Quelques infos sur le système GPS

par Seca4all

Tout d' abord , GPS Signifie **G**lobal **P**ositionnement **S**ystem.
Le système GPS permet de savoir avec précision votre positionnement sur notre bonne veille planète Terre.
Un réseau de 24 satellites (répartie sur 6 orbites et situés à 20 000 kms) gravite autour de la terre et envoie en permanence des information , le tout étant géré par l' armée américaine.
Afin de connaître sa position exacte , il est nécessaire de posséder un récepteur GPS (actuellement la mode est au 12 canaux , c 'est à dire la possibilité de recevoir simultanément 12 satellites) .

Fonctionnement sommaire d' un récepteur GPS :

La localisation de votre position s 'effectue par triangulation.
Votre récepteur reçoit et analyse les informations envoyées par les différent satellite visible au moment de l' acquisition du signal .
Connaissant la vitesse de propagation des ondes , le temps mis pour la réception des info envoyées par le satellite , le processeur de votre GPS va vous afficher en quelque milli secondes votre positionnement sur terre .

le signal GPS:

Les satellites émettent en permanence en bande L sur 2 fréquences:

- **L1=1575,42 Mhz**
- **L2=1227,60 Mhz.**

Chaque satellite signe numériquement sont émission et peut ainsi être identifié.

Il existe bien entendu ne nombreux type de récepteur GPS , du simple circuit électronique (très pratique pour la fabrication de balise auto émettrice) au récepteur GPS avec cartographie intégré. A vous d' acheter celui qui correspond le mieux à l'utilisation que vous voulez en faire.

Introduction au GPS différentiel (DGPS)

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Le système DGPS permet de corriger les erreurs (Temps de propagation des signaux, positions des satellites,...) et le brouillage (SA introduit par l'armée américaine) du système GPS. Le principe est simple: un récepteur GPS fixe calcule les erreurs par rapport à sa position qu'il connaît et il envoie les facteurs de correction. Il utilise les bandes FM et envoie les informations de correction sur le canal RDS (Radio Data System) qui est aussi utilisé par exemple sur les auto radios pour changer automatiquement la fréquence de réception d'un poste donné.

Il est possible d'obtenir une précision de position différentiel supérieure à 10 mètres à l'aide du DGPS en n'utilisant que les signaux du service de positionnement standard.

Fonctionnement du DGPS ?

Une station de référence DGPS est installée le long d'une voie navigable côtière dans une position fixe dont on connaît avec précision les coordonnées. Le récepteur GPS de la station mesure les signaux de tous les satellites en vue. Comme la station se trouve à un endroit de coordonnées connues, elle est capable de résoudre l'équation du temps de parcours réel et du temps de parcours théorique de chaque signal des satellites. La station de référence peut alors déterminer n'importe quelle erreur temporelle. La station différentielle transmet les corrections à effectuer à tous les satellites en vue. Le récepteur embarqué ne prend en compte que les corrections applicables aux satellites qu'il utilise pour la solution de navigation.

Le degré de précision du GPS

Le GPS offre deux niveaux de service : un service de positionnement standard (SPS), accessible à tout utilisateur, et un système de positionnement précis (PPS) dont l'accès est réservé principalement aux militaires américains. Le SPS offre une précision de l'ordre de 20 mètres dans le plan horizontal, 95 % du temps.

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Programmation sous VB

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Aide à la programmation d' un soft pour interprétation des données envoyés par un récepteur GPS :

Si vous vous souhaitez faire un programme d' interprétation des données GPS , ces quelques phrases au format NMEA (l'un des formats les plus utilisé pour les information de positionnement GPS) vous seront certainement utiles.

(Si vous êtes intéréssés par ce type de programme ,je peut vous faire parvenir une maquette de projet en VB 6.0 , contactez moi par mail : seca4all@yahoo.fr)

Phrases NMEA envoyées par le récepteur GPS (vers le PC par exemple) .

