= NMEA Revealed =
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This is a list of NMEA 0183 sentences with field descriptions.
It is primarily intended to help people understand GPS reports.

The master of this document is in asciidoc format at
http://gpsd.berlios.de/NMEA.txt[]; you are probably seeing it as a web
page. You may encounter versions of it, in plain ASCII, that do not
have a revision number and do not list an editor. These are older and
should probably be considered obsolescent.

== Sources and Applicable Standards ==

This collection may originally have been redacted from the document cited as
<<NMEA2000>>; see the list of sources at the end of this document.
The official NMEA standard was not consulted at any point, thus this
document is not a derivative work of that standard and is not
controlled by the rapacious lawyers of NMEA.

It appears there is an international standard, IEC 61162-1, published
in 2000, that is essentially NMEA 0183. <<IEC61162-1>> says it "is closely
aligned with NMEA 0183 version 2.30". Unfortunately, it costs money
and is not redistributable.

This collection of sentences is originally from the gpsdrive
distribution, but adds more information on the following topics:

* Old and new forms of VTG
* Units used in GGA
* Vendor extensions PRWIZCH and PMGNST
* FAA Mode Indicator field for RMC, RMB, VTG, GLL, BWC, XTE.
* New documentation on BWC, DTM, GBS, GNS, GRS, GST, MSK, and MSS sentences.
* Sentence examples merged from [GIDS]
* Sentence explanations from [GIDS] and elsewhere
* Corrected badly mangled ZDA description.
* Corrected DPT titling
* Common talker IDs
* Sentences HFB, ITS, TPC, TDS, TFI, TPC, TPR, TPT from [GLOBALSAT].
* Sentence PASHR from [PASHR].
* Satellite IDs: PRN vs NMEA-ID.
* Error status indications.

== Physical protocol layer ==

The NMEA specification requires a physical-level protocol compatible
with RS422 at 4800bps, 8N1 or 7N2. It is RS422 rather than RS232
because NMEA expects many navigational devices to feed a common serial
bus. The data encoding is ASCII with the high data bit not used and zeroed.

Consumer-grade GPS sensors normally report over an RS232 port or a USB
port emulating an RS232 serial device; some use Bluetooth. Baud rate
is variable, with 9600 probably the most common. Most devices use
8N1; there are rare exceptions that use 7N2 (San Jose Navigation) or
even 8O1 (Trimble).

== Sentence Mixes and NMEA Variations ==

Most GPS sensors emit only RMC, GSA, GSV, GLL, VTG, and (rarely) ZDA.
Newer ones conforming to NMEA 3.x may emit GBS as well. Other NMEA
sentences are usually only emitted by high-end maritime navigation
systems.

The form of VTG is incompatibly variable with NMEA version. See
the detailed description of that sentence for details.

In NMEA 2.3, several sentences (APB, BWC, BWR, GLL, RMA, RMB, RMC,
VTG, WCV, and XTE) got a new last field carrying the signal integrity
information needed by the FAA. (The values in the GGA mode field were
extended to carry this information as well.) Here are the values:

FAA Mode Indicator
     A = Autonomous mode
     D = Differential Mode
     E = Estimated (dead-reckoning) mode
     M = Manual Input Mode
     S = Simulated Mode
     N = Data Not Valid

This field may be empty. In pre-2.3 versions it is omitted. [NTUM] says
that according to the NMEA specification, it dominates the Status field --
the Status field will be set to "A" (data valid) for Mode Indicators A
and D, and to "V" (data invalid) for all other values of the Mode
Indicator. This is confirmed by [IEC].

In NMEA 3.0, the GBS sentence reports a complete set of error estimates. Note
however that many receivers claiming to emit "3.0" or "3.01" don't
actually ship this sentence.

== NMEA Encoding Conventions ==

An NMEA sentence consists of a start delimiter, followed by a
comma-separated sequence of fields, followed by the character '*'
(ASCII 42), followed by a CRC32 checksum expressed as two hexadecimal
digits, followed by an end-of-line marker.

The start delimiter is normally '$' (ASCII 36). Packets of AIVDM/AIVDO
data, which are otherwise formatted like NMEA, use '!'. It is
possible that recent revisions of NMEA may allow other exceptions;
we do not know.

The first field of a sentence is called the "tag" and normally
consists of a two-letter talker ID followed by a three-letter
type code.

Where a numeric latitude or longitude is given, the two digits

immediately to the left of the decimal point are whole minutes, to the right are decimals of minutes, and the remaining digits to the left of the whole minutes are whole degrees.

Eg. 4533.35 is 45 degrees and 33.35 minutes. ".35" of a minute is exactly 21 seconds.

Eg. 16708.033 is 167 degrees and 8.033 minutes. ".033" of a minute is about 2 seconds.

According to [UNMEA], the NMEA standard requires that a field (such as altitude, latitude, or longitude) must be left empty when the GPS has no valid data for it. However, many receivers violate this. It's common, for example, to see latitude/longitude/altitude figures filled with zeros when the GPS has no valid data.

== Dates and times ==

NMEA devices report date and time in UTC, aka GMT, aka Zulu time (as opposed to local time). But the way this report is computed results in some odd bugs and inaccuracies.

Date and time in GPS is represented as number of weeks from the start of zero second of 6 January 1980, plus number of seconds into the week. GPS time is not leap-second corrected, though satellites also broadcast a current leap-second correction which is updated on six-month boundaries according to rotational bulletins issued by the International Earth Rotation and Reference Systems Service (IERS).

The leap-second correction is only included in the satellite subframre broadcast, roughly once ever 20 minutes. While the satellites do notify GPSes of upcoming leap-seconds, this notification is not necessarily processed correctly on consumer-grade devices, and will not be available at all when a GPS receiver has just cold-booted. Thus, reported UTC time may be slightly inaccurate between a cold boot or leap second and the following subframe broadcast.

GPS date and time are subject to a rollover problem in the 10-bit week number counter, which will re-zero every 1024 weeks (roughly every 20 years). The last rollover (and the first since GPS went live in 1980) was in 1999; the next would fall in 2019, but plans are afoot to upgrade the satellite counters to 13 bits; this will delay the next rollover until 2173.

For accurate time reporting, therefore, a GPS requires a supplemental time references sufficient to identify the current rollover period, e.g. accurate to within 512 weeks. Many NMEA GPSes have a wired-in assumption about the UTC time of the last rollover and will thus report incorrect times outside the rollover period they were designed in.

For these reasons, NMEA GPS should not be considered high-quality references for absolute time. Some do, however, emit pulse-per-second RS232 signals which can be used to improve the precision of an external clock. See [PPS] for discussion.

== Error status indications

The NMEA sentences in the normal GPS inventory return four kinds of validity flags: Mode, Status, the Active/Void bit, and in later versions the FAA indicator mode. The FAA mode field is legally required and orthogonal to the others. Here's how the first three used in various sentences:

[frame="topbot",options="header"]
|==========
| | GPRMC | GPGLL | GPGGA | GPGSA
|Returns A/V | Yes | Yes | No | No
|Returns mode | No | No | No | Yes
|Returns status | No | Yes | Yes | No
|==========

The "Navigation receiver warning" is 'A' for Active and 'V' for Void. (or warning). You will see it when either there is no satellite lock, or to indicate a valid fix that has a DOP too high, or which fails an elevation test. In the latter case the visible sats are below some fixed elevation of the horizon (usually 15%, but some GPSes make this adjustable) making position unreliable due to poor geometrty and more variable signal lag induced by lengthened atmisphere transit.

Mode is associated with the GSA sentence associated with the last fix. It reports whether the fix was no good, sufficirnt for 2D, or sufficient for 3D (values 1, 2, and 3).

Status will be 0 ehen the sample from from which the reporting sentence was generated does not have a valid fix, 1 when it has a valid (normal-precision) fix, and 2 when the fig is DGPS corrected (reducing the base error).

In addition, some sentences may use empty fields to signify invalid data. It is not clear whether NMEA 0183 allows this, but real-world software must cope.

== Talker IDs ==

NMEA sentences do not identify the individuasl device that issued them; the format was originally designed for shipboard multidrop networks on which it's possible only to broadcast to all devices,. not address a specific one.

