

The NMEA 0183 Protocol

Table of Contents

1. What is the NMEA 0183 Standard?	page 1
2. Electrical Interface	2
3. General Sentence Format	2
4. Talker Identifiers	3
5. Sentence Identifiers and Sentence Formats	4
6. Some Proprietary Sentences	21
7. Manufacturer Codes	25
8. References	28

The material presented in this document has been compiled from various unofficial sources. It is neither a complete nor error-free description of the NMEA 0183 standard. In particular, it does not cover the new sentences and the high-speed interface defined in version 3.x.

Klaus Betke, May 2000. Revised August 2001.

1. What is the NMEA 0183 Standard?

The National Marine Electronics Association (NMEA) is a non-profit association of manufacturers, distributors, dealers, educational institutions, and others interested in peripheral marine electronics occupations. The NMEA 0183 standard defines an electrical interface and data protocol for communications between marine instrumentation.

NMEA 0183 is a voluntary industry standard, first released in March of 1983. It has been updated from time to time; the latest release, currently (August 2001) Version 3.0, July 2001, is available from the NMEA office (Warning: the price for non-members is 250 US\$).

P O Box 3435
New Bern NC 28564-3435
USA
www.nmea.org

NMEA has also established a working group to develop a new standard for data communications among shipboard electronic devices. The new standard, NMEA 2000, is a bi-directional, multi-transmitter, multi-receiver serial data network. It is multi-master and self-configuring, and there is no central controller. The NMEA began a beta testing period in January 2000 with eleven manufacturers. A release version of NMEA 2000 is expected in 2001.

2. Electrical Interface

NMEA 0183 devices are designated as either *talkers* or *listeners* (with some devices being both), employing an asynchronous serial interface with the following parameters:

Baud rate:	4800
Number of data bits:	8 (bit 7 is 0)
Stop bits:	1 (or more)
Parity:	none
Handshake:	none

NMEA 0183 allows a single talker and several listeners on one circuit. The recommended interconnect wiring is a shielded twisted pair, with the shield grounded only at the talker. The standard does not specify the use of a particular connector. Note: The new 0183-HS standard (HS = high speed) introduced in version 3.0 uses a 3-wire interface and a baud rate of 38400. This type of interface is not discussed here.

It is recommended that the talker output comply with EIA RS-422, a differential system with two signal lines, "A" and "B". Differential drive signals have no reference to ground and are more immune to noise. However, a single-ended line at TTL level is accepted as well. The voltages on the A line correspond to those on the TTL single wire, while the B voltages are inverted (when output A is at +5 V, output B is at 0 V, and vice versa. This is the unipolar RS-422 operation. In bipolar mode ± 5 V are used).

In either case, the recommended receive circuit uses an opto-isolator with suitable protection circuitry. The input should be isolated from the receiver's ground. In practice, the single wire, or the RS-422 "A" wire may be directly connected to a computer's RS-232 input. In fact even many of the latest products, like hand-held GPS receivers, do not have a RS-422 differential output, but just a single line with TTL or 5 V CMOS compatible signal level.

3. General Sentence Format

All data is transmitted in the form of *sentences*. Only printable ASCII characters are allowed, plus CR (carriage return) and LF (line feed). Each sentence starts with a "\$" sign and ends with <CR><LF>. There are three basic kinds of sentences: *talker sentences*, *proprietary sentences* and *query sentences*.

Talker Sentences. The general format for a talker sentence is:

```
$ttsss,d1,d2,...<CR><LF>
```

The first two letters following the "\$" are the *talker identifier*. The next three characters (sss) are the *sentence identifier*, followed by a number of *data fields* separated by commas, followed by an optional *checksum*, and terminated by carriage return/line feed. The data fields are uniquely defined for each sentence type. An example talker sentence is:

```
$HCHDM,238,M<CR><LF>
```

where "HC" specifies the talker as being a magnetic compass, the "HDM" specifies the magnetic heading message follows. The "238" is the heading value, and "M" designates the heading value as magnetic.

A sentence may contain up to 80 characters plus "\$" and CR/LF. If data for a field is not available, the field is omitted, but the delimiting commas are still sent, with no space between them. The checksum field consists of a "*" and two hex digits representing the exclusive OR of all characters between, but not including, the "\$" and "*".

