**GPS**

## C:\Documents and Settings\kiran\Desktop\gps modem pic.JPG

## Basic concept of GPS

A GPS receiver calculates its position by precisely timing the signals sent by GPS [satellites](http://en.wikipedia.org/wiki/Satellites) high above the Earth. Each satellite continually transmits messages that include

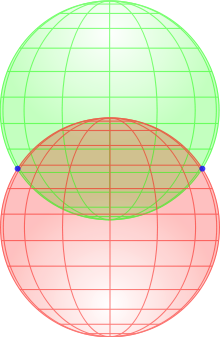
* the time the message was transmitted
* precise orbital information (the [ephemeris](http://en.wikipedia.org/wiki/Ephemeris))
* the general system health and rough orbits of all GPS satellites (the almanac).

The receiver uses the messages it receives to determine the transit time of each message and computes the distance to each satellite. These distances along with the satellites' locations are used with the possible aid of [trilateration](http://en.wikipedia.org/wiki/Trilateration), depending on which algorithm is used, to compute the position of the receiver. This position is then displayed, perhaps with a moving map display or latitude and longitude; elevation information may be included. Many GPS units show derived information such as direction and speed, calculated from position changes.

Three satellites might seem enough to solve for position since space has three dimensions and a position near the Earth's surface can be assumed. However, even a very small clock error multiplied by the very large [speed of light](http://en.wikipedia.org/wiki/Speed_of_light)[[35]](http://en.wikipedia.org/wiki/Gps#cite_note-34) — the speed at which satellite signals propagate — results in a large positional error. Therefore receivers use four or more satellites to solve for the receiver's location and time. The very accurately computed time is effectively hidden by most GPS applications, which use only the location. A few specialized GPS applications do however use the time; these include [time transfer](http://en.wikipedia.org/wiki/Time_transfer), traffic signal timing, and [synchronization of cell phone base stations](http://en.wikipedia.org/wiki/IS-95#Physical_layer).

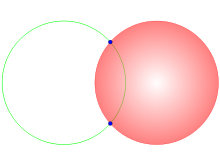
Although four satellites are required for normal operation, fewer apply in special cases. If one variable is already known, a receiver can determine its position using only three satellites. For example, a ship or aircraft may have known elevation. Some GPS receivers may use additional clues or assumptions (such as reusing the last known altitude, [dead reckoning](http://en.wikipedia.org/wiki/Dead_reckoning), [inertial navigation](http://en.wikipedia.org/wiki/Inertial_navigation_system), or including information from the vehicle computer) to give a less accurate (degraded) position when fewer than four satellites are visible.

**Position calculation introduction**

[](http://en.wikipedia.org/wiki/File:Lat_2spheres_2.svg)

[http://bits.wikimedia.org/skins-1.18/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Lat_2spheres_2.svg)

Two sphere surfaces intersecting in a circle

[](http://en.wikipedia.org/wiki/File:Circle_sphere_2-colour.svg)

[http://bits.wikimedia.org/skins-1.18/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Circle_sphere_2-colour.svg)

Surface of sphere intersecting a circle (not a solid disk) at two points

To provide an introductory description of how a GPS receiver works, error effects are deferred to a later section. Using messages received from a minimum of four visible satellites, a GPS receiver is able to determine the times sent and then the satellite positions corresponding to these times sent. The x, y, and z components of position, and the time sent, are designated as \scriptstyle\left[x_i,\, y_i,\, z_i,\, t_i\right]where the subscript i is the satellite number and has the value 1, 2, 3, or 4. Knowing the indicated time the message was received \scriptstyle\  \tilde{t}_\text{r}, the GPS receiver could compute the transit time of the message as \scriptstyle\left ( \tilde{t}_\text{r}-t_i\right ) , if \scriptstyle\  \tilde{t}_\text{r}would be equal to correct reception time, \scriptstyle\  t_\text{r}. A [pseudorange](http://en.wikipedia.org/wiki/Pseudorange), \scriptstyle p_i \triangleq \left ( \tilde{t}_\text{r}-t_i\right )c, would be the traveling distance of the message, assuming it traveled at the speed of light, [c](http://en.wikipedia.org/wiki/Speed_of_light).

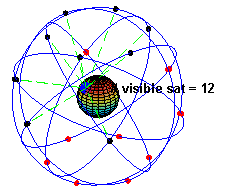
A satellite's position and pseudorange define a sphere, centered on the satellite, with radius equal to the pseudorange. The position of the receiver is somewhere on the surface of this sphere. Thus with four satellites, the indicated position of the GPS receiver is at or near the intersection of the surfaces of four spheres. In the ideal case of no errors, the GPS receiver would be at a precise intersection of the four surfaces.