NMEA sentences do, however, include a "talker ID" a two-character prefix that identifies the type of the transmitting unit. By far the most common talker ID is "GP", identifying a generic GPS, but all of the following are well known:

.Common talker IDs
|==========

|GP | Global Positioning System receiver
|LC | Loran-C receiver
|II | Integrated Instrumentation
|IN | Integrated Navigation
|EC | Electronic Chart Display & Information System (ECDIS)
|CD | Digital Selective Calling (DSC)
|GL | GLONASS, according to IEIC 61162-1
|GN | Mixed GPS and GLONASS data, according to IEIC 61162-1
|===

LC - LORAN-C is a marine navigation system run by the U.S. government, which is planning to shut it down in favor of GPS. Some non-LORAN devices emit GLL but use this talker ID for backward-compatibility reasons, so it may outlast the actual LORAN system.

II - II is emitted by the NMEA interfaces of several widely-used lines of marine-navigation electronics. One is the AutoHelm system by Raymarine; see also [SEATALK] for the native protocol of these devices.

IN -- Some Garmin GPS units use an IN talker ID.

EC -- ECDIS is a specialized geographical information system intended to support professional maritime navigation. NMEA talker units meeting the ECDIS standard use this prefix. Some of these emit GLL.

CD -- Modern marine VHF radios have a set of logic collectively known as Digital Selective Calling (DSC). These radios typically take data from a local position indicating device. This data is used in conjunction with a unique (FCC assigned) ID to cause your radio to broadcast your position data to others. Conversely, these radios are capable of recieving position data of other stations and emitting sentences indicating other station positions. This lets you plot the position of other vessels on a chart, for instance. There has been at least one instance of a DSC enabled radio overloading (mis-using) the LC talker prefix for this purpose. Otherwise they use the CD prefix. A vessel's nav system is likely to have both CD and some other position indicating talker on its bus(es).

Until the U.S. Coast Guard terminated the Omega Navigation System in 1997, another common talker prefix was "OM" for an Omega Navigation System receiver.

Here is a more complete list of talker ID prefixes. Most are not relevant to GPS systems.

.Big list of talker IDs
|===
|AG | Autopilot - General
|AP | Autopilot - Magnetic
|CC | Computer - Programmed Calculator (obsolete)
|CD | Communications - Digital Selective Calling (DSC)
|CM | Computer - Memory Data (obsolete)
|CS | Communications - Satellite
|CT | Communications - Radio-Telephone (MF/HF)
|CV | Communications - Radio-Telephone (VHF)
|CX | Communications - Scanning Receiver
|DE | DECCA Navigation (obsolete)
|DF | Direction Finder
|EC | Electronic Chart Display & Information System (ECDIS)
|EP | Emergency Position Indicating Beacon (EPIRB)
|ER | Engine Room Monitoring Systems
|GP | Global Positioning System (GPS)
|HC | Heading - Magnetic Compass
|HE | Heading - North Seeking Gyro
|HN | Heading - Non North Seeking Gyro
|II | Integrated Instrumentation
|IN | Integrated Navigation
|LA | Loran A (obsolete)
|LC | Loran C (obsolete)
|MP | Microwave Positioning System (obsolete)
|OM | OMEGA Navigation System (obsolete)
|OS | Distress Alarm System (obsolete)
|RA | RADAR and/or ARPA
|SD | Sounder, Depth
|SN | Electronic Positioning System, other/general
|SS | Sounder, Scanning
|TI | Turn Rate Indicator
|TR | TRANSIT Navigation System
|VD | Velocity Sensor, Doppler, other/general
|DM | Velocity Sensor, Speed Log, Water, Magnetic
|VW | Velocity Sensor, Speed Log, Water, Mechanical
|WI | Weather Instruments
|YC | Transducer - Temperature (obsolete)
|YD | Transducer - Displacement, Angular or Linear (obsolete)
|YF | Transducer - Frequency (obsolete)
|YL | Transducer - Level (obsolete)
|YP | Transducer - Pressure (obsolete)
|YR | Transducer - Flow Rate (obsolete)
|YT | Transducer - Tachometer (obsolete)
|YV | Transducer - Volume (obsolete)
|YX | Transducer
|ZA | Timekeeper - Atomic Clock
|ZC | Timekeeper - Chronometer
|ZQ | Timekeeper - Quartz
|ZV | Timekeeper - Radio Update, WWV or WWVH
|===

== Satellite IDs ==

Satellites may be identified by one of two different numbers in sentences such as GSV: a PRN number associate with their radio code, or an NMEA-ID.

For satellites 1-32, the GPS constellation, these numbers are the same. For satellites associated with WAAS (Wide Area Augnmentation System), EGNOS (European Geostationary Navigation Overlay Service),

and MSAS (Multi-functional Satellite Augmentation System), they are
different.

Here is a table of NMEA-ID allocations above 32 as of March 2010:

[frame="topbot",options="header"]
|==
|System |Satellite |PRN |NMEA-ID
|EGNOS |AOR-E |120 |33
|EGNOS |Artemis |124 |37
|EGNOS |IOR-W |126 |39
|MSAS |MTSAT-1 |129 |42
|EGNOS |IOR-E |131 |44
|WAAS |AMR |133 |46
|WAAS |PanAm |135 |48
|MSAS |MTSAT-2 |137 |50
|WAAS |Anik |138 |51
|==

In general, NMEA-ID = PRN - 87. Theoretically, all NMEA-emitting
devices should emit NMEA-IDs. In practice, some pass through PRNs.

== Obsolete sentences ==

The following NMEA sentences have been designated "obsolete" in a
publicly available NMEA document dated 2009.

|==
|APA - Autopilot Sentence "A"
|BER - Bearing & Distance to Waypoint, Dead Reckoning, Rhumb Line
|BPI - Bearing & Distance to Point of Interest
|DBK - Depth Below Keel
|DBS - Depth Below Surface
|
|DRU - Dual Doppler Auxiliary Data
|GDA - Dead Reckoning Positions
|GLA - Loran-C Positions
|GOA - OMEGA Positions
|GXA - TRANSIT Positions
|GTD - Geographical Position, Loran-C TDs
|GXA - TRANSIT Position
|HCC - Compass Heading
|HCD - Heading and Deviation
|HDM - Heading, Magnetic
|HDT - Heading, True
|HVD - Magnetic Variation, Automatic
|HVM - Magnetic Variation, Manually Set
|IMA - Vessel Identification
|MDA - Meteorological Composite
|MHU - Humidity
|MMB - Barometer
|MTA - Air Temperature
|MWH - Wave Height
|MWS - Wind & Sea State
|
|Rnn - Routes
|SBK - Loran-C Blink Status
|SCY - Loran-C Cycle Lock Status
|SCD - Loran-C ECDs
|SDB - Loran-C Signal Strength
|SGD - Position Accuracy Estimate
|SGR - Loran-C Chain Identifier
|SIU - Loran-C Stations in Use
|SLC - Loran-C Status
|SNC - Navigation Calculation Basis
|SNU - Loran-C SNR Status
|SPS - Loran-C Predicted Signal Strength
|SSF - Position Correction Offset
|STC - Time Constant
|STR - Tracking Reference
|SYS - Hybrid System Configuration
|==

== NMEA-Standard Sentences ==

Here are the NMEA-standard sentences we know about:

=== AAM - Waypoint Arrival Alarm ===

This sentence 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.

```
------------------------------------------------------------------------------
        1 2 3   4 5    6
        | | |   | |    |
 $--AAM,A,A,x.x,N,c--c*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Status, BOOLEAN, A = Arrival circle entered
2. Status, BOOLEAN, A = perpendicular passed at waypoint
3. Arrival circle radius
4. Units of radius, nautical miles
5. Waypoint ID
6. Checksum

Example: GPAAM,A,A,0.10,N,WPTNME*43

WPTNME is the waypoint name.

=== ALM - GPS Almanac Data ===

This sentence expresses orbital data for a specified GPS satellite.

```
------------------------------------------------------------------------------
```

```
       1   2   3  4   5  6    7  8    9    10     11     12     13     14  15   16
       |   |   |  |   |  |    |  |    |    |      |      |      |      |   |    |
 $--ALM,x.x,x.x,xx,x.x,hh,hhhh,hh,hhhh,hhhh,hhhhhh,hhhhhh,hhhhhh,hhhhhh,hhh,hhh,*hh<CR><LF>
--------------------------------------------------------------------------------
```

Field Number:

1. Total number of messages
2. Message Number
3. Satellite PRN number (01 to 32)
4. GPS Week Number
5. SV health, bits 17-24 of each almanac page
6. Eccentricity
7. Almanac Reference Time
8. Inclination Angle
9. Rate of Right Ascension
10. Root of semi-major axis
11. Argument of perigee
12. Longitude of ascension node
13. Mean anomaly
14. F0 Clock Parameter
15. F1 Clock Parameter
16. Checksum

Example: $GPALM,1,1,15,1159,00,441d,4e,16be,fd5e,a10c9f,4a2da4,686e81,58cbe1,0a4,001*5B

=== APA - Autopilot Sentence "A" ===

This sentence 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.