Proprietary Sentences. The standard allows individual manufacturers to define *proprietary sentence formats*. These sentences start with "\$P", then a 3 letter manufacturer ID, followed by whatever data the manufacturer wishes, following the general format of the standard sentences. Some proprietary sentences, mainly from Garmin, Inc., are listed in chapter 6.

Query sentences. A query sentence is a means for a listener to request a particular sentence from a talker. The general format is:

```
$t1l1Q,sss,[CR][LF]
```

The first two characters of the address field are the talker identifier of the requester and the next two characters are the talker identifier of the device being queried (listener). The fifth character is always a "Q" defining the message as a query. The next field (sss) contains the three letter mnemonic of the sentence being requested. An example query sentence is:

```
$CCGPQ,GGA<CR><LF>
```

where the "CC" device (computer) is requesting from the "GP" device (a GPS unit) the "GGA" sentence. The GPS will then transmit this sentence once per second until a different query is requested.

4. Talker Identifiers

AG	Autopilot - General
AP	Autopilot - Magnetic
CD	Communications – Digital Selective Calling (DSC)
CR	Communications – Receiver / Beacon Receiver
CS	Communications – Satellite
CT	Communications – Radio-Telephone (MF/HF)
CV	Communications – Radio-Telephone (VHF)
CX	Communications – Scanning Receiver
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
LC	Loran C
P	Proprietary Code
RA	RADAR and/or ARPA
SD	Sounder, Depth
SN	Electronic Positioning System, other/general
SS	Sounder, Scanning
TI	Turn Rate Indicator
VD	Velocity Sensor, Doppler, other/general
DM	Velocity Sensor, Speed Log, Water, Magnetic
VW	Velocity Sensor, Speed Log, Water, Mechanical
WI	Weather Instruments
YX	Transducer
ZA	Timekeeper – Atomic Clock
ZC	Timekeeper – Chronometer
ZQ	Timekeeper – Quartz
ZV	Timekeeper – Radio Update, WWV or WWVH

5. Sentence Identifiers and Formats

AAM Waypoint Arrival Alarm

```

      1 2 3   4 5   6
      | | |   | |   |
$--AAM,A,A,x.x,N,c--c*hh

```

- 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

ALM GPS Almanac Data

```

      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,hhh,hhh,*hh

```

- 1) Total number of messages
- 2) Message Number
- 3) Satellite PRN number (01 to 32)
- 4) GPS Week Number: Date and time in GPS is computed as number of weeks from 6 January 1980 plus number of seconds into the week.
- 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

APA Autopilot Sentence "A"

```

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

```

- 1) Status
 - V = LORAN-C Blink or SNR warning
 - A = 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 kilometres)
- 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

APB Autopilot Sentence "B"

```

                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

```

- 1) Status
 - V = LORAN-C Blink or SNR warning
 - A = 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

ASD Autopilot System Data

Format unknown

BEC Bearing & Distance to Waypoint – Dead Reckoning

```

                12
      1         2         3 4         5 6   7 8   9 10 11| 13
      |         |         | |         | |   | |   | | | |
$--BEC,hmmss.ss,llll.ll,a,yyyy.yy,a,x.x,T,x.x,M,x.x,N,c--c*hh

```

- 1) Time (UTC)
- 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

BOD Bearing – Waypoint to Waypoint

```

      1   2 3   4 5   6   7
      |   | |   | |   |   |
$--BOD,x.x,T,x.x,M,c--c,c--c*hh

```

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

BWC Bearing and Distance to Waypoint – Latitude, N/S, Longitude, E/W, UTC, Status

```

                                11
      1           2           3 4           5 6   7 8   9 10 | 12 13
      |           |           | |           | |   | |   | |   | |
$--BWC,hhmmss.ss,llll.ll,a,yyyy.yy,a,x.x,T,x.x,M,x.x,N,c--c*hh

```

- 1) Time (UTC)
- 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

BWR Bearing and Distance to Waypoint – Rhumb Line Latitude, N/S, Longitude, E/W, UTC, Status

```

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

```

- 1) Time (UTC)
- 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

```

- 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

```

- 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

```

- 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

```

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

DCN Decca Position

obsolete

DPT Heading – Deviation & Variation

```

      1   2   3
      |   |   |
$--DPT,x.x,x.x*hh