If the surfaces of two spheres intersect at more than one point, they intersect in a circle. The article [trilateration](http://en.wikipedia.org/wiki/Trilateration) shows this mathematically. A figure, Two Sphere Surfaces Intersecting in a Circle, is shown below. Two points where the surfaces of the spheres intersect are clearly shown in the figure. The distance between these two points is the diameter of the circle of intersection. The intersection of a third spherical surface with the first two will be its intersection with that circle; in most cases of practical interest, this means they intersect at two points.[[39]](http://en.wikipedia.org/wiki/Gps#cite_note-38) Another figure, Surface of Sphere Intersecting a Circle (not a solid disk) at Two Points, illustrates the intersection. The two intersections are marked with dots. Again the article [trilateration](http://en.wikipedia.org/wiki/Trilateration) clearly shows this mathematically.

For automobiles and other near-earth vehicles, the correct position of the GPS receiver is the intersection closest to the Earth's surface.[[40]](http://en.wikipedia.org/wiki/Gps#cite_note-39) For space vehicles, the intersection farthest from Earth may be the correct one.

The correct position for the GPS receiver is also the intersection closest to the surface of the sphere corresponding to the fourth satellite.

# GPS COMMANDS LIST



NMEA input  
  
         Some units also support an NMEA input mode. While not too many programs support this mode it does provide a standardized way to update or add waypoint and route data. Note that there is no handshaking or commands in NMEA mode so you just send the data in the correct sentence and the unit will accept the data and add or overwrite the information in memory. If the data is not in the correct format it will simply be ignored. A carriage return/line feed sequence is required. If the waypoint name is the same you will overwrite existing data but no warning will be issued. The sentence construction is identical to what the unit downloads so you can, for example, capture a WPL sentence from one unit and then send that same sentence to another unit but be careful if the two units support waypoint names of different lengths since the receiving unit might truncate the name and overwrite a waypoint accidently. If you create a sentence from scratch you should create a correct checksum. Be sure you know and have set you unit to the correct datum. Many units support the input of WPL sentences and a few support RTE as well.  
  
On NMEA input the receiver stores information based on interpreting the sentence itself. While some receivers accept standard NMEA input this can only be used to update a waypoint or similar task and not to send a command to the unit. Proprietary input sentences could be used to send commands. Since the Magellan upload and download maintenance protocol is based on NMEA sentences they support a modified WPL message that adds comments, altitude, and icon data.  
  
Some marine units may accept input for alarms such as deep or shallow water based on the DPT sentence or MTW to read the water temperature. For example the Garmin Map76 supports DPT, MTW (temperature), and VHW (speed) input sentences. Other units may use NMEA input to provide initialization data via proprietary sentences, or to select which NMEA sentences to output.  
The most important NMEA sentences include the GGA which provides the current Fix data, the RMC which provides the minimum gps sentences information, and the GSA which provides the Satellite status data.

GGA - essential fix data which provide 3D location and accuracy data.  
  
 $GPGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46.9,M,,\*47  
  
Where:  
     GGA-Global Positioning System Fix Data

123519-Fix taken at 12:35:19 UTC

4807.038,N-Latitude 48 deg 07.038' N

01131.000,E-Longitude 11 deg 31.000' E  
     1                             Fix quality: 0 = invalid  
                                                         1 = GPS fix (SPS)  
                                                             2 = DGPS fix  
                                                             3 = PPS fix  
                                                             4 = Real Time Kinematic  
                                                             5 = Float RTK  
                                                             6 = estimated (dead reckoning) (2.3 feature)  
                                                             7 = Manual input mode  
                                                             8 = Simulation mode  
     08                             Number of satellites being tracked  
     0.9                           Horizontal dilution of position  
     545.4,M                  Altitude, Meters, above mean sea level  
     46.9,M                     Height of geo id (mean sea level) above WGS84

     (empty field) time in seconds since last DGPS update (empty field) DGPS station ID number  
      
If the height of geoid is missing then the altitude should be suspect. Some non-standard implementations report altitude with respect to the ellipsoid rather than geoid altitude. Some units do not report negative altitudes at all. This is the only sentence that reports altitude.  
  