```
--------------------------------------------------------------------------------
       1 2  3   4 5 6 7  8  9 10    11
       | |  |   | | | |  |  | |     |
 $--APA,A,A,x.xx,L,N,A,A,xxx,M,c---c*hh<CR><LF>
--------------------------------------------------------------------------------
```

Field Number:

1. Status
   V = LORAN-C Blink or SNR warning
   V = general warning flag or other navigation systems when a reliable
       fix is not available
2. Status
   V = Loran-C Cycle Lock warning flag
   A = OK or not used
3. Cross Track Error Magnitude
4. Direction to steer, L or R
5. Cross Track Units (Nautic miles or kilometers)
6. Status
   A = Arrival Circle Entered
7. Status
   A = Perpendicular passed at waypoint
8. Bearing origin to destination
9. M = Magnetic, T = True
10. Destination Waypoint ID
11. checksum

Example: $GPAPA,A,A,0.10,R,N,V,V,011,M,DEST,011,M*82

=== APB - Autopilot Sentence "B" ===

This is a fixed form of the APA sentence with some ambiguities removed.

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.

```
                                        13    15
--------------------------------------------------------------------------------
       1 2 3   4 5 6 7 8   9 10   11  12|   14|
       | | |   | | | | |   | |    |   | |   | |
 $--APB,A,A,x.x,a,N,A,A,x.x,a,c--c,x.x,a,x.x,a*hh<CR><LF>
--------------------------------------------------------------------------------
```

Field Number:

1. Status
   V = LORAN-C Blink or SNR warning
   V = general warning flag or other navigation systems when a reliable
       fix is not available
2. Status
   V = Loran-C Cycle Lock warning flag
   A = OK or not used
3. Cross Track Error Magnitude
4. Direction to steer, L or R
5. Cross Track Units, N = Nautical Miles
6. Status
   A = Arrival Circle Entered
7. Status
   A = Perpendicular passed at waypoint
8. Bearing origin to destination
9. M = Magnetic, T = True
10. Destination Waypoint ID
11. Bearing, present position to Destination
12. M = Magnetic, T = True
13. Heading to steer to destination waypoint

14. M = Magnetic, T = True
15. Checksum

Example: $GPAPB,A,A,0.10,R,N,V,V,011,M,DEST,011,M,011,M*82

=== BOD - Bearing - Waypoint to Waypoint ===

```
------------------------------------------------------------------------------
        1   2 3   4 5    6    7
        |   | |   | |    |    |
 $--BOD,x.x,T,x.x,M,c--c,c--c*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Bearing Degrees, TRUE
2. T = True
3. Bearing Degrees, Magnetic
4. M = Magnetic
5. TO Waypoint
6. FROM Waypoint
7. Checksum

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.)

=== BWC - Bearing & Distance to Waypoint - Geat Circle ===

```
------------------------------------------------------------------------------
                                                       12
        1         2       3 4        5 6   7 8   9 10  11|    13 14
        |         |       | |        | |   | |   | |   | |    |   |
 $--BEC,hhmmss.ss,llll.ll,a,yyyyy.yy,a,x.x,T,x.x,M,x.x,N,c--c,m,*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. UTCTime
2. Waypoint Latitude
3. N = North, S = South
4. Waypoint Longitude
5. E = East, W = West
6. Bearing, True
7. T = True
8. Bearing, Magnetic
9. M = Magnetic
10. Nautical Miles
11. N = Nautical Miles
12. Waypoint ID
13. FAA mode indicator (NMEA 2.3 and later, optional)
14. Checksum

Example 1: $GPBWC,081837,,,,,,T,,M,,N,*13

Example 2: GPBWC,220516,5130.02,N,00046.34,W,213.8,T,218.0,M,0004.6,N,EGLM*11

=== BWR - Bearing and Distance to Waypoint - Rhumb Line ===

```
------------------------------------------------------------------------------
                                                    11
        1         2       3 4        5 6   7 8   9 10  | 12   13
        |         |       | |        | |   | |   | |   | |    |
 $--BWR,hhmmss.ss,llll.ll,a,yyyyy.yy,a,x.x,T,x.x,M,x.x,N,c--c*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. UTCTime
2. Waypoint Latitude
3. N = North, S = South
4. Waypoint Longitude
5. E = East, W = West
6. Bearing, True
7. T = True
8. Bearing, Magnetic
9. M = Magnetic
10. Nautical Miles
11. N = Nautical Miles
12. Waypoint ID
13. Checksum

=== BWW - Bearing - Waypoint to Waypoint ===

```
------------------------------------------------------------------------------
        1   2 3   4 5    6    7
        |   | |   | |    |    |
 $--BWW,x.x,T,x.x,M,c--c,c--c*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:
1. Bearing Degrees, TRUE

2. T = True
3. Bearing Degrees, Magnetic
4. M = Magnetic
5. TO Waypoint
6. FROM Waypoint
7. Checksum

=== DBK - Depth Below Keel ===

```
------------------------------------------------------------------------------
        1   2 3   4 5   6 7
        |   | |   | |   | |
 $--DBK,x.x,f,x.x,M,x.x,F*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Depth, feet
2. f = feet
3. Depth, meters
4. M = meters
5. Depth, Fathoms
6. F = Fathoms
7. Checksum

=== DBS - Depth Below Surface ===

```
------------------------------------------------------------------------------
        1   2 3   4 5   6 7
        |   | |   | |   | |
 $--DBS,x.x,f,x.x,M,x.x,F*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Depth, feet
2. f = feet
3. Depth, meters
4. M = meters
5. Depth, Fathoms
6. F = Fathoms
7. Checksum

=== DBT - Depth below transducer ===

```
------------------------------------------------------------------------------
        1   2 3   4 5   6 7
        |   | |   | |   | |
 $--DBT,x.x,f,x.x,M,x.x,F*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Depth, feet
2. f = feet
3. Depth, meters
4. M = meters
5. Depth, Fathoms
6. F = Fathoms
7. Checksum

=== DCN - Decca Position ===

```
------------------------------------------------------------------------------
                                      11  13      16
        1  2  3   4 5  6   7 8  9   10| 12| 14  15| 17
        |  |  |   | |  |   | |  |   | | | | |   | | |
 $--DCN,xx,cc,x.x,A,cc,x.x,A,cc,x.x,A,A,A,A,x.x,N,x*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Decca chain identifier
2. Red Zone Identifier
3. Red Line Of Position
4. Red Master Line Status
5. Green Zone Identifier
6. Green Line Of Position
7. Green Master Line Status
8. Purple Zone Identifier
9. Purple Line Of Position
10. Purple Master Line Status
11. Red Line Navigation Use
12. Green Line Navigation Use
13. Purple Line Navigation Use
14. Position Uncertainity
15. N = Nautical Miles
16. Fix Data Basis
    - 1 = Normal Pattern
    - 2 = Lane Identification Pattern
    - 3 = Lane Identification Transmissions
17. Checksum

(The DCN sentence is obsolete as of 3.01)

=== DPT - Depth of Water ===

