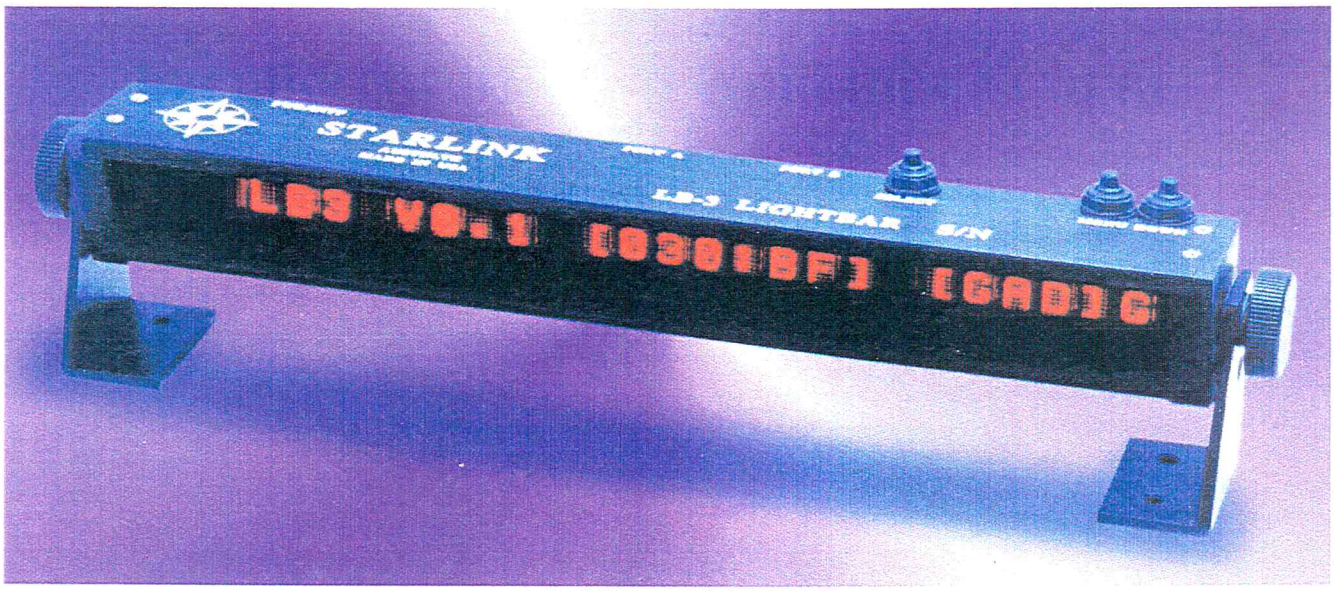
LB-3 Lightbar
Parallel Swath Path Guidance System



User's Manual
Version 1.3
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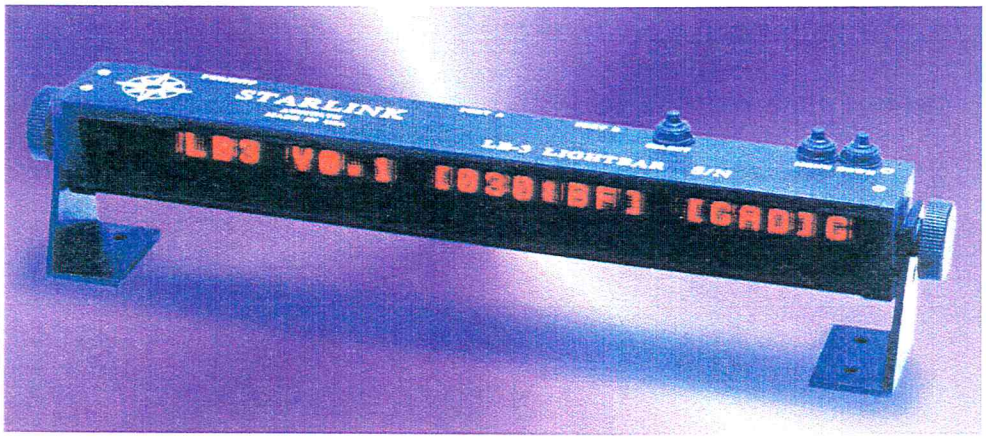
Table of Contents

STARLINK

LB-3

Swath Path Guidance System



The Starlink LB-3 GPS Guidance Lightbar connects directly to a GPS receiver and provides parallel swath guidance. No other computer or hardware is required. The lightbar's internal guidance computer receives the serial GPS position data and displays a steering indicator. The user may select either English or Metric System to display speed and distance.