```

- 1) Depth, meters
- 2) Offset from transducer;
positive means distance from transducer to water line,
negative means distance from transducer to keel
- 3) Checksum

DSC Digital Selective Calling Information

Format unknown

DSE Extended DSC

Format unknown

DSI DSC Transponder Initiate

Format unknown

DSR DSC Transponder Response

Format unknown

DTM Datum Reference

Format unknown

FSI Frequency Set Information

```

      1       2       3 4 5
      |       |       | | |
$--FSI,xxxxxx,xxxxxx,c,x*hh

```

- 1) Transmitting Frequency
- 2) Receiving Frequency
- 3) Communications Mode (NMEA Syntax 2)
- 4) Power Level
- 5) Checksum

GBS GPS Satellite Fault Detection

Format unknown

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,yyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh

```

- 1) Time (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
- 7) Number of satellites in view, 00 - 12
- 8) Horizontal Dilution of precision
- 9) Antenna Altitude above/below mean-sea-level (geoid)
- 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,a,x.x,a,x.x,a*hh

```

- 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
      | | | | | | |
$--GLL,llll.ll,a,yyyy.yy,a,hhmmss.ss,A*hh

```

- 1) Latitude
- 2) N or S (North or South)
- 3) Longitude
- 4) E or W (East or West)
- 5) Time (UTC)
- 6) Status A - Data Valid, V - Data Invalid
- 7) Checksum

GRS GPS Range Residuals

Format unknown

GST GPS Pseudorange Noise Statistics

Format unknown

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.x,x.x*x*hh

```

- 1) Selection mode
- 2) Mode
- 3) ID of 1st satellite used for fix
- 4) ID of 2nd satellite used for fix
- ...
- 14) ID of 12th satellite used for fix
- 15) PDOP in meters
- 16) HDOP in meters
- 17) VDOP in meters
- 18) Checksum

GSV Satellites in view

```

      1 2 3 4 5 6 7      n
      | | | | | | |      |
$--GSV,x,x,x,x,x,x,x,...*hh

```

- 1) total number of messages
- 2) message number
- 3) satellites in view
- 4) satellite number
- 5) elevation in degrees
- 6) azimuth in degrees to true
- 7) SNR in dB
- more satellite infos like 4)-7)
- n) Checksum

GTD Geographic Location in Time Differences

```

      1 2 3 4 5 6
      | | | | | |
$--GTD,x.x,x.x,x.x,x.x,x.x*x*hh

```

- 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

obsolete

HDG Heading – Deviation & Variation

```

      1   2   3 4   5 6
      |   |   | |   | |
$--HDG,x.x,x.x,a,x.x,a*hh

```

- 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

```

      1   2 3
      |   | |
$--HDM,x.x,M*hh

```

- 1) Heading Degrees, magnetic
- 2) M = magnetic
- 3) Checksum

HDT Heading – True

```

      1   2 3
      |   | |
$--HDT,x.x,T*hh

```

- 1) Heading Degrees, true
- 2) T = True
- 3) Checksum

HSC Heading Steering Command

```

      1   2 3   4 5
      |   | |   | |
$--HSC,x.x,T,x.x,M,*hh

```

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

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

- 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 MSK Receiver Interface (for DGPS Beacon Receivers)

1	2	3	4	5	6

\$GPMSK,xxx.x,xx,xxx,xx,N*hh

- 1) Frequency in kHz (283.5 to 325.0)
- 2) Frequency Selection
 - M1 = Manual
 - A1 = Automatic (field 1 empty)
- 3) MSK bit rate (100 or 200)
- 4) Bit Rate Selection
 - M2 = Manual
 - A2 = Automatic (field 3 empty)
- 5) Period of output of performance status message, 0 to 100 seconds (\$CRMSS)
- 6) Checksum

MSS MSK Receiver Signal Status

Format unknown

MWD Wind Direction & Speed

Format unknown

MTW Water Temperature

1	2	3

\$--MTW,x.x,C*hh

- 1) Degrees
- 2) Unit of Measurement, Celcius
- 3) Checksum

MWV Wind Speed and Angle

```

      1   2 3   4 5
      |   | |   | |
$--MWV,x.x,a,x.x,a*hh