GSA - GPS DOP and active satellites. This sentence provides details on the nature of the fix. It includes the numbers of the satellites being used in the current solution and the DOP. DOP (dilution of precision) is an indication of the effect of satellite geometry on the accuracy of the fix. It is a unitless number where smaller is better. For 3D fixes using 4 satellites a 1.0 would be considered to be a perfect number, however for overdetermined solutions it is possible to see numbers below 1.0. There are differences in the way the PRN's are presented which can effect the ability of some programs to display this data. For example, in the example shown below there are 5 satellites in the solution and the null fields are scattered indicating that the almanac would show satellites in the null positions that are not being used as part of this solution. Other receivers might output all of the satellites used at the beginning of the sentence with the null field all stacked up at the end. This difference accounts for some satellite display programs not always being able to display the satellites being tracked. Some units may show all satellites that have ephemeris data without regard to their use as part of the solution but this is non-standard.  
  
  $GPGSA,A,3,04,05,,09,12,,,24,,,,,2.5,1.3,2.1\*39  
  
Where:  
     GSA      Satellite status  
     A        Auto selection of 2D or 3D fix (M = manual)   
     3        3D fix - values include: 1 = no fix  
                                       2 = 2D fix  
                                       3 = 3D fix  
     04,05... PRNs of satellites used for fix (space for 12)   
     2.5      PDOP (dilution of precision)   
     1.3      Horizontal dilution of precision (HDOP)   
     2.1      Vertical dilution of precision (VDOP)  
     \*39      the checksum data, always begins with \*  
  
GSV - Satellites in View shows data about the satellites that the unit might be able to find based on its viewing mask and almanac data. It also shows current ability to track this data. Note that one GSV sentence only can provide data for up to 4 satellites and thus there may need to be 3 sentences for the full information. It is reasonable for the GSV sentence to contain more satellites than GGA might indicate since GSV may include satellites that are not used as part of the solution. It is not a requirment that the GSV sentences all appear in sequence. To avoid overloading the data bandwidth some receivers may place the various sentences in totally different samples since each sentence identifies which one it is.  
  
The field called SNR (Signal to Noise Ratio) in the NMEA standard is often referred to as signal strength. SNR is an indirect but more useful value that raw signal strength. It can range from 0 to 99 and has units of dB according to the NMEA standard, but the various manufacturers send different ranges of numbers with different starting numbers so the values themselves cannot necessarily be used to evaluate different units. The range of working values in a given gps will usually show a difference of about 25 to 35 between the lowest and highest values, however 0 is a special case and may be shown on satellites that are in view but not being tracked.  
  
  $GPGSV,2,1,08,01,40,083,46,02,17,308,41,12,07,344,39,14,22,228,45\*75  
  
Where:  
      GSV          Satellites in view  
      2            Number of sentences for full data  
      1            sentence 1 of 2  
      08           Number of satellites in view  
  
      01           Satellite PRN number  
      40           Elevation, degrees  
      083          Azimuth, degrees  
      46           SNR - higher is better  
           for up to 4 satellites per sentence  
      \*75          the checksum data, always begins with \*  
  
  
RMC - NMEA has its own version of essential gps pvt (position, velocity, time) data. It is called RMC, The Recommended Minimum, which will look similar to:  
  
$GPRMC,123519,A,4807.038,N,01131.000,E,022.4,084.4,230394,003.1,W\*6A  
  
Where:  
     RMC          Recommended Minimum sentence C  
     123519       Fix taken at 12:35:19 UTC  
     A            Status A=active or V=Void.  
     4807.038,N   Latitude 48 deg 07.038' N  
     01131.000,E  Longitude 11 deg 31.000' E  
     022.4        Speed over the ground in knots  
     084.4        Track angle in degrees True  
     230394       Date - 23rd of March 1994  
     003.1,W      Magnetic Variation  
     \*6A          The checksum data, always begins with \*  
  
Note that, as of the 2.3 release of NMEA, there is a new field in the RMC sentence at the end just prior to the checksum. For more information on this field see here.  
  
GLL - Geographic Latitude and Longitude is a holdover from Loran data and some old units may not send the time and data active information if they are emulating Loran data. If a gps is emulating Loran data they may use the LC Loran prefix instead of GP.  
  
  $GPGLL,4916.45,N,12311.12,W,225444,A,\*1D  
  
Where:  
     GLL          Geographic position, Latitude and Longitude  
     4916.46,N    Latitude 49 deg. 16.45 min. North  
     12311.12,W   Longitude 123 deg. 11.12 min. West  
     225444       Fix taken at 22:54:44 UTC  
     A            Data Active or V (void)  
     \*iD          checksum data  
  
Note that, as of the 2.3 release of NMEA, there is a new field in the GLL sentence at the end just prior to the checksum. For more information on this field see here.  
  
VTG - Velocity made good. The gps receiver may use the LC prefix instead of GP if it is emulating Loran output.  
  