Swath type and width are set up via the built-in menu interface. Just mark the endpoints of the first swath and the LB-3 calculates the remaining parameters.

Both the offset and directional errors are displayed graphically. You know how far right or left from your intended path you are and what your direction of travel is with respect to that path. Staying in the right spot couldn't be easier.

DGPS receiver status is available at the push of a button. The LB-3 monitors the GPS receiver mode, accuracy (HDOP), and the DGPS age of data. If a problem is detected, a warning indicator is shown on all displays.

The LB-3 can work in parallel with your existing equipment. It only needs to be connected to the GPS position data output of the GPS receiver.

The user interface is friendly and easy to use. Only three buttons are used for the control and selection of the LB-3 options. These buttons are located on top of the LB-3 and can be remotely wired to a flight stick or dash control.

Display data screens include: Swath Guidance Indicator, DGPS Receiver Status, Ground Speed and Course Over Ground, GPS Time, Swath Type, Swath Width, Baud Rate, and Serial Data.

See the LB-3 specification sheet in this manual for a more detailed description.

Swathing Made Easy

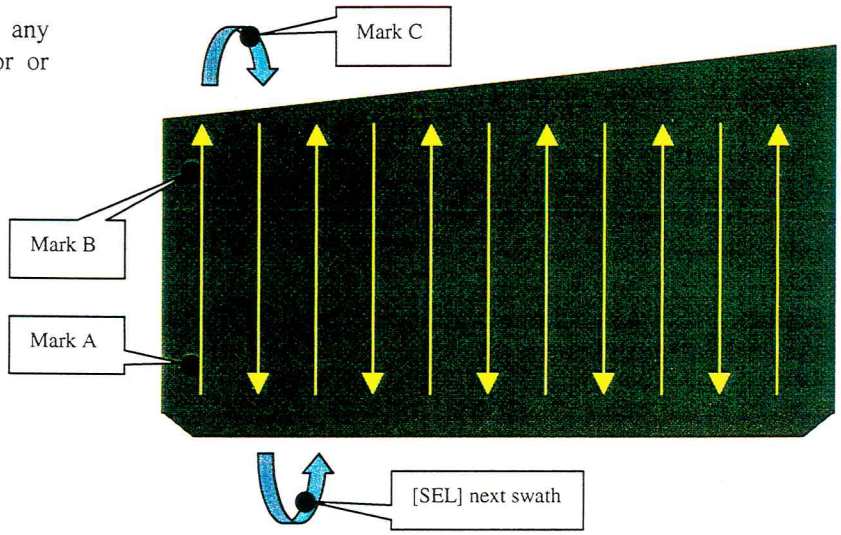
The LB-3 provides three types of swath patterns, Back&Forth, Squeeze, and RaceTrack. Each pattern allows you to cover the outside perimeter of the field prior to swathing. One pattern may work better than another due to the shape of the field, or the length of the turns you wish to make.

The **BACK&FORTH** pattern works well on any field, regardless of shape, provided your tractor or airplane is capable of making fairly sharp turns.

Marks A and B must represent a straight line parallel to the remaining swaths. Make sure you have a good view of the sky and the lightbar shows NO alarm conditions.

Mark C is made after you've completed the first swath and are moving in the direction of the remaining swaths (right in this case).