```

- 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

obsolete

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,x.x,a*hh

```

- 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

ROO Waypoints in Active Route

```

      1                               n
      |                               |
$--ROO,c---c,c---c,...*hh

```

- 1) waypoint ID
- ...
- n) checksum

RMA Recommended Minimum Navigation Information

```

      1 2       3 4       5 6   7   8   9   10 11 |
      | |       | |       | |   |   |   |   | |
$--RMA,A,l111.11,a,yyyyy.yy,a,x.x,x.x,x.x,x.x,x.x,a*hh

```

- 1) Blink Warning
- 2) Latitude
- 3) N or S
- 4) Longitude
- 5) E or W
- 6) Time Difference A, μ S
- 7) Time Difference B, μ S
- 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

```

                                     14
      1 2   3 4   5   6       7 8       9 10  11  12  13|
      | |   | |   |   |       | |       | |   |   | |
$--RMB,A,x.x,a,c--c,c--c,llll.ll,a,yyyy.yy,a,x.x,x.x,x.x,A*hh
    
```

- 1) Status, V = Navigation receiver warning
- 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) Checksum

RMC Recommended Minimum Navigation Information

```

                                     12
      1       2 3       4 5       6 7  8   9   10  11|
      |       | |       | |       | |   |   | |
$--RMC,hhmmss.ss,A,llll.ll,a,yyyy.yy,a,x.x,x.x,xxxx,x.x,a*hh
    
```

- 1) Time (UTC)
- 2) Status, V = Navigation receiver warning
- 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) Checksum

ROT Rate Of Turn

```

      1   2 3
      |   | |
$--ROT,x.x,A*hh
    
```

- 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
    
```

- 1) Source; 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
    
```

- 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

```

      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
    
```

- 9) Cursor Range From Own Ship
- 10) Cursor Bearing Degrees Clockwise From Zero
- 11) Range Scale
- 12) Range Units
- 14) Checksum

RTE Routes

```

      1   2   3 4   5           x   n
      |   |   | |   |           |   |
$--RTE,x.x,x.x,a,c--c,c--c, ..... c--c*hh
    
```

- 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
- x) More Waypoints
- n) Checksum

SFI Scanning Frequency Information

```

      1   2   3       4           n
      |   |   |       |           |
$--SFI,x.x,x.x,xxxxxx,c ..... xxxxxx,c*hh
    
```

- 1) Total Number Of Messages
- 2) Message Number
- 3) Frequency 1
- 4) Mode 1
- n) Checksum

STN Multiple Data ID

```

      1   2
      |   |
$--STN,x.x,*hh
    
```

- 1) Talker ID Number
- 2) Checksum

TLL Target Latitude and Longitude

Format unknown

TRF TRANSIT Fix Data

obsolete

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

- 1) Target Number
- 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

VBW Dual Ground/Water Speed

	1	2	3	4	5	6	7

\$--VBW,x.x,x.x,A,x.x,x.x,A*hh

- 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

- 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

```

- 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 = Kilometres
- 9) Checksum

VLW Distance Traveled through Water

```

      1   2 3   4 5
      |   | |   | |
$--VLW,x.x,N,x.x,N*hh

```

- 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

```

- 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
      |   | |   | | | |   | |
$--VTG,x.x,T,x.x,M,x.x,N,x.x,K*hh

```

- 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 = Kilometres Per Hour
- 9) Checksum

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

```

- 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

```

- 1) Velocity
- 2) N = knots
- 3) Waypoint ID
- 4) Checksum

WDC Distance to Waypoint – Great Circle

Format unknown

WDR Distance to Waypoint – Rhumb Line

Format unknown

WNC Distance – Waypoint to Waypoint

```

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

```

- 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

```

- 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

```

- 1) Transducer type
- 2) Measurement data
- 3) Units of measurement
- 4) Name of transducer
- x) More of the same
- n) Checksum

XTE Cross-Track Error – Measured

```

      1 2 3   4 5 6
      | | |   | | |
$--XTE,A,A,x.x,a,N,*hh

```

- 1) Status
 - V = LORAN-C blink or SNR warning
 - A = 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) Checksum

XTR Cross Track Error – Dead Reckoning

```

      1   2 3 4
      |   | | |
$--XTR,x.x,a,N*hh