  $GPVTG,054.7,T,034.4,M,005.5,N,010.2,K\*48  
  
where:  
        VTG          Track made good and ground speed  
        054.7,T      True track made good (degrees)  
        034.4,M      Magnetic track made good  
        005.5,N      Ground speed, knots  
        010.2,K      Ground speed, Kilometers per hour  
        \*48          Checksum  
  
Note that, as of the 2.3 release of NMEA, there is a new field in the VTG sentence at the end just prior to the checksum. For more information on this field see here.  
  
Receivers that don't have a magnetic deviation (variation) table built in will null out the Magnetic track made good.  
Decode of some Navigation Sentences  
  
WPL - Waypoint Location data provides essential waypoint data. It is output when navigating to indicate data about the destination and is sometimes supported on input to redefine a waypoint location. Note that waypoint data as defined in the standard does not define altitude, comments, or icon data. When a route is active, this sentence is sent once for each waypoint in the route, in sequence. When all waypoints have been reported, the RTE sentence is sent in the next data set. In any group of sentences, only one WPL sentence, or an RTE sentence, will be sent.  
  
$GPWPL,4807.038,N,01131.000,E,WPTNME\*5C  
  
With an interpretation of:  
  
     WPL         Waypoint Location  
     4807.038,N  Latitude  
     01131.000,E Longitude  
     WPTNME      Waypoint Name  
     \*5C         The checksum data, always begins with \*  
  
AAM - Waypoint Arrival Alarm is generated by some units to indicate the Status of arrival (entering the arrival circle, or passing the perpendicular of the course line) at the destination waypoint.  
  
  $GPAAM,A,A,0.10,N,WPTNME\*32  
  
Where:  
    AAM    Arrival Alarm  
    A      Arrival circle entered  
    A      Perpendicular passed  
    0.10   Circle radius  
    N      Nautical miles  
    WPTNME Waypoint name  
    \*32    Checksum data  
  
APB - Autopilot format B is sent by some gps receivers to allow them to be used to control an autopilot unit. This sentence is commonly used by autopilots and contains navigation receiver warning flag status, cross-track-error, waypoint arrival status, initial bearing from origin waypoint to the destination, continuous bearing from present position to destination and recommended heading-to-steer to destination waypoint for the active navigation leg of the journey.  
  
Note: some autopilots, Robertson in particular, misinterpret "bearing from origin to destination" as "bearing from present position to destination". This is likely due to the difference between the APB sentence and the APA sentence. for the APA sentence this would be the correct thing to do for the data in the same field. APA only differs from APB in this one field and APA leaves off the last two fields where this distinction is clearly spelled out. This will result in poor performance if the boat is sufficiently off-course that the two bearings are different.  
  
  $GPAPB,A,A,0.10,R,N,V,V,011,M,DEST,011,M,011,M\*3C   
  
where:  
    APB     Autopilot format B  
    A       Loran-C blink/SNR warning, general warning   
    A       Loran-C cycle warning   
    0.10    cross-track error distance   
    R       steer Right to correct (or L for Left)   
    N       cross-track error units - nautical miles (K for kilometers)   
    V       arrival alarm - circle   
    V       arrival alarm - perpendicular   
    011,M   magnetic bearing, origin to destination   
    DEST    destination waypoint ID   
    011,M   magnetic bearing, present position to destination   
    011,M   magnetic heading to steer (bearings could True as 033,T)   
  
BOD - Bearing - Origin to Destination shows the bearing angle of the line, calculated at the origin waypoint, extending to the destination waypoint from the origin waypoint for the active navigation leg of the journey.  
  
  $GPBOD,045.,T,023.,M,DEST,START\*01  
  
where:  
        BOD          Bearing - origin to destination waypoint  
        045.,T       bearing 045 True from "START" to "DEST"  
        023.,M       bearing 023 Magnetic from "START" to "DEST"  
        DEST         destination waypoint ID  
        START        origin waypoint ID  
        \*01          checksum  
  
BWC - Bearing & Distance to Waypoint using a Great Circle route. Time (UTC) and distance & bearing to, and location of, a specified waypoint from present position along the great circle path.  
  
  $GPBWC,225444,4917.24,N,12309.57,W,051.9,T,031.6,M,001.3,N,004\*29  
  
where:  
        BWC          Bearing and distance to waypoint - great circle  
        225444       UTC time of fix 22:54:44  
        4917.24,N    Latitude of waypoint  
        12309.57,W   Longitude of waypoint  
        051.9,T      Bearing to waypoint, degrees true  
        031.6,M      Bearing to waypoint, degrees magnetic  
        001.3,N      Distance to waypoint, Nautical miles  
        004          Waypoint ID  
        \*29          checksum  
  
RMB - The recommended minimum navigation sentence is sent whenever a route or a goto is active. On some systems it is sent all of the time with null data. The Arrival alarm flag is similar to the arrival alarm inside the unit and can be decoded to drive an external alarm. Note the use of leading zeros in this message to preserve the character spacing. This is done, I believe, because some autopilots may depend on exact character spacing.  
  