$GPALM

GPS Almanac Data

A set of sentences transmitted by some Garmin units in response to a received $PGRMO,GPALM,1 sentence. It can also be received by some GPS units (eg. Garmin GPS 16 and GPS 17) to initialize the stored almanac information in the unit.

```
$GPALM,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,*CC
1 = Total number of sentences in set
2 = Sentence sequence number in set
3 = Satellite number
4 = GPS week number
5 = Bits 17 to 24 of almanac page indicating SV health
6 = Eccentricity
7 = Reference time of almanac
8 = Inclination angle
9 = Right ascension rate
10 = Semi major axis route
11 = Argument of perigee (omega)
12 = Ascension node longitude
13 = Mean anomaly
14 = af0 clock parameter
15 = af1 clock parameter
```

$GPBOD

Bearing Origin to Destination

```
eg.  BOD,045.,T,023.,M,DEST,START
           045.,T       bearing 045 degrees True from "START" to "DEST"
           023.,M       breaing 023 degrees Magnetic from "START" to "DEST"
           DEST         destination waypoint ID
           START        origin waypoint ID
```

Example 1: $GPBOD,099.3,T,105.6,M,POINTB,*01
Waypoint ID: "POINTB" Bearing 99.3 True, 105.6 Magnetic
This sentence is transmitted in the GOTO mode, without an active route on your GPS. WARNING: this is the bearing from the moment you press enter in the GOTO page to the destination waypoint and is NOT updated dynamically! To update the information, (current bearing to waypoint), you will have to press enter in the GOTO page again.

Example 2: $GPBOD,097.0,T,103.2,M,POINTB,POINTA*52
This sentence is transmitted when a route is active. It contains the active leg information: origin waypoint "POINTA" and destination waypoint "POINTB", bearing between the two points 97.0 True, 103.2 Magnetic. It does NOT display the bearing from current location to destination waypoint! WARNING Again this information does not change until you are on the next leg of the route. (The bearing from POINTA to POINTB does not change during the time you are on this leg.)

$GPBWC

Bearing and distance to waypoint, great circle

```
eg1. $GPBWC,081837,,,,,,T,,M,,N,*13

        BWC,225444,4917.24,N,12309.57,W,051.9,T,031.6,M,001.3,N,004*29
           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


eg2. $GPBWC,220516,5130.02,N,00046.34,W,213.8,T,218.0,M,0004.6,N,EGLM*11
                1      2    3     4    5    6  7   8   9    10  11 12 13


      1    220516    timestamp
      2    5130.02   Latitude of next waypoint
      3    N         North/South
      4    00046.34  Longitude of next waypoint
      5    W         East/West
      6    213.0     True track to waypoint
      7    T         True Track
```

```
8    218.0     Magnetic track to waypoint
9    M         Magnetic
10   0004.6    range to waypoint
11   N         unit of range to waypoint, N = Nautical miles
12   EGLM      Waypoint name
13   *11       checksum
```

$GPGGA

Global Positioning System Fix Data

eg1. $GPGGA,170834,4124.8963,N,08151.6838,W,1,05,1.5,280.2,M,-34.0,M,,,*75

Name	Example Data	Description
Sentence Identifier	$GPGGA	Global Positioning System Fix Data
Time	170834	17:08:34 UTC
Latitude	4124.8963, N	41d 24.8963' N or 41d 24' 54" N
Longitude	08151.6838, W	81d 51.6838' W or 81d 51' 41" W
Fix Quality: - 0 = Invalid - 1 = GPS fix - 2 = DGPS fix	1	Data is from a GPS fix
Number of Satellites	05	5 Satellites are in view
Horizontal Dilution of Precision (HDOP)	1.5	Relative accuracy of horizontal position
Altitude	280.2, M	280.2 meters above mean sea level
Height of geoid above WGS84 ellipsoid	-34.0, M	-34.0 meters
Time since last DGPS update	blank	No last update
DGPS reference station id	blank	No station id
Checksum	*75	Used by program to check for transmission errors

Courtesy of Brian McClure, N8PQI.