```
------------------------------------------------------------------------------
        1   2   3
        |   |   |
 $--DPT,x.x,x.x*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Depth, meters

```
2. Offset from transducer,
     positive means distance from tansducer to water line
     negative means distance from transducer to keel
3. Checksum

This sentence was incorrectly titled "Heading - Deviation & Variation"
in [NMEA2000].  It's documented at
<http://www.humminbird.com/normal.asp?id=853>

=== DTM - Datum Reference ===

------------------------------------------------------------------------------
          1  2  3   4  5   6  7  8    9
          |  |  |   |  |   |  |  |    |
 $ --DTM,ref,x,llll,c,llll,c,aaa,ref*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. Local datum code.
2. Local datum subcode.  May be blank.
3. Latitude offset (minutes)
4. N or S
5. Longitude offset (minutes)
6. E or W
7. Altitude offset in meters
8. Datum name. What's usually seen here is "W84", the standard
   WGS84 datum used by GPS.
9. Checksum.

=== FSI - Frequency Set Information ===

------------------------------------------------------------------------------
        1      2      3 4 5
        |      |      | | |
 $--FSI,xxxxxx,xxxxxx,c,x*hh<CR><LF>
------------------------------------------------------------------------------

 Field Number:
1. Transmitting Frequency
2. Receiving Frequency
3. Communications Mode (NMEA Syntax 2)
4. Power Level
5. Checksum


=== GBS - GPS Satellite Fault Detection ===

------------------------------------------------------------------------------
           1      2   3   4   5   6   7   8   9
           |      |   |   |   |   |   |   |   |
 $--GBS,hhmmss.ss,x.x,x.x,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. UTC time of the GGA or GNS fix associated with this sentence
2. Expected error in latitude (meters)
3. Expected error in longitude (meters)
4. Expected error in altitude (meters)
5. PRN of most likely failed satellite
6. Probability of missed detection for most likely failed satellite
7. Estimate of bias in meters on most likely failed satellite
8. Standard deviation of bias estimate
9. Checksum

Note: Source [MX521] describes a proprietary extension of GBS with
a 9th data field. The 8-field version is in NMEA 3.0.

=== GGA - Global Positioning System Fix Data ===

Time, Position and fix related data for a GPS receiver.

------------------------------------------------------------------------------
                                                      11
        1         2       3 4        5 6 7  8   9  10 |  12 13  14   15
        |         |       | |        | | |  |   |   | |  | |   |    |
 $--GGA,hhmmss.ss,llll.ll,a,yyyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. Universal Time Coordinated (UTC)
2. Latitude
3. N or S (North or South)
4. Longitude
5. E or W (East or West)
6. GPS Quality Indicator,
     - 0 - fix not available,
     - 1 - GPS fix,
     - 2 - Differential GPS fix
           (values above 2 are 2.3 features)
     - 3 = PPS fix
     - 4 = Real Time Kinematic
     - 5 = Float RTK
     - 6 = estimated (dead reckoning)
     - 7 = Manual input mode
     - 8 = Simulation mode
7. Number of satellites in view, 00 - 12
8. Horizontal Dilution of precision (meters)
9. Antenna Altitude above/below mean-sea-level (geoid) (in meters)
10. Units of antenna altitude, meters
11. Geoidal separation, the difference between the WGS-84 earth
     ellipsoid and mean-sea-level (geoid), "-" means mean-sea-level
     below ellipsoid
12. Units of geoidal separation, meters
13. Age of differential GPS data, time in seconds since last SC104
```

```
     type 1 or 9 update, null field when DGPS is not used
14. Differential reference station ID, 0000-1023
15. Checksum

=== GLC - Geographic Position, Loran-C ===

------------------------------------------------------------------------------
                                          12    14
       1    2   3 4   5 6   7 8   9 10  11|   13|
       |    |   | |   | |   | |   | |   | |   | |
 $--GLC,xxxx,x.x,a,x.x,a,x.x,a,x.x,x,a,x.x,a,x.x,a*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. GRI Microseconds/10
2. Master TOA Microseconds
3. Master TOA Signal Status
4. Time Difference 1 Microseconds
5. Time Difference 1 Signal Status
6. Time Difference 2 Microseconds
7. Time Difference 2 Signal Status
8. Time Difference 3 Microseconds
9. Time Difference 3 Signal Status
10. Time Difference 4 Microseconds
11. Time Difference 4 Signal Status
12. Time Difference 5 Microseconds
13. Time Difference 5 Signal Status
14. Checksum

=== GLL - Geographic Position - Latitude/Longitude ===

------------------------------------------------------------------------------
       1       2 3        4 5         6 7   8
       |       | |        | |         | |   |
 $--GLL,llll.ll,a,yyyyy.yy,a,hhmmss.ss,a,m,*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. Latitude
2. N or S (North or South)
3. Longitude
4. E or W (East or West)
5. Universal Time Coordinated (UTC)
6. Status A - Data Valid, V - Data Invalid
7. FAA mode indicator (NMEA 2.3 and later)
8. Checksum

=== GNS - Fix data ===

------------------------------------------------------------------------------
      1         2       3 4        5 6    7  8   9   10  11  12  13
      |         |       | |        | |    |  |   |   |   |   |   |
$--GNS,hhmmss.ss,llll.ll,a,yyyyy.yy,a,c--c,xx,x.x,x.x,x.x,x.x,x.x*hh
------------------------------------------------------------------------------

Field Number:

1. UTC
2. Latitude
3. N or S (North or South)
4. Longitude
5. E or W (East or West)
6. Mode indicator
7. Total number of satelites in use,00-99
8. HDROP
9. Antenna altitude, meters, re:mean-sea-level(geoid.
10. Goeidal separation meters
11. Age of diferential data
12. Differential reference station ID
13. CRC

=== GRS - GPS Range Residuals ===

------------------------------------------------------------------------------
             1    2  3  4  5  6  7  8  9 10 11 12 13 14  15
             |    |  |  |  |  |  |  |  |  |  |  |  |  |   |
 $ --GRS,hhmmss.ss,m,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. TC time of associated GGA fix
2. 0 = Residuals used in GGA, 1 = residuals calculated after GGA
3. Satellite 1 residual in meters
4. Satellite 2 residual in meters
5. Satellite 3 residual in meters
6. Satellite 4 residual in meters (blank if unused)
7. Satellite 5 residual in meters (blank if unused)
8. Satellite 6 residual in meters (blank if unused)
9. Satellite 7 residual in meters (blank if unused)
10. Satellite 8 residual in meters (blank if unused)
11. Satellite 9 residual in meters (blank if unused)
12. Satellite 10 residual in meters (blank if unused)
13. Satellite 11 residual in meters (blank if unused)
14. Satellite 12 residual in meters (blank if unused)
15. Checksum

The order of satellites the same as those in the last GSA.

Example: $GPGRS,024603.00,1,-1.8,-2.7,0.3,,,,,,,,,*6C


=== GST - GPS Pseudorange Noise Statistics ===

------------------------------------------------------------------------------
```

```
             1    2 3 4 5 6 7 8   9
             |    | | | | | | |   |
 $ --GST,hhmmss.ss,x,x,x,x,x,x,x,*hh<CR><LF>
```

Field Number:

1. TC time of associated GGA fix
2. Total RMS standard deviation of ranges inputs to the navigation solution
3. Standard deviation (meters) of semi-major axis of error ellipse
4. Standard deviation (meters) of semi-minor axis of error ellipse
5. Orientation of semi-major axis of error ellipse (true north degrees)
6. Standard deviation (meters) of latitude error
7. Standard deviation (meters) of longitude error
8. Standard deviation (meters) of altitude error
9. Checksum

=== GSA - GPS DOP and active satellites ===

```
        1 2 3                       14 15  16  17  18
        | | |                        |  |   |   |   |
 $--GSA,a,a,x,x,x,x,x,x,x,x,x,x,x,x,x,x.x,x.x,x.x*hh<CR><LF>
```

Field Number:

1. Selection mode: M=Manual, forced to operate in 2D or 3D, A=Automatic, 3D/2D
2. Mode (1 = no fix, 2 = 2D fix, 3 = 3D fix)
3. ID of 1st satellite used for fix
4. ID of 2nd satellite used for fix
5. ID of 3rd satellite used for fix
6. ID of 4th satellite used for fix
7. ID of 5th satellite used for fix
8. ID of 6th satellite used for fix
9. ID of 7th satellite used for fix
10. ID of 8th satellite used for fix
11. ID of 9th satellite used for fix
12. ID of 10th satellite used for fix
13. ID of 11th satellite used for fix
14. ID of 12th satellite used for fix
15. PDOP
16. HDOP
17. VDOP
18. Checksum

=== GSV - Satellites in view ===

These sentences describe the sky position of a UPS satellite in view.
Typically they're shipped in a group of 2 or 3.

```
        1 2 3 4 5 6 7     n
        | | | | | | |     |
 $--GSV,x,x,x,x,x,x,x,...*hh<CR><LF>
```

Field Number:

1. total number of GSV messages to be transmitted in this group
2. 1-origin number of this GSV message within current group
3. total number of satellites in view (leading zeros sent)
4. satellite PRN number (leading zeros sent)
5. elevation in degrees (00-90) (leading zeros sent)
6. azimuth in degrees to true north (000-359) (leading zeros sent)
7. SNR in dB (00-99) (leading zeros sent)
   more satellite info quadruples like 4-7
   n) checksum

Example:

```
    $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
```

Some GPS receivers may emit more than 12 quadruples (more than three
GPGSV sentences), even though NMEA-0813 doesn't allow this. (The
extras might be WAAS satellites, for example.) Receivers may also
report quads for satellites they aren't tracking, in which case the
SNR field will be null; we don't know whether this is formally allowed
or not.