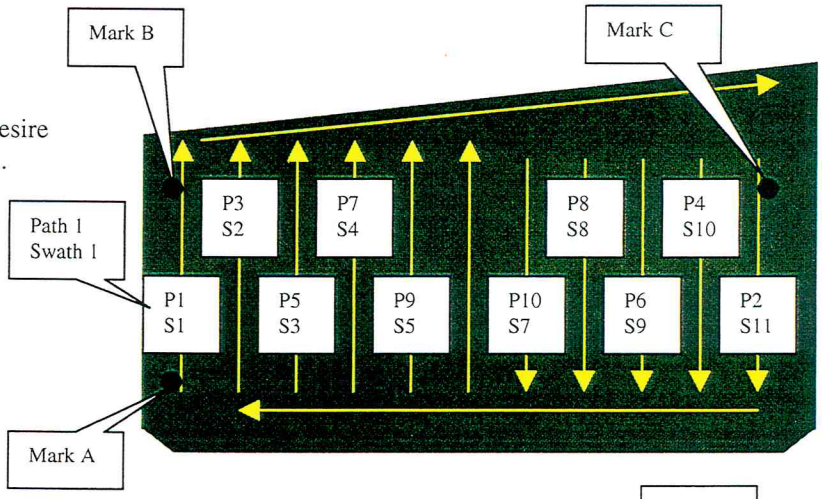
The [SEL] and [DOWN] buttons are then used to choose the next swath you want to run. Swaths are numbered in order but you can run any swath you want at any time and in any direction.



The **SQUEEZE** pattern works best when you desire to continually reduce the turn size within the field.

Marks A and B must represent a straight line parallel to the remaining swaths. Make sure you have a good view of the sky and the lightbar shows NO alarm conditions.

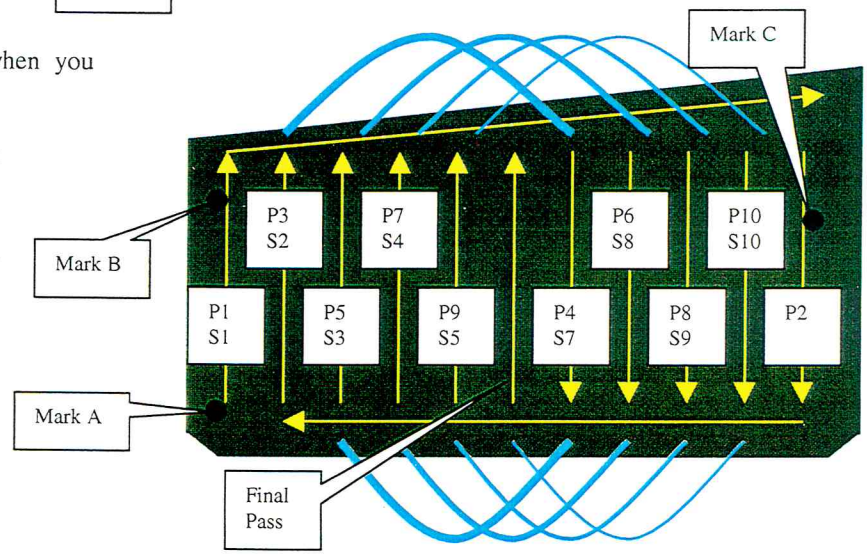
Mark C is made when you are located somewhere along the swath path at the opposite end of swath 1.



The **RACETRACK** pattern works best when you desire a constant turn size over half the field.

Marks A and B must represent a straight line parallel to the remaining swaths. Make sure you have a good view of the sky and the lightbar shows NO alarm conditions.

Mark C is made when you are located somewhere along the swath path at the opposite end of swath 1.



INSTALLING THE LIGHTBAR

1. Place yourself in your usual driving position.

2. Choose an area to mount the LB-3 lightbar where you won't have to look away from your normal driving view. Secure the LB-3 through the holes provided in the support gimbals. To minimize glare, adjust the viewing angle by loosening and tightening the knobs on each side of the lightbar.

GETTING POWER TO THE LIGHTBAR

1. Power can be provided two ways, either through a separate cable connected to the seven (7) pin PWR/INTF port, or directly from the GPS receiver into Port A.