```

- 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

```

- 1) Local zone minutes description, same sign as local hours
- 2) Local zone description, 00 to +/- 13 hours
- 3) Year
- 4) Month, 01 to 12
- 5) Day, 01 to 31
- 6) Time (UTC)
- 7) Checksum

ZDL Time and Distance to Variable Point

Format unknown

ZFO UTC & Time from Origin Waypoint

```
      1      2      3  4
      |      |      |  |
$--ZFO,hhmmss.ss,hhmmss.ss,c--c*hh
```

- 1) Time (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
```

- 1) Time (UTC)
- 2) Time Remaining
- 3) Destination Waypoint ID
- 4) Checksum

6. Some Proprietary Sentences

\$PGRMC Sensor Configuration Information

Garmin proprietary sentence

```

          13 14
    1 2 3 4 5 6 7 8 9 10| 12|
    | | | | | | | | | | | |
$PGRMC,A,x.x,hh,x.x,x.x,x.x,x.x,c,c,2,c*hh

```

- 1) Fix mode, A=automatic (only option)
- 2) Altitude above/below mean sea level, -1500.0 to 18000.0 meters
- 3) Earth datum index. If the user datum index (96) is specified, fields 5-8 must contain valid values. Otherwise, fields 4-8 must be null.
- 4) User earth datum semi-major axis, 6360000.0 to 6380000.0 meters (.001 meters resolution)
- 5) User earth datum inverse flattening factor, 285.0 to 310.0 (10⁻⁹ resolution)
- 6) User earth datum delta x earth centered coordinate, -5000.0 to 5000.0 meters (1 meter resolution)
- 7) User earth datum delta y earth centered coordinate, -5000.0 to 5000.0 meters (1 meter resolution)
- 8) User earth datum delta z earth centered coordinate, -5000.0 to 5000.0 meters (1 meter resolution)
- 9) Differential mode, A = automatic (output DGPS data when available, non-DGPs otherwise), D = differential exclusively (output only differential fixes)
- 10) NMEA Baud rate, 1 = 1200, 2 = 2400, 3 = 4800, 4 = 9600
- 11) Filter mode, 2 = no filtering (only option)
- 12) PPS mode, 1 = No PPS, 2 = 1 Hz
- 13) Checksum

\$PGRME Estimated Position Error

Garmin proprietary sentence

```

    1 2 3 4 5 6 7
    | | | | | | |
$PGRME,x.x,M,x.x,M,x.x,M*hh

```

- 1) Estimated horizontal position error (HPE)
- 2) Unit, metres
- 3) Estimated vertical error (VPE)
- 4) Unit, metres
- 5) Overall spherical equivalent position error
- 6) Unit, metres
- 7) Checksum

\$PGRMF Position Fix Sentence

Garmin proprietary sentence

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

\$PGRMF,x.x,x.x,ddmmyy,hhmmss,x.x,ddmm.mmmmm,c,dddmm.mmmmm,c,c,c,x.x,x.x,c,c*hh

- 1) GPS week number (0 - 1023)
- 2) GPS seconds (0 - 604799)
- 3) UTC date of position fix
- 4) UTC time of position fix
- 5) GPS leap second count
- 6) Latitude
- 7) N or S
- 8) Longitude
- 9) E or W
- 10) Mode
 - M = manual
 - A = automatic
- 11) Fix type
 - 0 = no fix
 - 1 = 2D fix
 - 2 = 3D fix
- 12) Speed over ground, 0 to 999 kilometers/hour
- 13) Course over ground, 0 to 359 degrees, true
- 14) Position dilution of precision, 0 to 9 (rounded to nearest integer value)
- 15) Time dilution of precision, 0 to 9 (rounded to nearest integer value)
- 16) Checksum

\$PGRMI Sensor Initialisation Information

Garmin proprietary sentence

1	2	3	4	5	6	7

\$PGRMI,ddmm.mmm,N,ddmm.mmm,E,ddmmyy,hhmmss*hh

- 1) Latitude
- 2) N or S
- 3) Longitude
- 4) E or W
- 5) Current UTC date
- 6) Current UTC time
- 7) Checksum

\$PGRMM Map Datum

Garmin proprietary sentence

1	2

\$PGRMM,c---c*hh

- 1) Currently active horizontal datum (WGS-84, NAD27 Canada, ED50, a.s.o)
- 2) Checksum

