line Guidance Mode

Applied Area Detection

CenterLine allows you to detect when the vehicle has entered a previously applied area. To use applied area detection the Lightbar Setup - Alarm menu field needs to be setup prior to starting guidance. See “Alarm” on page 17 of this User Guide for more details on how to set up this menu field.

Detecting A Previously Applied Area

Figure 41 shows how previously applied area detection works. As the vehicle enters a previously applied area, the lightbar displays the message APPLIED. If the vehicle continues to apply product while driving in a previously applied area the console alarm will sound. If product application is turned off while in a previously applied area the alarm will not sound. Once the vehicle exits the previously applied area the APPLIED message stops displaying.

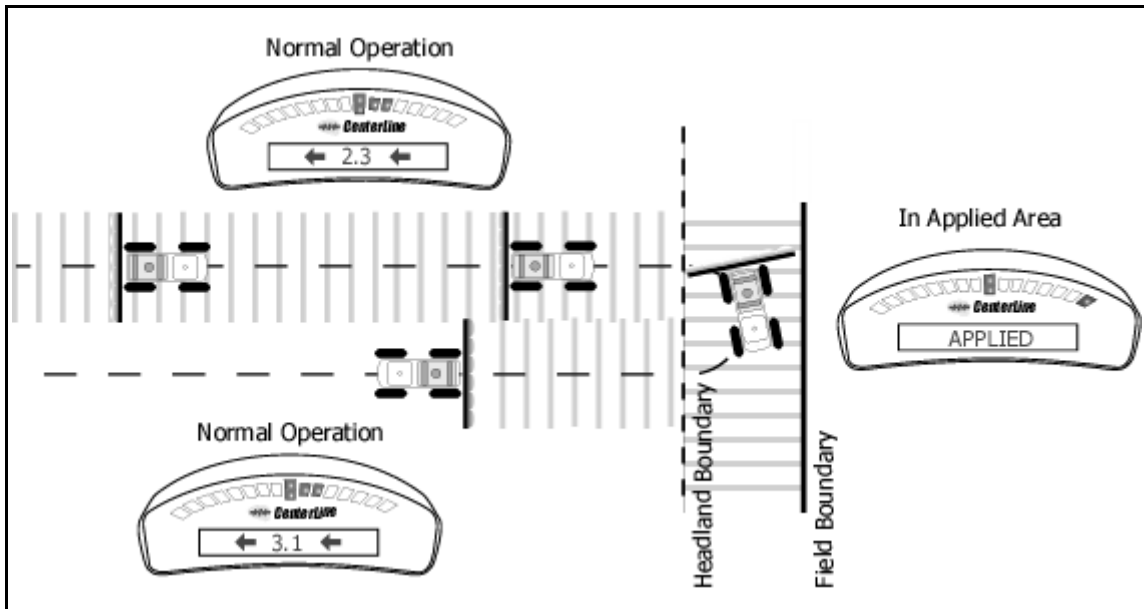


Figure 41: Applied Area Detection in Headlands

Detecting Neighboring Swath

Applied area detection will notify the user if the vehicle crosses into a previously applied neighboring swath. Figure 42 shows an Applied Area Overlap example. The vehicle can overlap up to 25% of the Swath Width with out being notified. Once the edge of the vehicle swath overlaps 25% or more into a neighboring swath the lightbar will display <APPLIED>. The alarm will sound only if product application continues.