=== GTD - Geographic Location in Time Differences ===

```
         1   2   3   4   5  6
         |   |   |   |   |  |
 $--GTD,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>
```

Field Number:

1. time difference
2. time difference
3. time difference
4. time difference
5. time difference
   n) checksum

=== GXA - TRANSIT Position - Latitude/Longitude ===

Location and time of TRANSIT fix at waypoint

```
        1         2       3 4        5 6    7 8
```

```
        |         |       | |        | |    | |
 $--GXA,hhmmss.ss,llll.ll,a,yyyyy.yy,a,c--c,X*hh<CR><LF>
```

Field Number:

1. UTC of position fix
2. Latitude
3. East or West
4. Longitude
5. North or South
6. Waypoint ID
7. Satelite number
8. Checksum

(The GXA sentence is obsolete as of 3.01.)

=== HDG - Heading - Deviation & Variation ===

```
        1   2   3 4   5 6
        |   |   | |   | |
 $--HDG,x.x,x.x,a,x.x,a*hh<CR><LF>
```

Field Number:

1. Magnetic Sensor heading in degrees
2. Magnetic Deviation, degrees
3. Magnetic Deviation direction, E = Easterly, W = Westerly
4. Magnetic Variation degrees
5. Magnetic Variation direction, E = Easterly, W = Westerly
6. Checksum

=== HDM - Heading - Magnetic ===

Vessel heading in degrees with respect to magnetic north produced by
any device or system producing magnetic heading.

```
        1   2 3
        |   | |
 $--HDM,x.x,M*hh<CR><LF>
```

Field Number:

1. Heading Degrees, magnetic
2. M = magnetic
3. Checksum

=== HDT - Heading - True ===

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

```
        1   2 3
        |   | |
 $--HDT,x.x,T*hh<CR><LF>
```

Field Number:

1. Heading Degrees, true
2. T = True
3. Checksum

=== HFB - Trawl Headrope to Footrope and Bottom ===

```
         1  2  3  4 5
         |  |  |  | |
 $--HFB,x.x,M,y.y,M*hh<CR><LF>
```

Field Number:

1. Distance from headrope to footrope
2. Meters (0-100)
3. Distance from headrope to bottom
4. Meters (0-100)
5. Checksum

From [GLOBALSAT]. Shown with a "@II" leader rather than "$GP".

=== HSC - Heading Steering Command ===

```
        1   2 3   4  5
        |   | |   |  |
 $--HSC,x.x,T,x.x,M,*hh<CR><LF>
```

Field Number:

1. Heading Degrees, True
2. T = True
3. Heading Degrees, Magnetic
4. M = Magnetic
5. Checksum

[GLOBALSAT] describes a completely different meaning for this
sentence, having to do with water temperature sensors. It is
unclear which is correct.

```
=== ITS - Trawl Door Spread 2 Distance ===

------------------------------------------------------------------------------
         1  2 3
         |  | |
 $--ITS,x.x,M*hh<CR><LF>
------------------------------------------------------------------------------

Field Number)

1. Second spread distance
2. Meters
3. Checksum.

From [GLOBALSAT]. Shown with a "@II" leader rather than "$GP".

=== LCD - Loran-C Signal Data ===

------------------------------------------------------------------------------
        1    2   3   4   5   6   7   8   9   10  11  12  13  14
        |    |   |   |   |   |   |   |   |   |   |   |   |   |
 $--LCD,xxxx,xxx,xxx,xxx,xxx,xxx,xxx,xxx,xxx,xxx,xxx,xxx,xxx*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. GRI Microseconds/10
2. Master Relative SNR
3. Master Relative ECD
4. Time Difference 1 Microseconds
5. Time Difference 1 Signal Status
6. Time Difference 2 Microseconds
7. Time Difference 2 Signal Status
8. Time Difference 3 Microseconds
9. Time Difference 3 Signal Status
10. Time Difference 4 Microseconds
11. Time Difference 4 Signal Status
12. Time Difference 5 Microseconds
13. Time Difference 5 Signal Status
14. Checksum

=== MSK - Control for a Beacon Receiver ===

------------------------------------------------------------------------------
         1  2  3  4  5   6
         |  |  |  |  |   |
 $--MSK,nnn,m,nnn,m,nnn*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. Frequency to use
2. Frequency mode, A=auto, M=manual
3. Beacon bit rate
4. Bitrate, A=auto, M=manual
5. Frequency for MSS message status (null for no status)
6. Checksum

=== MSS - Beacon Receiver Status ===

------------------------------------------------------------------------------
         1  2  3  4    5   6
         |  |  |  |    |   |
 $--MSS,nn,nn,fff,bbb,xxx*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. Signal strength (dB 1uV)
2. Signal to noise ratio (dB)
3. Beacon frequency (kHz)
4. Beacon data rate (BPS)
5. Unknown integer value
6. Checksum


=== MTW - Mean Temperature of Water ===

------------------------------------------------------------------------------
        1   2 3
        |   | |
 $--MTW,x.x,C*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. Degrees
2. Unit of Measurement, Celcius
3. Checksum

[GLOBALSAT] lists this as "Meteorological Temperature of Water", which
is probably incorrect.

=== MWV - Wind Speed and Angle ===

------------------------------------------------------------------------------
        1   2 3   4 5
        |   | |   | |
 $--MWV,x.x,a,x.x,a*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. Wind Angle, 0 to 360 degrees
2. Reference, R = Relative, T = True
3. Wind Speed
```

4. Wind Speed Units, K/M/N
5. Status, A = Data Valid
6. Checksum

=== OLN - Omega Lane Numbers ===

```
------------------------------------------------------------------------------
        1          2          3          4
        |--------+ |--------+ |--------+ |
 $--OLN,aa,xxx,xxx,aa,xxx,xxx,aa,xxx,xxx*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Omega Pair 1
2. Omega Pair 1
3. Omega Pair 1
4. Checksum

(The OLN sentence is obsolete as of 2.30)

=== OSD - Own Ship Data ===

```
------------------------------------------------------------------------------
        1   2 3   4 5   6 7   8   9 10
        |   | |   | |   | |   |   | |
 $--OSD,x.x,A,x.x,a,x.x,a,x.x,a,x.x,x.x,a*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Heading, degrees true
2. Status, A = Data Valid
3. Vessel Course, degrees True
4. Course Reference
5. Vessel Speed
6. Speed Reference
7. Vessel Set, degrees True
8. Vessel drift (speed)
9. Speed Units
10. Checksum

=== R00 - Waypoints in active route ===

```
------------------------------------------------------------------------------
        1               n
        |               |
 $--R00,c---c,c---c,....*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. waypoint ID

...

n) checksum

=== RMA - Recommended Minimum Navigation Information ===

```
------------------------------------------------------------------------------
                                                      12
        1 2       3 4        5 6   7   8   9   10  11|
        | |       | |        | |   |   |   |   |   | |
 $--RMA,A,llll.ll,a,yyyyy.yy,a,x.x,x.x,x.x,x.x,x.x,a*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Blink Warning
2. Latitude
3. N or S
4. Longitude
5. E or W
6. Time Difference A, uS
7. Time Difference B, uS
8. Speed Over Ground, Knots
9. Track Made Good, degrees true
10. Magnetic Variation, degrees
11. E or W
12. Checksum

=== RMB - Recommended Minimum Navigation Information ===

To be sent by a navigation receiver when a destination waypoint is active.

```
------------------------------------------------------------------------------
                                                        14
        1 2   3 4    5    6       7 8        9 10  11  12  13|  15
        | |   | |    |    |       | |        | |   |   |   | |   |
 $--RMB,A,x.x,a,c--c,c--c,llll.ll,a,yyyyy.yy,a,x.x,x.x,x.x,A,m,*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Status, A= Active, V = Void
2. Cross Track error - nautical miles
3. Direction to Steer, Left or Right
4. TO Waypoint ID
5. FROM 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 in degrees True
12. Destination closing velocity in knots
13. Arrival Status, A = Arrival Circle Entered
14. FAA mode indicator (NMEA 2.3 and later)
15. Checksum

Example: $GPRMB,A,0.66,L,003,004,4917.24,N,12309.57,W,001.3,052.5,000.5,V*0B

=== RMC - Recommended Minimum Navigation Information ===

```
------------------------------------------------------------------------------
                                                          12
       1         2 3       4 5        6  7   8   9    10 11|  13
       |         | |       | |        |  |   |   |    |  | |   |
 $--RMC,hhmmss.ss,A,llll.ll,a,yyyyy.yy,a,x.x,x.x,xxxx,x.x,a,m,*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. UTC Time
2. Status, V=Navigation receiver warning A=Valid
3. Latitude
4. N or S
5. Longitude
6. E or W
7. Speed over ground, knots
8. Track made good, degrees true
9. Date, ddmmyy
10. Magnetic Variation, degrees
11. E or W
12. FAA mode indicator (NMEA 2.3 and later)
13. Checksum

A status of V means the GPS has a valid fix that is below an internal
quality threshold, e.g. because the dilution of precision is too high
or an elevation mask test failed.