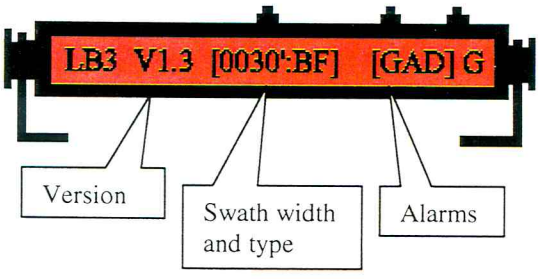
> **If you are wiring the power cable, disconnect the connector from the LB-3 and connect the red wire to +12 VOLTS and the black wire to Ground.**
>
> **If you are using a cigarette lighter power adapter, make sure that your vehicle has a negative ground system, then plug in the power.**

2. Connect the LB-3 Port A interface cable to the GPS receiver.

3. Connect power to the LB-3 as needed.

THE LB-3 IS NOW "LIT UP"

1. The first display screen should look something like this:

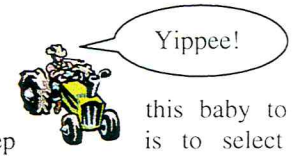


2. Use the [SEL] and [DOWN] buttons on the top of the bar to adjust the display brightness.

3. If the receiver is ready but you see the warning message !NO GPS POSITION DATA! flashing on the screen, you'll need to make sure the LB-3 is configured properly and the GPS receiver is sending the correct messages. Refer to 'Configuring the LB-3' on page 7 and then hurry back here so we can begin having fun with Swathing.

> **The GPS receiver MUST be tracking satellites and detect a good beacon signal before you can continue. If this is the first time your GPS receiver is being powered up, it may take 15 minutes before the receiver is ready. You see it has to download Almanac information from every satellite so it knows whose whom in space. But it only needs to get acquainted with the satellites one time, after that the receiver should be ready in less than 30 seconds. When ready, the Alarms [GAD] on the initial display screen will be replaced with dashes [- - -] indicating you are ready to begin operation.**

THE LIGHTBAR AND THE RECEIVER ARE COMMUNICATING. . . NOW WHAT?



1. Now we put this baby to the test. The next step is to select the Swath type, width, and the display units (either English or Metric)

Setting Swath Parameters

1. Press the [MENU] button to display the 'Configuration' screen.

2. Press [DOWN], to select the type of swath desired.

3. Press the [MENU] button to display the 'Swath Width:' screen. The [DOWN] button decreases the units by one, the [SEL] button increases the units by five.

4. Press the [MENU] button three times to display the 'Units:' screen. The [DOWN] button

selects FEET/MPH, the [SEL] button selects METERS/KPH.

5. Press the [MENU] button to return to the initialization screen.

ALARMS

1. System performance can be adversely affected under certain operating conditions. Loss of differential signal and/or poor satellite geometry can cause the accuracy of the system to fall below that required for precision guidance. Should conditions exist which cause the accuracy to lessen, the user is notified with one of three possible alarm conditions [**G**, **A**, or **D**]. These alarms are displayed on the far right side of each screen.

2. [**GPS**] The system is not operating in three-dimensional Differential GPS mode. At least four (4) usable satellites, five (5) or more is preferable, must be communicating with the receiver along with a valid correction signal in order to operate in 3-dimensional DGPS mode. [**Accuracy**] The Horizontal Dilution of Precision (HDOP) is greater than two (2.0). HDOP is a fancy term for approximating the error in your position solution caused by poor satellite geometry. Simply stated, it usually means that you do not have enough satellites in view (should have a minimum of 5) or the antenna's view of the sky is partially blocked. [**Data**] The age of satellite correction data has exceeded 15 seconds. Your GPS receiver is not receiving the correction signal. It may be tuned to the wrong frequency, the service provider may be out of range or unavailable, or there may be some electrical noise interfering with the signal.

3. The system should never be used when alarms are present. Many times the alarm conditions are only temporary and will clear up by themselves. Should alarm conditions remain, refer to the troubleshooting section ['Darn Thing Still Ain't Working'] in this manual and the User's Manual supplied with your GPS receiver.

TO BEGIN YOUR FIRST SWATH

1. Make sure the GPS antenna has a good view of the sky and the system is operating with NO alarm conditions. Using a visible site as a point of reference, steer a straight line parallel to your intended swath paths as you mark your reference points A and B.

NOTE

It is extremely important that you set the 'A' and 'B' marks correctly. When setting these points, make sure that NO ALARM conditions exist and that the straight line drawn between A and B is actually PARALLEL to your desired swath lanes.