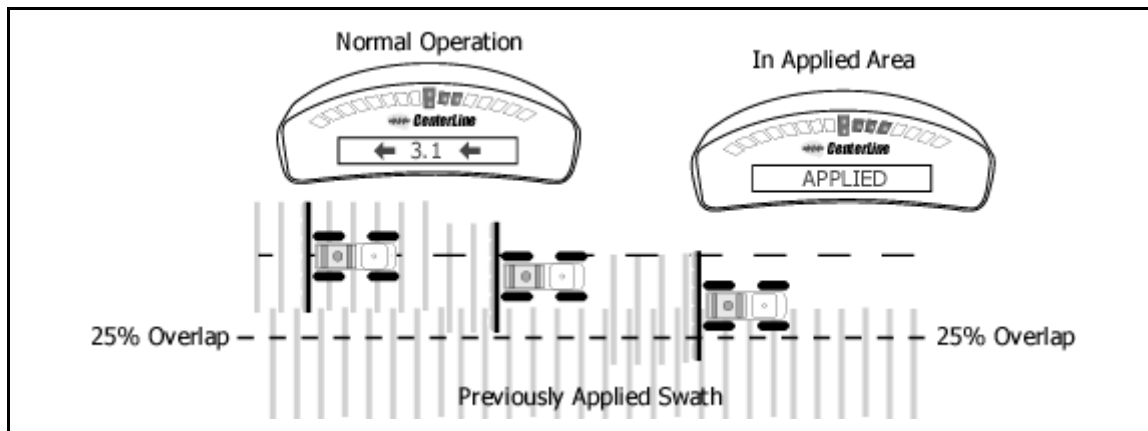


Figure 42: Applied Area Overlap in Neighboring Swath

Lightbar Index

The CenterLine lightbar is capable of displaying a considerable amount of information to the user. This information can be represented as text in the display window, illuminated cross track LEDs or a combination of text and lights. Information displayed on the lightbar depends on both user defined settings and system warnings not controlled by the user. Table 13 describes each possible lightbar state and possible information that could be displayed.

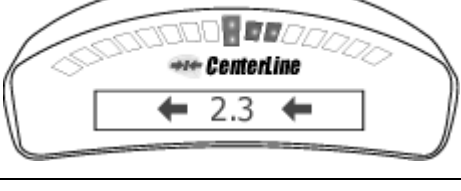
Lightbar State	Description
	Mark A: Displayed when establishing the guidance point A of the reference guideline.
	Mark B: Displayed when establishing the guidance point B of the reference guideline.
	Swath #: A user selected lightbar message. When not on the initial guideline the first character is either L or R for Left and Right of the initial guideline. The number identifies how many lines left or right of the initial guideline.
	X-Track Error: A user defined lightbar message. This cross track error message is displayed when the vehicle is on the guideline and there is no error.
	X-Track Error: A user defined lightbar message. In this example the operator should steer to the left 2.3 ft. (Assuming the system unit is set to US and Lightbar is set to Swath mode.)

Table 13: CenterLine Lightbar Index

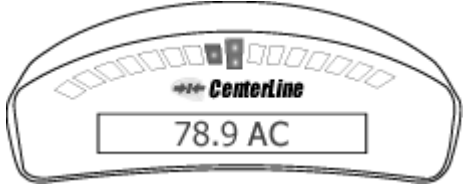
Lightbar State	Description
	Ground Speed: A user defined lightbar message indicating the vehicle speed in Miles per Hour (MPH). System unit is set to US.
	Ground Speed: A user defined lightbar message indicating the vehicle speed in Kilometers per Hour (KPH). System unit is set to Metric.
	Course on Ground (COG): A user defined lightbar message indicating the vehicles heading in degrees 0 to 359. The example to the left indicates the vehicle's course on the ground is due South (180 degrees).
	Area Applied: A user defined lightbar message indicating the current amount of area applied in Acres. System unit set to US.
	Area Applied: A user defined lightbar message indicating the current amount of area applied in Hectares. System unit set to Metric.
	Applied Area Detection: This message is displayed when the vehicle is with in a previously applied area. Note the Red stop lights are illuminated. At this point an alarm should sound. See "Applied Area Detection" on page 37.

Table 13: CenterLine Lightbar Index

Lightbar State	Description
	Curved guidance information graphics. The four horizontal bars in the text display represent a perspective view of the swath ahead of the vehicle. The bars will skew left or right to represent the curved path ahead.
	Mapping Boundary: This message is displayed when the user is mapping the field boundary. The arrow symbol on the left indicates the field boundary is on the left side of the vehicle.
	Mapping Boundary: This message is displayed when the user is mapping the field boundary. The arrow symbol on the right indicates the field boundary is on the right side of the vehicle.
	System Warning: The message is displayed when there is loss of differential GPS corrections. Guidance calculations are stopped until differential corrections resume.
	System Warning: This message is displayed when there is a complete loss of GPS signal to the GPS receiver or Smartpad. Guidance calculations are stopped until DGPS signal resumes.
	Lightbar Version Message: This message is displayed when the user starts up CenterLine or runs the Lightbar Test. This number will vary and is based on lightbar version and model.

Table 13: CenterLine Lightbar Index