\$PGRMO Output Sentence Enable/Disable

Garmin proprietary sentence

```

      1      2 3
      |      | |
$PGRMO,cccc,c*hh

```

- 1) Target sentence description (e.g., PGRMT, GPGSV, etc.)
- 2) Target sentence mode
 - 0 = disable specified sentence
 - 1 = enable specified sentence
 - 2 = disable all
 - 3 = enable all output sentences (except GPALM)
- 3) Checksum

\$PGRMT Sensor Status Information

Garmin proprietary sentence

```

      1      2 3 4 5 6 7 8      9 10
      |      | | | | | | |      | |
$PGRMT,c...c,c,c,c,c,c,c,x.x,c*hh

```

- 1) Product, model and software version
e.g. "GPS25VEE] 1.10"
- 2) Rom checksum test
P = pass
F = fail
- 3) Receiver failure discrete
P = pass
F = fail
- 4) Stored data lost
R = retained
L = lost
- 5) Real time clock lost
R = retained
L = lost
- 6) Oscillator drift discrete
P = pass
F = excessive drift detected
- 7) Data collection discrete
C = collecting
null if not collecting
- 8) Board temperature in degrees C
- 9) Board configuration data
R = retained
L = lost
- 10) Checksum

\$PGRMV 3D Velocity

Garmin proprietary sentence

```

      1      2      3      4
      |      |      |      |
$PGRMV,x.x,x.x,x.x*hh

```

- 1) True east velocity, -999.9 to 9999.9 meters/second
- 2) True north velocity, -999.9 to 9999.9 meters/second
- 3) Up velocity, -999.9 to 9999.9 meters/second
- 4) Checksum

\$PGRMZ Altitude Information

Garmin proprietary sentence

```
      1   2 3 4  
      |   | | |  
$PGRMZ,x.x,f,h*hh
```

- 1) Altitude
- 2) Unit, feets
- 3) Position fix dimensions
 2 user altitude
 3 GPS altitude
- 4) Checksum

\$PSLIB Differential GPS Beacon Receiver Control

Starlink, Inc. proprietary sentence, used by Garmin and others

```
      1   2   3 4  
      |   |   | |  
$PSLIB,x.x,x.x,c*hh
```

- 1) Frequency
- 2) Bit rate
- 3) Request type
 J = status request
 K = configuration request
 blank = tuning message
- 4) Checksum

7. Manufacturer Codes

Note: This list is out-of-date, but perhaps still useful.

