

Science lecture #3: Using the GPS

The Global Positioning System (GPS) is a navigational system designed to accurately pinpoint the location of a transmitter/receiver anywhere on the face of the earth. Twenty four satellites have been strategically placed in space all around the earth, each one equipped with an atomic clock that sends out radio signals. These satellites transmit the exact time and location to ground-based receivers (which is what a GPS unit is), and makes it able for you to determine where you are. GPS was originally designed by the United States Dept. of Defense (for the military), but is now used more and more by the general public for navigation, scientific purposes, and many forms of recreation.

Accuracy of a GPS unit/receiver depends on the grade (quality) of the unit. We recommend the use of a **Garmin GPSMAP 76S** Chartplotting Receiver. Higher-grade units have less error when computing the signals received from the satellites. There are also a number of *external factors* which can affect the accuracy of your GPS reading. A **minimum of 4 satellite signals is required** for accurate triangulation of a ground position. (When only 3 satellites are transmitting, there is the possibility of 2 potential locations and therefore not accurate.) By adding the fourth satellite, it becomes possible to narrow it down to one and only one location. ***If there are less than 3 satellite signals, your GPS unit will not compute at all. Instead, you will see a "lost satellite reception" message in your view screen.*

A second factor is that GPS receivers can only transmit to satellites which are above the horizon. A third factor is that buildings, forests, canyon walls, and even your head can block satellite signals. If your GPS unit cannot "lock-on" to four or more satellites, it may be best to change your position (move around) until you obtain a "locked" signal. If you are in an area where you are surrounded by tall obstacles such as buildings or canyon walls, you may have an additional problem of satellite signals "bouncing off" these structures. This causes what is known as "multi-path error." When this happens, the best thing to do is to stand as clear as possible from these structures. If the situation is unavoidable, just consider your data to be less accurate than what is being transmitted.

Strength of Signal. The stronger the satellite signal, the more accurate your GPS reading. (This is known as the "signal-to-noise ratio" or SNR.) The strength of the signal depends on how well your GPS unit "sees" the overhead satellites – with the key being that *satellite signals are the strongest when they are not too high or not too low on the horizon.* Most GPS units will display a number or image which relates to how well the satellites are arranged. The better the arrangement (i.e., a satellite in each of the four quadrants on a compass), the better the triangulation and the more accurate the reading.

Setting-Up to use the GPS. To properly use a GPS unit, it must first be "set-up and initialized." It means being able to fine-tune the GPS for basic use in calculating distances, speed, time differences, direction, the navigation grid system, and other basics. Each GPS unit comes with its own detailed instructions. Follow the step by step instructions and you should be able to begin navigating right away. A "Quick Start Guide" is included with your unit, and on page 12 you will find easy-to-follow instructions on **Initializing the GPS Receiver**. Here's a quick rundown on how to set up and initialize your receiver, after you install the batteries and the lanyard:

1. Turn the power ON by pressing and holding down the key which has a "red lightbulb" symbol.

2. A "Welcome" page will pop-up, followed by an "Information page," and finally a "Warning" page. Instructions at the bottom of the screen will tell you to press the "PAGE" key to continue. The PAGE key is located at the 2 o'clock position above the screen.
3. The next screen that pops-up is the GPS Information Screen, which tells you the *current date*, the *current time*, your *current speed*, your *current elevation*, the *location of the satellites* which are reading your signals, and the Cartesian Coordinates of your *current position*. The current date will be given automatically, since your GPS unit receives this information direct from the satellites. The **time must be changed to the local time**, however.
4. Changing the time: Press the MENU key twice, so that your screen reads "Main Menu" at the top. Press the lower half of the large black oval key to scroll down the screen until you highlight the "Setup" line. Press the ENTER key. At the top of the screen the word "General" will be highlighted. Press the right side of the large black oval key several times until you've highlighted the word "Time." Press the lower half of the large black oval key again, until you highlight the frame which reads "Time Zone." Press the ENTER key. Press the lower half of the large black oval key to scroll down to the word "Hawaii," then press ENTER again. Now that you've changed the time zone to Hawai'i, you may exit the "Time Zone" by pressing the QUIT key twice. This should take you back to the GPS Information Screen.
5. The GPS Information Screen should now show the current local time. To "**initialize**" your GPS receiver, it may be best to go outdoors where you have an unblocked view of the sky. At times, your GPS receiver may lose its connection with the satellites overhead; when this happens, the GPS unit will "beep" 3 times, and a message will appear on your screen which reads, "Lost Satellite Reception." Position the GPS unit upright for a stronger signal, and that should bring the satellite reception back.
6. The GPS unit will *automatically* initialize itself if you maintain a good connection with the satellites overhead. A message on your screen will read "3D GPS Location," telling you the unit has been initialized. If for some reason you are still NOT able to get a good satellite connection, press the MENU key and then the lower half of the large black oval key to highlight "New Location" on your screen, then press ENTER. A small window will appear with the word "Automatic" highlighted. Press ENTER again, and this should re-initialize the GPS unit (the Quick Start Guide states "this selection will force the unit to search for satellites").

Also included is an "Owner's Manual and Reference Guide," and in it you will again find instructions for **initializing**... on pages 7 and 8. After the Initialization process is complete, it is recommended to **calibrate the Electronic Compass** also. To do this, you may follow the instructions in the Quick Start Guide on page 13, or read below:

1. From the GPS Information Screen, press the PAGE key twice. You should be looking at the Compass Screen with a large black arrow in the center.
2. Hold the GPS unit in a leveled position, as if you were holding a plate of food. Press the MENU key. Then press the lower half of the large black oval key to highlight "Calibrate Compass" on the screen, and press the ENTER key.
3. A screen saying "Calibrate Compass" should appear, with instructions to *slowly turn two full*

circles in the same direction while holding the GPSMAP 76S level. Press the ENTER key to begin the calibration process, and turn the GPS unit two full circles as indicated.

4. A bar graph at the bottom of the screen shows your progress, and it will let you know when you are finished. When you are finished, an "OK" message will be highlighted at the bottom of the screen. Press the ENTER key to complete the calibration process.
5. Note: if the calibration process was not done successfully, press the ENTER key again to re-do the calibration process.

Once your GPS unit has been initialized and calibrated, the most useful function is to learn how to use the GPS unit correctly. You can do this by going to the "Simulator" screen and have the GPS unit explain itself to you. To do this, go back to the GPS Information Screen by pressing the QUIT key twice. To put the GPS unit in Simulator mode:

1. Press the MENU key once. Then press the lower half of the large black oval key to highlight "Start Simulator" on the screen. Press the ENTER key once.

2. A message near the top of the screen should read "Simulating GPS." save the current position as a waypoint. **Waypoints** are fixed locations with specified longitudes and latitudes (and Cartesian coordinates), that have been maintained by the GPS put in place by the U.S. government. Waypoints map out a destination, or a point along the way to a destination. They may also be points of reference, like a natural rock formation, a lake, or some other permanent terrain feature. Most GPS units will allow the user to assign a name to each waypoint; many models also let the user select a symbol to identify the waypoint on a graphic map display.