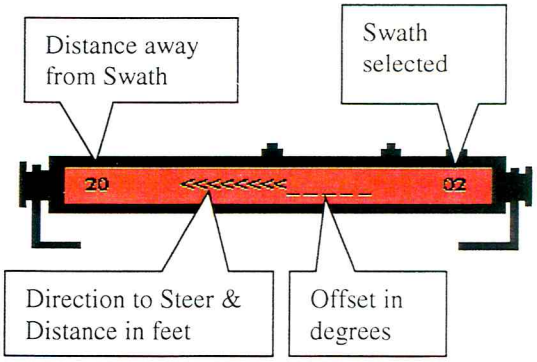
2. Press the [MENU] button until you see the "[SEL] Marks A" Display

3. When you are lined up on the first swath, press the [SEL] button to enter the "A" mark. '[SEL] Marks B' will now be displayed.

4. Continue to the end of the first swath path and press [SEL] to enter the "B" mark.

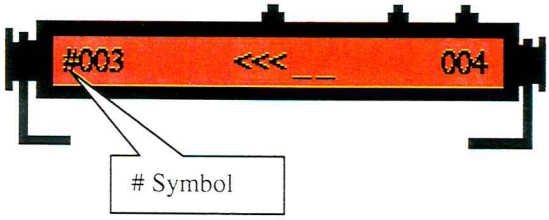
5. The 'C' mark is made depending on the type of swath you have selected. Refer to the appropriate diagram in the section titled 'Swathing Made Easy' on page 4.

6. Once you reach the end of a swath path, press the [SEL] button to advance to the next swath. (You can advance the swath at any time by pressing the [SEL] button. You can also select a lower numbered swath path by using the [DOWN] button).



6. Offset in feet indicates the direction you must steer to reach the swath path you have selected. Simply move in the direction of the arrows. The distance (feet or meters) to the selected swath is shown on the left side of the screen. You can also estimate your distance by

counting the number of arrows shown. The 'LB3 Specification' on page 10 details the significance of each arrow and degree offset.



8. A pound symbol (#) appears to the left of the distance number whenever you are positioned inside the 'A' and 'B' marks and within 10 feet, left or right, of your selected swath path. If you set the 'A' and 'B' marks at the beginning and end of the field, the # symbol can be used to tell you when to start and stop the spraying or seeding operation.

9. Offset in degrees provides you approximations of the angle in which you are approaching the selected swath. The number of dashes increases as your angle of approach to the selected swath increases. For example, if you were approaching the selected swath at a 90-degree angle, you would see the maximum number of dashes present. If however, you were paralleling the selected swath, the dashes would be minimum or none at all and your distance to the next swath would not change. If you turn away from the selected swath at a sharp angle, the number of dashes would again increase and of course your distance to the selected swath would increase. When used together, the distance indicator and offset dashes will help you judge your rate of approach to the selected swath. This provides you with the best indication of when to begin your turn onto the selected swath.

10. To enter new reference marks at the end of the current field or to change reference marks: Press [MENU] button to display '[SEL] Clears ABC Marks' and clear the current reference marks with the [SEL] button.

NOTE:

If your GPS receiver is outputting 10 navigation solutions per second, you may notice that as you move over bumps and dips in the field, the directional indicators will move rapidly back and forth. This is because the GPS antenna is moving from side to side and with 10 updates per second the receiver sees this as a change in direction. (This problem shows up more at lower speeds.) For better accuracy, do not chase the arrows but try to center the number of arrows across the display.

11. A little practice time with the menus and button controls of the LB-3 and you'll see how easy it is to steer a straight path.

12. The LB-3 automatically saves the user's configuration settings even when the unit is powered down. The next time you turn on the lightbar, the baud rate, swath type, swath width, and Metric or English parameters will be the same as they were the last time the unit was used. Even the 'A' and 'B' marks will remain the same unless they were cleared by the user prior to shutdown. This makes it easy for the operator to return to his last location should he need to shut down the system for any reason.

CONFIGURING THE LB-3

1. The first thing you have to do is make sure the LB-3 lightbar and GPS receiver are talking to each other at the same speed. This is actually the number of bits of data per second that is transferred between them (also known as the baud rate).