=== ROT - Rate Of Turn ===

```
------------------------------------------------------------------------------
       1   2 3
       |   | |
 $--ROT,x.x,A*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Rate Of Turn, degrees per minute, "-" means bow turns to port
2. Status, A means data is valid
3. Checksum

=== RPM - Revolutions ===

```
------------------------------------------------------------------------------
       1 2 3   4   5 6
       | | |   |   | |
 $--RPM,a,x,x.x,x.x,A*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Sourse, S = Shaft, E = Engine
2. Engine or shaft number
3. Speed, Revolutions per minute
4. Propeller pitch, % of maximum, "-" means astern
5. Status, A means data is valid
6. Checksum

=== RSA - Rudder Sensor Angle ===

```
------------------------------------------------------------------------------
       1   2 3   4 5
       |   | |   | |
 $--RSA,x.x,A,x.x,A*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Starboard (or single) rudder sensor, "-" means Turn To Port
2. Status, A means data is valid
3. Port rudder sensor
4. Status, A means data is valid
5. Checksum

=== RSD - RADAR System Data ===

```
------------------------------------------------------------------------------
                                                      14
       1   2   3   4   5   6   7   8   9   10  11 12 13|
       |   |   |   |   |   |   |   |   |   |   |   | | |
 $--RSD,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,a,a*hh<CR><LF>
------------------------------------------------------------------------------
```

(Some fields are missing from this description.)

Field Number:
1. Unknown
2. Unknown
3. Unknown
4. Unknown
5. Unknown
6. Unknown
7. Unknown
8. Unknown

```
9. Cursor Range From Own Ship
10. Cursor Bearing Degrees Clockwise From Zero
11. Range Scale
12. Range Units
13  Unknown
14. Checksum


=== RTE - Routes ===

------------------------------------------------------------------------------
        1   2   3 4    5           x    n
        |   |   | |    |           |    |
 $--RTE,x.x,x.x,a,c--c,c--c, ..... c--c*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. Total number of messages being transmitted
2. Message Number
3. Message mode
     c = complete route, all waypoints
     w = working route, the waypoint you just left, the waypoint
     you're heading to, then all the rest
4. Waypoint ID

More waypoints follow.  Last field is a checksum as usual.

The Garmin 65 and possibly other units report a $GPR00 in the same format.

=== SFI - Scanning Frequency Information ===

------------------------------------------------------------------------------
        1   2   3      4                    x
        |   |   |      |                    |
 $--SFI,x.x,x.x,xxxxxx,c ..........  xxxxxx,c*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:
1. Total Number Of Messages
2. Message Number
3. Frequency 1
4. Mode 1
x. Checksum

=== STN - 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.

------------------------------------------------------------------------------
        1   2
        |   |
 $--STN,x.x,*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. Talker ID Number
2. Checksum

=== TDS - Trawl Door Spread Distance ===

------------------------------------------------------------------------------
         1  2 3
         |  | |
 $--TDS,x.x,M*hh<CR><LF>
------------------------------------------------------------------------------

Field Number)

1. Distance between trawl doors
2. Meters (0-300)
3. Checksum.

From [GLOBALSAT].  Shown with a "@II" leader rather than "$GP".

=== TFI - Trawl Filling Indicator ===

------------------------------------------------------------------------------
        1 2 3 4
        | | | |
 $--TFI,x,y,z*hh<CR><LF>
------------------------------------------------------------------------------

Field number:

1. Catch sensor #1 (0 = off, 1 = on, 2 = no answer)
2. Catch sensor #2 (0 = off, 1 = on, 2 = no answer)
3. Catch sensor #3 (0 = off, 1 = on, 2 = no answer)

From [GLOBALSAT].  Shown with a "@II" leader rather than "$GP".

=== TPC - Trawl Position Cartesian Coordinates ===

------------------------------------------------------------------------------
        1 2 3 4  5  6 7
        | | | |  |  | |
 $--TPC,x,M,y,P,z.z,M*hh,<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. Horizontal distance from the vessel center line
```

2. Meters
3. Horizontal distance from the transducer to the trawl along the
     vessel center line. The value is normally positive assuming the
     trawl is located behind the vessel.
4. Meters
5. Depth of the trawl below the surface
6. Meters
7. Checksum

From [GLOBALSAT]. Shown with a "@II" leader rather than "$GP".
This entry actually merges their TPC description with another
entry labeled (apparently incorrectly) TPT, which differs from the
TPT shown below.

=== TPR - Trawl Position Relative Vessel ===

```
------------------------------------------------------------------------------
        1 2 3 4  5  6 7
        | | | |  |  | |
 $--TPR,x,M,y,P,z.z,M*hh,<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Horizontal range relative to target
2. Meters (0-4000)
3. Bearing to target relative to vessel heading. Resolution is one degree.
4. Separator
5. Depth of trawl below the surface
6. Meters (0-2000)
7. Checksum

From [GLOBALSAT]. Shown with a "@II" leader rather than "$GP".

=== TPT - Trawl Position True ===

```
------------------------------------------------------------------------------
        1 2 3 4  5  6 7
        | | | |  |  | |
 $--TPT,x,M,y,P,z.z,M*hh,<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Horizontal range relative to target
2. Meters (0-4000)
3. True bearing to taget (ie. relative north). Resolution is one degree.
4. Separator
5. Depth of trawl below the surface
6. Meters (0-2000)
7. Checksum

From [GLOBALSAT]. Shown with a "@II" leader rather than "$GP".

=== TRF - TRANSIT Fix Data ===

```
------------------------------------------------------------------------------
                                                                 13
        1         2      3       4 5        6 7   8   9   10  11  12|
        |         |      |       | |        | |   |   |   |   |   | |
 $--TRF,hhmmss.ss,xxxxxx,llll.ll,a,yyyyy.yy,a,x.x,x.x,x.x,x.x,xxx,A*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. UTC Time
2. Date, ddmmyy
3. Latitude
4. N or S
5. Longitude
6. E or W
7. Elevation Angle
8. Number of iterations
9. Number of Doppler intervals
10. Update distance, nautical miles
11. Satellite ID
12. Data Validity
13. Checksum

(The TRF sentence is obsolete as of 2.3.0)

=== TTM - Tracked Target Message ===

```
------------------------------------------------------------------------------
                                       11     13
        1  2   3   4 5   6   7 8   9   10|    12| 14
        |  |   |   | |   |   | |   |   | |    | | |
 $--TTM,xx,x.x,x.x,a,x.x,x.x,a,x.x,x.x,a,c--c,a,a*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Target Number (0-99)
2. Target Distance
3. Bearing from own ship
4. Bearing Units
5. Target Speed
6. Target Course
7. Course Units
8. Distance of closest-point-of-approach
9. Time until closest-point-of-approach "-" means increasing
10. "-" means increasing
11. Target name
12. Target Status

13. Reference Target
14. Checksum

[GLOBALSAT] gives this in a slightly different form, with 14th and
15th fields conveying time of observation and whether target
acquisition was automatic or manual.

=== VBW - Dual Ground/Water Speed ===

```
------------------------------------------------------------------------------
        1   2   3 4   5   6 7
        |   |   | |   |   | |
 $--VBW,x.x,x.x,A,x.x,x.x,A*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Longitudinal water speed, "-" means astern
2. Transverse water speed, "-" means port
3. Status, A = Data Valid
4. Longitudinal ground speed, "-" means astern
5. Transverse ground speed, "-" means port
6. Status, A = Data Valid
7. Checksum

=== VDR - Set and Drift ===

```
------------------------------------------------------------------------------
        1   2 3   4 5   6 7
        |   | |   | |   | |
 $--VDR,x.x,T,x.x,M,x.x,N*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Degress True
2. T = True
3. Degrees Magnetic
4. M = Magnetic
5. Knots (speed of current)
6. N = Knots
7. Checksum

=== VHW - Water speed and heading ===

```
------------------------------------------------------------------------------
        1   2 3   4 5   6 7   8 9
        |   | |   | |   | |   | |
 $--VHW,x.x,T,x.x,M,x.x,N,x.x,K*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Degress True
2. T = True
3. Degrees Magnetic
4. M = Magnetic
5. Knots (speed of vessel relative to the water)
6. N = Knots
7. Kilometers (speed of vessel relative to the water)
8. K = Kilometers
9. Checksum

[GLOBALSAT] describes a different format in which the first three
fields are water-temperature measurements. It's not clear which
is correct.