Global Positioning System Fix Data. Time, position and fix related data for a GPS receiver.

eg2. $GPGGA,hhmmss.ss,ddmm.mmm,a,dddmm.mmm,b,q,xx,p.p,a.b,M,c.d,M,x.x,nnnn

hhmmss.ss = UTC of position
ddmm.mmm = latitude of position
a = N or S, latitutde hemisphere
dddmm.mmm = longitude of position

b = E or W, longitude hemisphere
q = GPS Quality indicator (0=No fix, 1=Non-differential GPS fix, 2=Differential GPS fix, 6=Estimated fix)
xx = number of satellites in use
p.p = horizontal dilution of precision
a.b = Antenna altitude above mean-sea-level
M = units of antenna altitude, meters
c.d = Geoidal height
M = units of geoidal height, meters
x.x = Age of Differential GPS data (seconds since last valid RTCM transmission)
nnnn = Differential reference station ID, 0000 to 1023

$GPGLL

Geographic Position, Latitude / Longitude and time.

```
eg1. $GPGLL,3751.65,S,14507.36,E*77
eg2. $GPGLL,4916.45,N,12311.12,W,225444,A


           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 valid


eg3. $GPGLL,5133.81,N,00042.25,W*75
                1    2     3    4 5

      1    5133.81   Current latitude
      2    N         North/South
      3    00042.25  Current longitude
      4    W         East/West
      5    *75       checksum
```

$--GLL,lll.ll,a,yyyyy.yy,a,hhmmss.ss,A llll.ll = Latitude of position

a = N or S
yyyyy.yy = Longitude of position
a = E or W
hhmmss.ss = UTC of position
A = status: A = valid data

$GPGSA

GPS DOP and active satellites

```
eg1. $GPGSA,A,3,,,,,,16,18,,22,24,,,3.6,2.1,2.2*3C
eg2. $GPGSA,A,3,19,28,14,18,27,22,31,39,,,,,1.7,1.0,1.3*34
```

```
1    = Mode:
       M=Manual, forced to operate in 2D or 3D
       A=Automatic, 3D/2D
2    = Mode:
       1=Fix not available
       2=2D
       3=3D
3-14 = PRN's of Satellite Vechicles (SV's) used in position fix (null for
unused fields)
15   = Position Dilution of Precision (PDOP)
16   = Horizontal Dilution of Precision (HDOP)
17   = Vertical Dilution of Precision (VDOP)
```

$GPGSV

GPS Satellites in view

```
eg. $GPGSV,3,1,11,03,03,111,00,04,15,270,00,06,01,010,00,13,06,292,00*74
    $GPGSV,3,2,11,14,25,170,00,16,57,208,39,18,67,296,40,19,40,246,00*74
    $GPGSV,3,3,11,22,42,067,42,24,14,311,43,27,05,244,00,,,,*4D


    $GPGSV,1,1,13,02,02,213,,03,-3,000,,11,00,121,,14,13,172,05*62


1    = Total number of messages of this type in this cycle
2    = Message number
3    = Total number of SVs in view
4    = SV PRN number
5    = Elevation in degrees, 90 maximum
6    = Azimuth, degrees from true north, 000 to 359
7    = SNR, 00-99 dB (null when not tracking)
8-11 = Information about second SV, same as field 4-7
12-15= Information about third SV, same as field 4-7
16-19= Information about fourth SV, same as field 4-7
```

$GPHDT

Heading, True.

Actual vessel heading in degrees Ture produced by any device or system producing true heading.

$--HDT,x.x,T
x.x = Heading, degrees True

$GPR00

List of waypoint IDs in currently active route

```
eg1. $GPR00,EGLL,EGLM,EGTB,EGUB,EGTK,MBOT,EGTB,,,,,,,*58
eg2. $GPR00,MINST,CHATN,CHAT1,CHATW,CHATM,CHATE,003,004,005,006,007,,,*05


List of waypoints. This alternates with $GPWPL cycle
which itself cycles waypoints.
```

$GPRMA

Recommended minimum specific Loran-C data

```
eg. $GPRMA,A,lll,N,lll,W,x,y,ss.s,ccc,vv.v,W*hh
A    = Data status
lll  = Latitude
N    = N/S
lll  = longitude
S    = W/E
x    = not used
y    = not used
ss.s = Speed over ground in knots
ccc  = Course over ground
vv.v = Variation
W    = Direction of variation E/W
hh   = Checksum
```