2. Press the [MENU] button until the 'Configuration' screen is displayed. Press the [DOWN] and then the [MENU] button twice to access the baud rates. Cycle through them using the [SEL] button. Choices are 4800, 9600, and 19200. The baud rate must match the serial port communications rate of your GPS receiver.

3. Once you've matched the baud rates, the receiver and lightbar will happily speak to each other and you are ready to begin.

DARNED THING STILL AIN'T WORKING

1. Check the LB-3 Port A interface cable and make sure that it is securely fastened. Is this cable going to the right port on the GPS receiver?

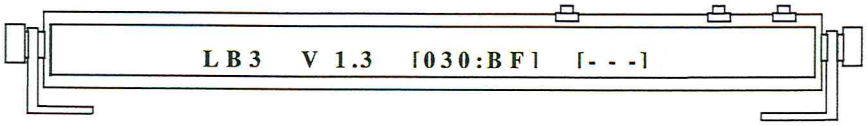
2. In order to operate properly, the LB-3 lightbar must receive two messages from the GPS receiver. These are National Marine Electronics Association (NMEA) messages known as GPGGA (GPS Fix Data) and either GPVTG (Course Over Ground and Speed) or GPRMC (GPS Transit Data). These messages are the serial port data strings that are displayed on the LB-3 in the 'Configuration' submenu. To view them, press [MENU] until the 'Configuration' screen is displayed. Follow the LB-3 Menu guide until the messages flash across the screen at a rate equal to the GPS receiver output (normally once per second).

3. Ensure the baud rate selected from the lightbar menu matches the GPS receiver output data rate.

4. Don't quit! Technical support is a toll free call away. Starlink engineers are available to assist you by calling 1-800-460-2167.

Satisfaction Guaranteed!!

LB-3 Lightbar Menu Screens



INITIALIZATION SCREEN **LB3 V1.3 [015:BF] [---]**

↳ [*Select*] increase or [*Down*] decrease to adjust display brightness

SWATH SETUP **[SEL]Marks A**

↳ [*Select*] Marks A

↳ [*Select*] Marks B, [*Menu*] Clears ABC Mark

↳ [*Select*] Marks C [*Menu*] Clears ABC Mark

↳ [*Select*] Offset Error (1ST screen if A,B,C marks set)

DGPS STATUS **D3x08 HDP: 01.0 BCN004 ***

↳ [*Down*] Displays SPD: 005.2 MPH COG: 240.0

↳ [*Menu*] Displays TIME: 22:48:00

CONFIGURATION **Configuration ***

↳ [*Down*] Swath Type: Back&Forth

↳ [*Down*] Race Track

↳ [*Down*] Squeeze

↳ [*Menu*] Swath Width:

↳ [*Select*] Increases width by 5

↳ [*Down*] Decreases width by 1:

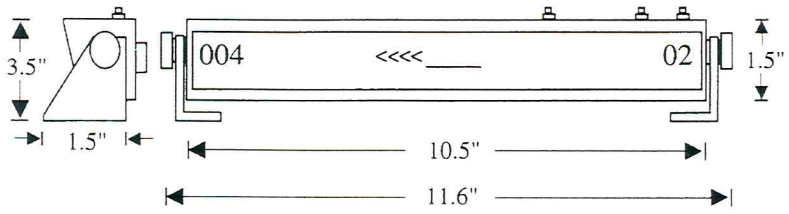
↳ [Menu] Selects and reconfigures baud rate (4800, 9600, or 19200)

↳ [*Menu*] Displays serial port data for diagnostics

↳ [*Menu*] Displays Metric/English select option

↳ [*Select & Down*] Selects units "Meters/KPH" or "Feet/MPH"

LB-3 Specifications



Lightbar Features

Interfacing	RS232 @ 4800, 9600, or 19200 baud
Message Types	$GPGGA and $GPVTG or $GPRMC
Operating Temperature	-40° to + 50°C
Display	Alphanumeric dot matrix LED
Offset in Feet	> > > Symbols set at 1, 2, 3, 4, 6, 8, 10, 20, and 40 feet
Offset in Degrees	_ _ _ Symbols set at 1, 2, 4, 6, 8, 10, 12, 20 and 40 degrees
Swath Types	Back & Forth, Squeeze, Race Track
Swath Widths	5 to 300 Feet (English) 5 to 99.9 Meters (Metric)