=== VLW - Distance Traveled through Water ===

```
------------------------------------------------------------------------------
        1   2 3   4 5
        |   | |   | |
 $--VLW,x.x,N,x.x,N*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Total cumulative distance
2. N = Nautical Miles
3. Distance since Reset
4. N = Nautical Miles
5. Checksum

=== VPW - Speed - Measured Parallel to Wind ===

```
------------------------------------------------------------------------------
        1   2 3   4 5
        |   | |   | |
 $--VPW,x.x,N,x.x,M*hh<CR><LF>
------------------------------------------------------------------------------
```

Field Number:

1. Speed, "-" means downwind
2. N = Knots
3. Speed, "-" means downwind
4. M = Meters per second
5. Checksum

=== VTG - Track made good and Ground speed ===

```
------------------------------------------------------------------------------
         1  2  3  4  5  6  7  8 9   10
         |  |  |  |  |  |  |  | |   |
 $--VTG,x.x,T,x.x,M,x.x,N,x.x,K,m,*hh<CR><LF>
------------------------------------------------------------------------------
```

```
Field Number:

1. Track Degrees
2. T = True
3. Track Degrees
4. M = Magnetic
5. Speed Knots
6. N = Knots
7. Speed Kilometers Per Hour
8. K = Kilometers Per Hour
9. FAA mode indicator (NMEA 2.3 and later)
10. Checksum

Note: in some older versions of NMEA 0183, the sentence looks like this:

------------------------------------------------------------------------------
         1  2  3   4  5
         |  |  |   |  |
 $--VTG,x.x,x,x.x,x.x,*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. True course over ground (degrees) 000 to 359
2. Magnetic course over ground 000 to 359
3. Speed over ground (knots) 00.0 to 99.9
4. Speed over ground (kilometers) 00.0 to 99.9
5. Checksum

The two forms can be distinguished by field 2, which will be
the fixed text 'T' in the newer form.  The new form appears
to have been introduced with NMEA 3.01 in 2002.

Some devices, such as those described in [GLOBALSAT], leave the
magnetic-bearing fields 3 and 4 empty.

=== VWR - Relative Wind Speed and Angle ===

------------------------------------------------------------------------------
         1  2  3  4  5  6  7  8 9
         |  |  |  |  |  |  |  | |
 $--VWR,x.x,a,x.x,N,x.x,M,x.x,K*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. Wind direction magnitude in degrees
2. Wind direction Left/Right of bow
3. Speed
4. N = Knots
5. Speed
6. M = Meters Per Second
7. Speed
8. K = Kilometers Per Hour
9. Checksum

=== WCV - Waypoint Closure Velocity ===

------------------------------------------------------------------------------
        1   2 3    4
        |   | |    |
 $--WCV,x.x,N,c--c*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. Velocity
2. N = knots
3. Waypoint ID
4. Checksum

=== WNC - Distance - Waypoint to Waypoint ===

------------------------------------------------------------------------------
        1   2 3   4 5    6    7
        |   | |   | |    |    |
 $--WNC,x.x,N,x.x,K,c--c,c--c*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. Distance, Nautical Miles
2. N = Nautical Miles
3. Distance, Kilometers
4. K = Kilometers
5. TO Waypoint
6. FROM Waypoint
7. Checksum


=== WPL - Waypoint Location ===

------------------------------------------------------------------------------
        1       2 3        4 5    6
        |       | |        | |    |
 $--WPL,llll.ll,a,yyyyy.yy,a,c--c*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. Latitude
2. N or S (North or South)
3. Longitude
4. E or W (East or West)
5. Waypoint name
6. Checksum
```

```
=== XDR - Cross Track Error - Dead Reckoning ===

--------------------------------------------------------------------------------
        1 2   3 4            n
        | |   | |            |
 $--XDR,a,x.x,a,c--c, ..... *hh<CR><LF>
--------------------------------------------------------------------------------

Field Number:

1. Transducer Type
2. Measurement Data
3. Units of measurement
4. Name of transducer

There may be any number of quadruplets like this, each describing a
sensor.  The last field will be a checksum as usual.

=== XTE - Cross-Track Error, Measured ===

--------------------------------------------------------------------------------
        1 2 3   4 5 6   7
        | | |   | | |   |
 $--XTE,A,A,x.x,a,N,m,*hh<CR><LF>
--------------------------------------------------------------------------------

Field Number:

1. Status
     - V = LORAN-C Blink or SNR warning
     - V = general warning flag or other navigation systems when a reliable
         fix is not available
2. Status
     - V = Loran-C Cycle Lock warning flag
     - A = OK or not used
3. Cross Track Error Magnitude
4. Direction to steer, L or R
5. Cross Track Units, N = Nautical Miles
6. FAA mode indicator (NMEA 2.3 and later, optional)
7. Checksum

=== XTR - Cross Track Error - Dead Reckoning ===

--------------------------------------------------------------------------------
        1   2 3 4
        |   | | |
 $--XTR,x.x,a,N*hh<CR><LF>
--------------------------------------------------------------------------------

Field Number:

1. Magnitude of cross track error
2. Direction to steer, L or R
3. Units, N = Nautical Miles
4. Checksum

=== ZDA - Time & Date - UTC, day, month, year and local time zone ===

--------------------------------------------------------------------------------
        1         2  3  4    5  6  7
        |         |  |  |    |  |  |
 $--ZDA,hhmmss.ss,xx,xx,xxxx,xx,xx*hh<CR><LF>
--------------------------------------------------------------------------------

Field Number:

1. UTC time (hours, minutes, seconds, may have fractional subsecond)
2. Day, 01 to 31
3. Month, 01 to 12
4. Year (4 digits)
5. Local zone description, 00 to +- 13 hours
6. Local zone minutes description, apply same sign as local hours
7. Checksum

Example: $GPZDA,160012.71,11,03,2004,-1,00*7D

=== ZFO - UTC & Time from origin Waypoint ===

--------------------------------------------------------------------------------
        1         2         3    4
        |         |         |    |
 $--ZFO,hhmmss.ss,hhmmss.ss,c--c*hh<CR><LF>
--------------------------------------------------------------------------------

Field Number:

1. Universal Time Coordinated (UTC)
2. Elapsed Time
3. Origin Waypoint ID
4. Checksum

=== ZTG - UTC & Time to Destination Waypoint ===

--------------------------------------------------------------------------------
        1         2         3    4
        |         |         |    |
 $--ZTG,hhmmss.ss,hhmmss.ss,c--c*hh<CR><LF>
--------------------------------------------------------------------------------

Field Number:

1. Universal Time Coordinated (UTC)
2. Time Remaining
3. Destination Waypoint ID
4. Checksum
```

```
=== Other sentences ===

There isis evidence for the existence ofv the following NMEA semtences
on the Web:

|=====================================================
|ASD - Autopilot System Data
|DSC - Digital Selective Calling Information
|DSE - Extended DSC
|DSI - DSC Transponder Initiate
|DSR - DSC Transponder Response
|MWD - Wind Direction & Speed
|TLL - Target Latitude and Longitude
|WDR - Distance to Waypoint - Rhumb Line
|WDC - Distance to Waypoint - Great Circle
|ZDL - Time and Distance to Variable Point
|=====================================================

== Vendor extensions ==

This list is very incomplete.