  $GPRMB,A,0.66,L,003,004,4917.24,N,12309.57,W,001.3,052.5,000.5,V\*20  
  
where:  
           RMB          Recommended minimum navigation information  
           A            Data status A = OK, V = Void (warning)  
           0.66,L       Cross-track error (nautical miles, 9.99 max),  
                                steer Left to correct (or R = right)  
           003          Origin waypoint ID  
           004          Destination waypoint ID  
           4917.24,N    Destination waypoint latitude 49 deg. 17.24 min. N  
           12309.57,W   Destination waypoint longitude 123 deg. 09.57 min. W  
           001.3        Range to destination, nautical miles (999.9 max)  
           052.5        True bearing to destination  
           000.5        Velocity towards destination, knots  
           V            Arrival alarm  A = arrived, V = not arrived  
           \*20          checksum  
  
RTE - RTE is sent to indicate the names of the waypoints used in an active route. There are two types of RTE sentences. This route sentence can list all of the waypoints in the entire route or it can list only those still ahead. Because an NMEA sentence is limited to 80 characters there may need to be multiple sentences to identify all of the waypoints. The data about the waypoints themselves will be sent in subsequent WPL sentences which will be sent in future cycles of the NMEA data.  
  
  $GPRTE,2,1,c,0,W3IWI,DRIVWY,32CEDR,32-29,32BKLD,32-I95,32-US1,BW-32,BW-198\*69  
  
Where:  
           RTE          Waypoints in active route  
           2            total number of sentences needed for full data  
           1            this is sentence 1 of 2  
           c            Type c = complete list of waypoints in this route  
                        w = first listed waypoint is start of current leg  
           0            Route identifier  
           W3IWI,...    Waypoint identifiers (names)  
           \*69          checksum  
  
XTE - Measured cross track error is a small subset of the RMB message for compatibility with some older equipment designed to work with Loran. Note that the same limitations apply to this message as the ones in the RMB since it is expected to be decoded by an autopilot.  
  
  $GPXTE,A,A,0.67,L,N\*6F  
  
Where:  
           XTE          Cross track error, measured  
           A            General warning flag V = warning  
                                (Loran-C Blink or SNR warning)  
           A            Not used for GPS (Loran-C cycle lock flag)  
           0.67         cross track error distance  
           L            Steer left to correct error (or R for right)  
           N            Distance units - Nautical miles  
           \*6F          checksum  
  
Other sentences that may be useful  
  
ALM - GPS Almanac Data contains GPS week number, satellite health and the complete almanac data for one satellite. Multiple messages may be transmitted, one for each satellite in the GPS constellation, up to maximum of 32 messages. Note that these sentences can take a long time to send so they are not generally sent automatically by the gps receiver. (Sorry I don't have an exact example of the sentence.) Note that this sentence breaks the 80 character rule. Also note that this sentence is often accepted as input so that you can preload a new almanac in a receiver.  
  
     $GPALM,A.B,C.D,E,F,hh,hhhh,...  
  
Where:  
       ALM   Almanac Data being sent  
       A     Total number of messages  
       B     Message number  
       C     Satellite PRN number  
       D     GPS week number (0-1023)   
       E     Satellite health (bits 17-24 of message)  
       F     eccentricity  
       hh    t index OA, almanac reference time  
       hhhh  sigma index 1, inclination angle  
       ...   OMEGADOT rate of right ascension  
             SQRA(A) root of semi-major axis  
             Omega, argument of perigee  
             Omega index 0, longitude of ascension node  
             M index 0, mean anomaly  
             a index f0, clock parameter  
             a index f1, clock parameter  
  
HCHDG - Compass output is used on Garmin etrex summit, vista , and 76S receivers to output the value of the internal flux-gate compass. Only the magnetic heading and magnetic variation is shown in the message.  
  