Port A GPS Serial Cable: DB9 Female

Pin	Description
1	Reserved
2	Serial GPS Data Input
3	Serial DNAV Control Output
4	Reserved
5	Ground
6	Reserved
7	Reserved
8	Reserved
9	Reserved

Port B Remote Switch: DB9 Female

Pin	Description
1	S1 [Down] Switch
2	Reserved
3	Reserved
4	S2 [Menu] Switch
5	Ground
6	Reserved
7	Reserved
8	Reserved
9	S3 [Select] Switch

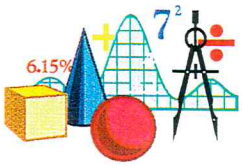
NOTE:
Port B remote switch wiring requires a Normally Open-Momentary Close switch connected to Pin 5 (ground). DO NOT connect switch to power supply ground.

Additional Features

- Standalone parallel swath guidance system.
- Connects directly to GPS receiver.
- Internal guidance computer
- Shows positional and directional error for easy to steer feedback.
- Shows DGPS receiver status.
- 10 position updates per second possible.
- Easy to use menu driven via 3 button user controls.
- Back and forth, race track, and squeeze patterns.
- Adjustable swath widths.
- Daylight readable with adjustable brightness.
- 24-character dot matrix LED alphanumeric display.
- Nonvolatile configuration memory. One time setup.
- External switch inputs.
- NMEA format RS232 interface.
- 10 to 32 VDC input range.
- Rugged aluminum enclosure.

Support

- High performance and reliability.
- Full one year parts and labor warranty.
- 48 hour repair turnaround.
- Made and serviced in the USA.
- Unbeatable technical support.



What's All This Rocket Scientist Satellite Stuff About?

Global Positioning System (GPS)

GPS is a satellite-based global navigation system created and operated by the United States Department of Defense (DOD). Originally intended solely to enhance military defense capabilities, GPS capabilities have expanded to provide highly accurate position and timing information for many civilian applications.

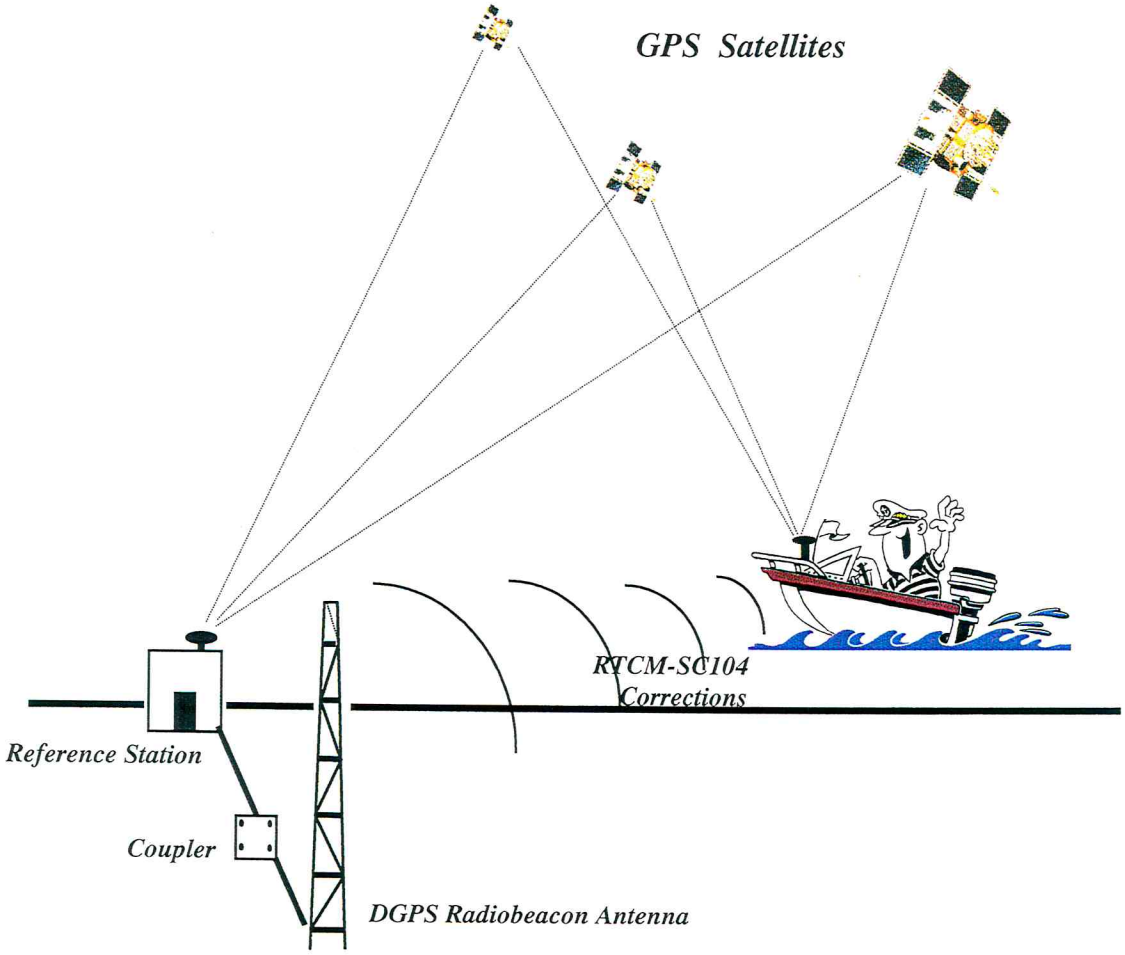
An in-depth study of GPS is required to fully understand it, but not to see how it works or appreciate what it can do for you. Simply stated, twenty four satellites in six orbital paths circle the earth twice each day at an inclination angle of approximately 55 degrees to the equator. This constellation of satellites continuously transmits coded positional and timing information at high frequencies in the 1500 Megahertz range. GPS receivers with antennas located in a position to clearly view the satellites, pick up these signals and use the coded information to calculate a position in an earth coordinate system.