=== PASHR - RT300 proprietary roll and pitch sentence ===

------------------------------------------------------------------------------
         1           2   3    4      5      6     7     8     9  10 11 12
         |           |   |    |      |      |     |     |     |   | |  |
$PASHR,hhmmss.sss,hhh.hh,T,rrr.rr,ppp.pp,xxx.xx,a.aaa,b.bbb,c.ccc,d,e*hh<CR><LF>
------------------------------------------------------------------------------

Field number:

1.  hhmmss.sss - UTC time
2.  hhh.hh - Heading in degrees
3.  T - flag to indicate that the Heading is True Heading (i.e. to True North)
4.  rrr.rr - Roll Angle in degrees
5.  ppp.pp - Pitch Angle in degrees
6.  xxx.xx - Heave
7.  a.aaa - Roll Angle Accuracy Estimate (Stdev) in degrees
8.  b.bbb - Pitch Angle Accuracy Estimate (Stdev) in degrees
9.  c.ccc - Heading Angle Accuracy Estimate (Stdev) in degrees
10. d - Aiding Status
11. e - IMU Status
12. hh - Checksum

[PASHR] describes this sentence as NMEA, though other sources say it is Ashtech
proprietary and describe a different format.

Example: $PASHR,085335.000,224.19,T,-01.26,+00.83,+00.00,0.101,0.113,0.267,1,0*06

=== PGRME - Garmin Estimated Error ===

------------------------------------------------------------------------------
        1  2  3  4  5  6  7
        |  |  |  |  |  |  |
 $PGRME,hhh,M,vvv,M,ttt,M*hh<CR><LF>
------------------------------------------------------------------------------

Field Number:

1. Estimated horizontal position error (HPE),
2. M=meters
3. Estimated vertical position error (VPE)
4. M=meters
5. Overall spherical equivalent position error
6. M=meters
7. Checksum

Example: $PGRME,15.0,M,45.0,M,25.0,M*22

=== PMGNST - Magellan Status ===

------------------------------------------------------------------------------
          1   2 3  4    5    6  7    8
          |   | |  |    |    |  |    |
 $PMGNST,xx.xx,m,t,nnn,xx.xx,nnn,nn,c
------------------------------------------------------------------------------

Field Number:

1. Firmware version number?
2. Mode (1 = no fix, 2 = 2D fix, 3 = 3D fix)
3. T if we have a fix
4. numbers change - unknown
5. time left on the GPS battery in hours
6. numbers change (freq. compensation?)
7. PRN number receiving current focus
8. nmea_checksum

Only supported on Magellan GPSes.

=== PRWIZCH - Rockwell Channel Status ===

------------------------------------------------------------------------------
 $PRWIZCH,n,s,n,s,n,s,n,s,n,s,n,s,n,s,n,s,n,s,n,s,n,s,n,s,c*hh<CR><LF>
------------------------------------------------------------------------------

Fields consist of 12 pairs of a satellite PRN followed by a
signal quality number in the range 0-7 (0 worst, 7 best).

Only emitted by the now-obsolete Zodiac (Rockwell) chipset.

=== PUBX 00 - uBlox Lat/Long Position Data ===

------------------------------------------------------------------------------
 $PUBX,00,hhmmss.ss,Latitude,N,Longitude,E,AltRef,NavStat,Hacc,Vacc,SOG,COG,Vvel,+ageC,HDOP,VDOP,TDOP,GU,RU,DR,*hh<CR><LF>
------------------------------------------------------------------------------
```

```
Example:
$PUBX,00,081350.00,4717.113210,N,00833.915187,E,546.589,G3,2.1,2.0,0.007,77.52,0+.007,,0.92,1.19,0.77,9,0,0*5F<CR><LF>

Only emitted by uBlox Antaris chipset.

=== PUBX 01 - uBlox UTM Position Data ===

The $PUBX,01 is a UTM (Universal Transverse Mercator projection) version
of the $PUBX,00 sentence.

------------------------------------------------------------------------------
$PUBX,01,hhmmss.ss,Easting,E,Northing,N,AltMSL,NavStat,Hacc,Vacc,SOG,COG,Vvel,ag+eC,HDOP,VDOP,TDOP,GU,RU,DR,*hh<CR><LF>
------------------------------------------------------------------------------

Example:
$PUBX,01,075142.00,467125.245,E,5236949.763,N,498.235,G3,2.1,1.9,0.005,85.63,0.0+00,,0.78,0.90,0.52,12,0,0*65

Only emitted by uBlox Antaris chipset.

=== PUBX 03 - uBlox Satellite Status ===

------------------------------------------------------------------------------
 $PUBX,03,GT{,ID,s,AZM,EL,SN,LK},*hh<CR><LF>
------------------------------------------------------------------------------

Example:
$PUBX,03,11,23,-,,,45,010,29,-,,,46,013,07,-,,,42,015,08,U,067,31,42,025,10,U,19+5,33,46,026,18,U,326,08,39,026,17,-,,,32,015,26,U,306,(

Only emitted by uBlox Antaris chipset.

(There's no PUBX 02)

=== PUBX 04 - uBlox Time of Day and Clock Information ===

------------------------------------------------------------------------------
$PUBX,04,hhmmss.ss,ddmmyy,UTC_TOW,week,reserved,Clk_B,Clk_D,PG,*hh<CR><LF>
------------------------------------------------------------------------------

Example:

$PUBX,04,073731.00,091202,113851.00,1196,113851.00,1930035,-2660.664,43,*3C<CR><+LF>

Only emitted by uBlox Antaris chipset.

== References ==

[bibliography]
- [[[NMEA2000]]]
    The NMEA 0183 protocol
    http://nmeatool.nmea2000.de/download/0183.pdf
    Probably the ancestor of this document.

- [[[DEPRIEST]]]
    "NMEA data"
    http://www.gpsinformation.org/dale/nmea.htm
    Used for PMGNST and the FAA mode code.

- [[[MX521]]]
    "MX521 GPS/DGPS Sensor Installation Manual"
    http://www.mx-marine.com/downloads/MX521_Install_manual_051804.pdf
    Used for GBS, GRS.

- [[[MX535]]
    "MX535 UAIS Ship Borne Class A Transponder Unit Techical & Installation Manual"
    http://www.mx-marine.com/downloads/mx535/MX535_Tech_Manual_Rev_E.pdf
    Used for GNS.

- [[[ZODIAC]]]
    "Zodiac Serial Data Interface Specification"
    http://users.rcn.com/mardor/serial.pdf
    Used for PRWIZCH.

- [[[GH79L4N]]]
    "Specifications for GPS Receiver GH-79L4-N"
    http://www.tecsys.de/db/gps/gh79l1an_intant.pdf
    Used for GPDTM.

- [[[GIDS]]]
    "GPS - NMEA sentence information"
    http://aprs.gids.nl/nmea/
    Used for BWC, MSK, MSS.

- [[[NMEAFAQ]]]
    "The NMEA FAQ"
    http://vancouver-webpages.com/peter/nmeafaq.txt
    Used for R00.

- [[[UNMEA]]]
    "Understanding NMEA 0183"
    http://pcptpp030.psychologie.uni-regensburg.de/trafficresearch/NMEA0183/
    Source for the claim that NMEA requires undefined data fields to
    be empty.

- [[[NTUM]]]
    "NemaTalker User Manual"
    http://www.sailsoft.nl/NemaTalker/UserManual/InstrGPS.htm
    Source for the claim that Mode Indicator dominates Status.

- [[[IEC61162-1]]]
    "International Standard IEC 61162-1" (preview)
    http://domino.iec.ch/preview/info_iec61162-1%7Bed2.0%7Den.pdf

- [[[SEATALK]]]
    "SeaTalk Technical Reference"
    http://www.thomasknauf.de/seatalk.htm
```

- [[[GLOBALSAT]]]
    "NMEA (National Marine Electronics Association) 0183 Protocol"
    http://www.usglobalsat.com/faq_details/NMEA.htm

- [[[PASHR]]]
    "News - NMEA PASHR Output Format Added"
    http://www.oxts.com/default.asp?pageRef=76&newsID=69

- [[[WAAS]]]
    "WAAS Information"
    http://gpsinformation.net/exe/waas.html

- [[[PPS]]]
    "Pulse per second"
    http://en.wikipedia.org/wiki/Pulse_per_second