  $HCHDG,101.1,,,7.1,W\*3C  
  
where:  
     HCHDG    Magnetic heading, deviation, variation  
     101.1    heading  
     ,,       deviation (no data)  
     7.1,W    variation  
  
ZDA - Data and Time  
  
  $GPZDA,hhmmss.ss,dd,mm,yyyy,xx,yy\*CC  
  $GPZDA,201530.00,04,07,2002,00,00\*60  
  
where:  
    hhmmss    HrMinSec(UTC)  
        dd,mm,yyy Day,Month,Year  
        xx        local zone hours -13..13  
        yy        local zone minutes 0..59  
        \*CC       checksum  
  
MSK - Control for a Beacon Receiver  
  
  $GPMSK,318.0,A,100,M,2\*45  
  
where:  
       318.0      Frequency to use  
       A          Frequency mode, A=auto, M=manual  
       100        Beacon bit rate  
       M          Bitrate, A=auto, M=manual  
       2          frequency for MSS message status (null for no status)  
       \*45        checksum  
  
MSS - Beacon Receiver Status  
  
  $GPMSS,55,27,318.0,100,\*66  
  
where:  
       55         signal strength in dB  
       27         signal to noise ratio in dB  
       318.0      Beacon Frequency in KHz  
       100        Beacon bitrate in bps  
       \*66        checksum  
  
Proprietary Sentences  
  
Proprietary sentences can either be output from the gps or used as input to control information. They always start with P which is followed by a 3 character manufactures code and additional characters to define the sentence type.  
Garmin  
  
The following are Garmin proprietary sentences. "P" denotes proprietary, "GRM" is Garmin's manufacturer code, and "M" or "Z" indicates the specific sentence type. Note that the PGRME sentence is not set if the output is set to NMEA 1.5 mode.  
  
  $PGRME,15.0,M,45.0,M,25.0,M\*1C  
  
where:  
     15.0,M       Estimated horizontal position error in meters (HPE)  
     45.0,M       Estimated vertical error (VPE) in meters  
     25.0,M       Overall spherical equivalent position error  
  
  
  $PGRMZ,93,f,3\*21  
  
where:  
      93,f         Altitude in feet  
      3            Position fix dimensions 2 = user altitude  
                                           3 = GPS altitude  
   This sentence shows in feet, regardless of units shown on the display.  
   Note that for units with an altimeter this will be altitude computed  
   by the internal altimeter.  
  
  
  $PGRMM,NAD27 Canada\*2F  
     Currently active horizontal datum  
  
PSLIB  
  
Proprietary sentences are used to control a Starlink differential beacon receiver. (Garmin's DBR is Starlink compatible as are many others.) When the GPS receiver is set to change the DBR frequency or b/s rate, the "J" sentence is replaced (just once) by (for example): $PSLIB,320.0,200\*59 to set the DBR to 320 KHz, 200 b/s.  
  
      $PSLIB,,,J\*22   Status request  
      $PSLIB,,,K\*23   configuration request  
  
These two sentences are normally sent together in each group of sentences from the GPS. The three fields are: Frequency, bit Rate, Request Type. The value in the third field may be: J = status request, K = configuration request, or null (blank) = tuning message. The correct values for frequency range from 283.5-325.0 KHz while the bit rate can be set to 0, 25, 50, 100 or 200 bps.  
Magellan  
  
Magellan uses proprietary sentences to do all of their waypoint and route maintenance. They use the MGN prefix for their sentences. This use is documented in their interface specification and will not be repeated here. However, they also send proprietary sentences to augment the gps data just like Garmin does. Here is an example of a sentence sent by the GPS Companion product:  
  
  $PMGNST,02.12,3,T,534,05.0,+03327,00\*40   
  
where:  
      ST      status information  
      02.12   Version number?  
      3       2D or 3D  
      T       True if we have a fix False otherwise  
      534     numbers change - unknown  
      05.0    time left on the gps battery in hours  
      +03327  numbers change (freq. compensation?)  
      00      PRN number receiving current focus  
      \*40    checksum  
  
A tracklog on a Meridian is made up of propretary sentences that look like:  
  
$PMGNTRK,4322.061,N,07948.473,W,00116,M,173949.42,A,,020602\*67  
$PMGNTRK,4322.058,N,07948.483,W,00090,M,174202.45,A,,020602\*69.  
  
where  
  
      TRK       Tracklog  
      4322.071  Latitude  
      N         North or South  
      07948.473 Longitude  
      W         East or West  
      00116     Altitude  
      M         Meters or Feet  
      173949.42 UTC time  
      A         Active or Void  
      ,,        Track Name  
      020602    date  
      \*67       checksum  
  
Motorola  
The PMOTG is used by Motorola Oncore receivers to send a command to the receiver. This command is used to set the output of the sentence to a particular frequency in seconds (or to 0) or to switch the output formula to motorola binary, gps, or loran.  
  