$GPRMB

Recommended minimum navigation information (sent by nav. receiver when a destination waypoint is active)

```
eg1. $GPRMB,A,0.66,L,003,004,4917.24,N,12309.57,W,001.3,052.5,000.5,V*0B


           A            Data status A = OK, V = warning
           0.66,L       Cross-track error (nautical miles, 9.9 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
           052.5        True bearing to destination
           000.5        Velocity towards destination, knots
           V            Arrival alarm  A = arrived, V = not arrived
           *0B          mandatory checksum


eg2. $GPRMB,A,4.08,L,EGLL,EGLM,5130.02,N,00046.34,W,004.6,213.9,122.9,A*3D
             1   2  3   4    5    6     7   8      9   10    11    12   13


      1    A         validity
```

```
      2    4.08      off track
      3    L         Steer Left (L/R)
      4    EGLL      last waypoint
      5    EGLM      next waypoint
      6    5130.02   Latitude of Next waypoint
      7    N         North/South
      8    00046.34  Longitude of next waypoint
      9    W         East/West
      10   004.6     Range
      11   213.9     bearing to waypt.
      12   122.9     closing velocity
      13   A         validity
      14   *3D       checksum


eg3. $GPRMB,A,x.x,a,c--c,d--d,llll.ll,e,yyyyy.yy,f,g.g,h.h,i.i,j*kk
1    = Data Status (V=navigation receiver warning)
2    = Crosstrack error in nautical miles
3    = Direction to steer (L or R) to correct error
4    = Origin waypoint ID#
5    = Destination waypoint ID#
6    = Destination waypoint latitude
7    = N or S
8    = Destination waypoint longitude
9    = E or W
10   = Range to destination in nautical miles
11   = Bearing to destination, degrees True
12   = Destination closing velocity in knots
13   = Arrival status; (A=entered or perpendicular passed)
14   = Checksum
```

$GPRMC

Recommended minimum specific GPS/Transit data

```
eg1. $GPRMC,081836,A,3751.65,S,14507.36,E,000.0,360.0,130998,011.3,E*62
eg2. $GPRMC,225446,A,4916.45,N,12311.12,W,000.5,054.7,191194,020.3,E*68


           225446       Time of fix 22:54:46 UTC
           A            Navigation receiver warning A = Valid position, V =
Warning
           4916.45,N    Latitude 49 deg. 16.45 min. North
           12311.12,W   Longitude 123 deg. 11.12 min. West
           000.5        Speed over ground, Knots
           054.7        Course Made Good, degrees true
           191194       UTC Date of fix, 19 November 1994
           020.3,E      Magnetic variation, 20.3 deg. East
           *68          mandatory checksum


eg3. $GPRMC,220516,A,5133.82,N,00042.24,W,173.8,231.8,130694,004.2,W*70
             1    2    3    4    5     6    7    8      9     10  11 12


      1   220516     Time Stamp
      2   A          validity - A-ok, V-invalid
      3   5133.82    current Latitude
```

```
      4   N          North/South
      5   00042.24   current Longitude
      6   W          East/West
      7   173.8      Speed in knots
      8   231.8      True course
      9   130694     Date Stamp
      10  004.2      Variation
      11  W          East/West
      12  *70        checksum


eg4. for NMEA 0183 version 3.00 active the Mode indicator field is added
     $GPRMC,hhmmss.ss,A,llll.ll,a,yyyyy.yy,a,x.x,x.x,ddmmyy,x.x,a,m*hh
Field #
1    = UTC time of fix
2    = Data status (A=Valid position, V=navigation receiver warning)
3    = Latitude of fix
4    = N or S of longitude
5    = Longitude of fix
6    = E or W of longitude
7    = Speed over ground in knots
8    = Track made good in degrees True
9    = UTC date of fix
10   = Magnetic variation degrees (Easterly var. subtracts from true
course)
11   = E or W of magnetic variation
12   = Mode indicator, (A=Autonomous, D=Differential, E=Estimated, N=Data
not valid)
13   = Checksum
```

$GPRTE

Routes

```
eg.
$GPRTE,2,1,c,0,PBRCPK,PBRTO,PTELGR,PPLAND,PYAMBU,PPFAIR,PWARRN,PMORTL,PLISM
R*73
    $GPRTE,2,2,c,0,PCRESY,GRYRIE,GCORIO,GWERR,GWESTG,7FED*34
           1 2 3 4 5 ..
```

1. Number of sentences in sequence
2. Sentence number
3. 'c' = Current active route, 'w' = waypoint list starts with destination waypoint
4. Name or number of the active route
5. onwards, Names of waypoints in Route

$GPTRF

Transit Fix Data

Time, date, position, and information related to a TRANSIT Fix.