GPS is the navigation system of choice for today and many years to come. While GPS is clearly the most accurate worldwide all-weather navigation system yet developed, it still can exhibit significant errors. GPS receivers determine their position by calculating the time it takes for the radio signals transmitted from each satellite to reach earth. It's that old "Distance = Rate x Time" equation. Radio waves travel at the speed of light (Rate). Time is determined using an ingenious code matching technique within the GPS receiver. With time determined, and the fact that the satellite's position is reported in each coded navigation message, by using a little trigonometry the receiver can determine its location on earth.

Position accuracy depends on the receiver's ability to accurately calculate the time it takes for each satellite signal to travel to earth. This is where the problem lies. There are primarily five sources of errors that can affect the receiver's calculation. These errors consist of (1) ionosphere and troposphere delays on the radio signal, (2) signal multi-path, (3) receiver clock biases, (4) orbital satellite (ephemeris) position errors, and (5) the intentional degradation of the satellite signal by the DOD. This intentional degradation of the signal is known as "Selective Availability" (SA) and is intended to prevent adversaries from exploiting highly accurate GPS signals and using them against the United States or its allies. SA accounts for the majority of the error budget. The combination of these errors in conjunction with poor satellite geometry can limit GPS accuracy to 100 meters 95% of the time and up to 300 meters 5% of the time. Fortunately, many of these errors can be reduced or eliminated through a technique known as "**Differential**."

Differential GPS (DGPS)

DGPS works by placing a high-performance GPS receiver (reference station) at a known location. Since the receiver knows its exact location, it can determine the errors in the satellite signals. It does this by measuring the ranges to each satellite using the signals received and comparing these measured ranges to the actual ranges calculated from its known position. The difference between the measured and calculated range is the total error. The error data for each tracked satellite is formatted into a correction message and transmitted to GPS users. The correction message format follows the standard established by the Radio Technical Commission for Maritime Services, Special Committee 104 (RTCM-SC104). These differential corrections are then applied to the GPS calculations, thus removing most of the satellite signal error and improving accuracy. The level of accuracy obtained is a function of the GPS receiver. Sophisticated receivers like the Starlink DNAV-212 and INVICTA 210 series can achieve accuracy on the order of 1 meter or less.



Differential GPS Broadcast Site