  $PMOTG,xxx,yyyy  
  
where:  
      xxx    the sentence to be controlled  
      yyyy   the time interval (0-9999 seconds)  
  
or $PMOTG,FOR,y  
  
where:  
      y    MPB=0, GPS=1, Loran=2  
  
Rockwell International  
  
The Rockwell chipset is used on a number of gps receivers. It outputs some proprietary sentences with the PRWI prefix and accepts input from some special sentences similar to the approach used by Magellan. It can also be switched to a separate binary mode using a proprietary sentence. The input sentence most used to initialize the unit is $PRWIINIT and one output sentence is $PRWIRID  
  
  $PRWIRID,12,01.83,12/15/97,0003,\*42  
  
where:  
     $PRWIRID  
     12         12 channel unit  
     01.83      software version  
     12/15/97   software date  
     0003       software options (HEX value)  
                Bit 0 minimize ROM usage   
                Bit 1 minimize RAM usage  
     \*42        checksum  
  
An input sentence that will define which NMEA sentences are to be output from the Rockwell unit is:  
  
  $PRWIILOG,GGA,A,T,1,0  
  
where:  
   $PRWIILOG  
   GGA        type of sentence  
   A          A=activate, V=deactivate  
   T          cyclic  
   1          every 1 second  
   0          ??  
  
The initialization sentence which can be input to speed up acquisition looks like:  
  
$PRWIINIT,V,,,4308.750,N,07159.791,W,100.0,0.0,M,0.0,T,175244,230503\*77  
  
where:  
   $PRWIINIT     INIT = initialization  
   V             V = reset, A = no reset  
   ,,         Reserved for future use  
   4308.750      Latitude  
   N             N = North, S = South    
   07159.791     Longitude  
   W             W = West, E = East  
   100.0         Altitude in meters  
   0.0           Speed  
   M             M = m/s, N = knots, K = km/hr  
   0.0           Heading  
   T             T = True, M = Magnetic  
   175244     UTC time (hour, min, sec)  
   230503        UTC date (day, month, year)  
   \*77           Checksum  
  
Note: Commas may be used to signify using existing data. If units are supplied then the data must be present. Speed and direction must be supplied together. Lat/Lon must be supplied together. UTC time and date must be supplied together. If heading is magnetic then lat/lon needs to be supplied along with UTC time and date.  
  
The sentences available for the Rockwell Jupiter chipset are: GGA, GSA, GSV, VTG, RMC and some proprietary sentences.  
SiRF  
  
The SiRF line of chips support several input sentences that permit the user to customize the way the chip behaves. In addition SiRF has a binary protocol that is even more powerful permitting different implementations to behave entirely differently. However, most applications do not attempt to customize the behavior so a user will need to make sure that the any customization is compatible with the application they are planning to use. There are 5 input sentences defined that begin with $PSRF which is followed by three digits. Each sentence takes a fix amount of input fields which must exist, no null fields, and is terminated with the standard CR/LF sequence. The checksum is required.  
  
The sentences 100 and 102 set the serial ports. 100 sets the main port A while 102 sets the DGPS input port B. 100 has an extra field that can be used to switch the interface to binary mode. Binary mode requires 8 bits, 1 stop bit, no parity. There is a command in binary mode that will switch the interface back to NMEA. Do not use the NMEA command to switch to binary mode unless you have the ability to switch it back. You could render your gps inoperative.  
  
 $PSRF100,0,9600,8,1,0\*0C  
 $PSRF102,9600,8,1,0\*3C  
where  
   $PSRF100  
   0          0=SiRF, 1=NMEA  - This is where the protocol is changed.  
   9600       b/s rate 4800, 9600, 19200, 38400  
   8          7, 8 Databits  
   1          0, 1 Stopbits  
   0          0=none, 1=odd, 2=even Parity

\*0C        checksum  
  
The sentences 101 and 104 can be used to initialize values to be used by the gps. Supplying these values can shorten the initial lock time. If the clock offset is set to 0 then an internal default will be used. Sentence 101 supplies data in the internal ECEF (Earth centered, Earth Fixed) format in meters while sentence 104 supplies the data in the traditional Lat / Lon format.  
  