$--TRF,hhmmss.ss,xxxxxx,llll.ll,a,yyyyy.yy,a,x.x,x.x,x.x,x.x,xxx
hhmmss.ss = UTC of position fix
xxxxxx = Date: dd/mm/yy
llll.ll,a = Latitude of position fix, N/S
yyyyy.yy,a = Longitude of position fix, E/W
x.x = Elevation angle
x.x = Number of iterations
x.x = Number of Doppler intervals
x.x = Update distance, nautical miles
x.x = Satellite ID

$GPSTN

Multiple Data ID.

This sentence is transmitted before each individual sentence where there is a need for the Listener to determine the exact source of data in the system. Examples might include dual-frequency depthsounding equipment or equipment that integrates data from a number of sources and produces a single output.

$--STN,xx
xx = Talker ID number, 00 to 99

$GPVBW

Dual Ground / Water Speed

Water referenced and ground referenced speed data.

$--VBW,x.x,x.x,A,x.x,x.x,A
x.x = Longitudinal water speed, knots
x.x = Transverse water speed, knots
A = Status: Water speed, A = Data valid
x.x = Longitudinal ground speed, knots
x.x = Transverse ground speed, knots
A = Status: Ground speed, A = Data valid

$GPVTG

Track Made Good and Ground Speed.

```
eg1. $GPVTG,360.0,T,348.7,M,000.0,N,000.0,K*43
eg2. $GPVTG,054.7,T,034.4,M,005.5,N,010.2,K*41
```

```
           054.7,T      True course made good over ground, degrees
           034.4,M      Magnetic course made good over ground, degrees
           005.5,N      Ground speed, N=Knots
           010.2,K      Ground speed, K=Kilometers per hour


eg3. for NMEA 0183 version 3.00 active the Mode indicator field
     is added at the end
     $GPVTG,054.7,T,034.4,M,005.5,N,010.2,K,A*53
           A            Mode indicator (A=Autonomous, D=Differential,
                        E=Estimated, N=Data not valid)
```

$GPWPL

Waypoint location

```
eg1. $GPWPL,4917.16,N,12310.64,W,003*65


           4917.16,N    Latitude of waypoint
           12310.64,W   Longitude of waypoint
           003          Waypoint ID


             When a route is active, this sentence is sent once for each
             waypoint in the route, in sequence. When all waypoints have
             been reported, GPR00 is sent in the next data set. In any
             group of sentences, only one WPL sentence, or an R00
             sentence, will be sent.


eg2.  $GPWPL,5128.62,N,00027.58,W,EGLL*59
         1     2     3    4  5   6


      1    5128.62   Latitude of nth waypoint on list
      2    N         North/South
      3    00027.58  Longitude of nth waypoint
      4    W         East/West
      5    EGLL      Ident of nth waypoint
      6    *59       checksum
```

$GPXTE

Cross Track Error, Measured

```
eg1. $GPXTE,A,A,0.67,L,N


           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


eg2. $GPXTE,A,A,4.07,L,N*6D
           1 2  3   4 5 6


     1    A         validity
     2    A         cycle lock
     3    4.07      distance off track
     4    L         steer left (L/R)
     5    N         distance units
     6    *6D       checksum
```

$GPZDA

Date and Time

UTC, day, month, year, and local time zone.

$--ZDA,hhmmss.ss,xx,xx,xxxx,xx,xx
hhmmss.ss = UTC
xx = Day, 01 to 31
xx = Month, 01 to 12
xxxx = Year
xx = Local zone description, 00 to +/- 13 hours
xx = Local zone minutes description (same sign as hours)