 $PSRF101,-2686700,-4304200,3851624,95000,497260,921,12,3\*22  
 $PSRF104,37.3875111,-121.97232,0,95000,237759,922,12,3\*3A  
  
where  
   $PSRF104  
   37.3875111 Latitude in degrees  
   -121.97232 Longitude in degrees  
   0          Ellipsoid Altitude in meters  
   95000      Clock offset  
   237759     GPS Time of Week in seconds  
   922        GPS Week Number  
   12         Channel count (1 to 12)  
   3          Reset config where  
              1 = warm start, ephemeris valid  
              2 = clear ephemeris, warm start (First Fix)  
              3 = initialize with data, clear ephemeris  
              4 = cold start, clear all data  
              8 = cold start, set factory defaults  
   \*3A        checksum  
  
The sentence 103 is used to control which NMEA sentences are to be sent and how often. Each sentence type is controlled individually. If the query bit is set then the gps responds by sending this message in the next second no matter what the rate is set to. Note that if trickle power is in use (can only be set in binary mode) then the actual update rate will be the selected update rate times the trickle rate which could mean that the data will be sent less frequently than was set here.  
  
 $PSRF103,05,00,01,01\*20  
  
where  
   $PSRF103  
   05         00=GGA  
              01=GLL  
              02=GSA  
              03=GSV  
              04=RMC  
              05=VTG  
   00         mode, 0=set rate, 1=query  
   01         rate in seconds, 0-255  
   01         checksum 0=no, 1=yes  
   \*20        checksum  
  
The 105 sentence controls a debug mode which causes the gps to report any errors it finds with the input data. $PSRF105,1\*3E would turn debug on while $PSRF105,0\*3F would turn it off.  
Magnavox  
  
The old Magnavox system used mostly proprietary sentences. The Magnavox system was acquired by Leica Geosystems in 1994. Information on this system can be found at this site. The NMEA sentences themselves are described here. They all use the MVX prefix and include:  
  
Control Port Input sentences  
  
    \* $PMVXG,000 Initialization/Mode Control - Part A  
    \* $PMVXG,001 Initialization/Mode Control - Part B  
    \* $PMVXG,007 Control Port Configuration  
    \* $PMVXG,023 Time Recovery Configuration  
    \* $CDGPQ,YYY Query From a Remote Device / Request to Output a Sentence   
  
Control Port Output Sentences  
  
    \* $PMVXG,000 Receiver Status  
    \* $PMVXG,021 Position, Height, Velocity  
    \* $PMVXG,022 DOPs  
    \* $PMVXG,030 Software Configuration  
    \* $PMVXG,101 Control Sentence Accept/Reject  
    \* $PMVXG,523 Time Recovery Configuration  
    \* $PMVXG,830 Time Recovery Results   
  
Sony  
  
The Sony interface uses a proprietary sentence that looks like:  
  
$PSNY,0,00,05,500,06,06,06,06\*14  
  
where  
   PSNY  
   0          Preamp (external antenna) status  
              0 = Normal  
              1 = Open  
              2 = shorted  
   00         Geodesic system (datum) 0-25, 0 = WGS84  
   05          Elevation mask in degrees  
   500          Speed Limit in Km  
   06         PDOP limit with DGPS on  
   06          HDOP limit with DGPS on  
   06          PDOP limit with DGPS off  
   06          HDOP limit with DGPS off  
   \*14          Checksum  
  
Sample Streams  
  
These streams will be modified when a route is active with the inclusion of route specific data.  
Garmin  
  
Garmin g12 sentences for version 4.57  
  
$GPRMC,183729,A,3907.356,N,12102.482,W,000.0,360.0,080301,015.5,E\*6F  
$GPRMB,A,,,,,,,,,,,,V\*71  
$GPGGA,183730,3907.356,N,12102.482,W,1,05,1.6,646.4,M,-24.1,M,,\*75  
$GPGSA,A,3,02,,,07,,09,24,26,,,,,1.6,1.6,1.0\*3D  
$GPGSV,2,1,08,02,43,088,38,04,42,145,00,05,11,291,00,07,60,043,35\*71  
$GPGSV,2,2,08,08,02,145,00,09,46,303,47,24,16,178,32,26,18,231,43\*77  
$PGRME,22.0,M,52.9,M,51.0,M\*14  
$GPGLL,3907.360,N,12102.481,W,183730,A\*33  
$PGRMZ,2062,f,3\*2D  
$PGRMM,WGS 84\*06  
$GPBOD,,T,,M,,\*47  
$GPRTE,1,1,c,0\*07  
$GPRMC,183731,A,3907.482,N,12102.436,W,000.0,360.0,080301,015.5,E\*67  
$GPRMB,A,,,,,,,,,,,,V\*71

While originally a military project, GPS is considered a dual-use technology, meaning it has significant military and civilian applications.

GPS has become a widely deployed and useful tool for commerce, scientific uses, tracking, and surveillance. GPS's accurate time facilitates everyday activities such as banking, mobile phone operations, and even the control of power grids by allowing well synchronized hand-off switching