AAR	Asian American Resources
ACE	Auto-Comm Engineering Corporation
ACR	ACR Electronics, Inc.
ACS	Arco Solar, Inc.
ACT	Advanced Control Technology
AGI	Airguide Instrument Company
AHA	Autohelm of America
AIP	Aiphone Corporation
ALD	Alden Electronics, Inc.
AMR	AMR Systems
AMT	Airmar Technology
ANS	Antenna Specialists
ANX	Analytix Electronic Systems
ANZ	Anschutz of America
APC	Apelco
APN	American Pioneer, Inc.
APX	Amperex, Inc.
AQC	Aqua-Chem, Inc.
AQD	Aquadynamics, Inc.
AQM	Aqua Meter Instrument Company
ASP	American Solar Power
ATE	Aetna Engineering
ATM	Atlantic Marketing Company, Inc.
ATR	Airtron
ATV	Activation, Inc.
AVN	Advanced Navigation, Inc.
AWA	Awa New Zealand, Limited
BBL	BBL Industries, Inc.
BBR	BBR and Associates
BDV	Brisson Development, Inc.
BEC	Boat Electric Company
BGS	Barringer Geoservice
BGT	Brookes and Gatehouse, Inc.
BHE	BH Electronics
BHR	Bahr Technologies, Inc.
BLB	Bay Laboratories
BME	Bartel Marine Electronics
BNI	Neil Brown Instrument Systems
BNS	Bowditch Navigation Systems
BRM	Mel Barr Company
BRY	Byrd Industries
BTH	Benthos, Inc.
BTK	Baltek Corporation
BTS	Boat Sentry, Inc.
BXA	Bendix-Avalex, Inc.
CAT	Catel
CBN	Cybernet Marine Products
CCA	Copal Corporation of America
CCC	Coastal Communications Company
CCL	Coastal Climate Company
CCM	Coastal Communications
CDC	Cordic Company
CEC	Ceco Communications, Inc.
CHI	Charles Industries, Limited
CKM	Cinkel Marine Electronics Industries
CMA	Societe Nouvelle D'Equiment du Calvados
CMC	Coe Manufacturing Company
CME	Cushman Electronics, Inc.
CMP	C-Map, s.r.l.
CMS	Coastal Marine Sales Company
CMV	CourseMaster USA, Inc.
CNV	Coastal Navigator
CNX	Cynex Manufacturing Company
CPL	Computrol, Inc.
CPN	Compunav
CPS	Columbus Positioning, Inc.
CPT	CPT, Inc.
CRE	Crystal Electronics, Limited
CRO	The Caro Group
CRY	Crystek Crystals Corporation
CSI	Communication Systems International, Inc.
CSM	Comsat Maritime Services
CST	Cast, Inc.
CSV	Combined Services
CTA	Current Alternatives
CTB	Cetec Benmar
CTC	Cell-tech Communications
CTE	Castle Electronics
CTL	C-Tech, Limited
CNI	Continental Instruments
CWD	Cubic Western Data
CWV	Celwave R.F., Inc.
CYZ	cYz, Inc.
DCC	Dolphin Components Corporation
DEB	Debeg GmbH
DFI	Defender Industries, Inc.
DGC	Digicourse, Inc.
DME	Digital Marine Electronics Corp.
DMI	Datamarine International, Inc.
DNS	Dornier System GmbH
DNT	Del Norte Technology, Inc.
DPS	Danaplus, Inc.
DRL	R.L. Drake Company
DSC	Dynascan Corporation
DYN	Dynamote Corporation
DYT	Dytek Laboratories, Inc.
EBC	Emergency Beacon Corporation
ECT	Echotec, Inc.
EEV	EEV, Inc.
EFC	Efcom Communication Systems
ELD	Electronic Devices, Inc.
EMC	Electric Motion Company
EMS	Electro Marine Systems, Inc.
ENA	Energy Analysts, Inc.
ENC	Encron, Inc.
EPM	Epsco Marine
EPT	Eastprint, Inc.
ERC	The Ericsson Corporation
ESA	European Space Agency
FDN	Fluiddyne
FHE	Fish Hawk Electronics
FJN	Jon Fluke Company
FMM	First Mate Marine Autopilots
FNT	Franklin Net and Twine, Limited
FRC	The Fredericks Company
FTG	T.G. Faria Corporation
FUJ	Fujitsu Ten Corporation of America
FEC	Furuno Electric Company (??)

FUR	Furuno USA, Inc.	MDL	Medallion Instruments, Inc.
GAM	GRE America, Inc.	MEC	Marine Engine Center, Inc.
GCA	Gulf Cellular Associates	MEG	Maritec Engineering GmbH
GES	Geostar Corporation	MFR	Modern Products, Ltd
GFC	Graphic Controls Corporation	MFV	Frank W. Murphy Manufacturing
GIS	Galax Integrated Systems	MGN	Magellan Corporation
GPI	Global Positioning Instrument Corporation	MGS	MG Electronic Sales Corporation
GRM	Garmin Corporation	MIE	Mieco, Inc.
GSC	Gold Star Company, Limited	MIM	Marconi International Marine Company
GTO	Gro Electronics	MLE	Martha Lake Electronics
GVE	Guest Corporation	MLN	Matlin Company
GVT	Great Valley Technology	MLP	Marlin Products
HAL	HAL Communications Corporation	MLT	Miller Technologies
HAR	Harris Corporation	MMB	Marsh-McBirney, Inc.
HIG	Hy-Gain	MME	Marks Marine Engineering
HIT	Hi-Tec	MMP	Metal Marine Pilot, Inc.
HPK	Hewlett-Packard	MMS	Mars Marine Systems
HRC	Harco Manufacturing Company	MNI	Micro-Now Instrument Company
HRT	Hart Systems, Inc.	MNT	Marine Technology
HTI	Heart Interface, Inc.	MNX	Marinex
HUL	Hull Electronics Company	MOT	Motorola
HWM	Honeywell Marine Systems	MPN	Memphis Net and Twine Company, Inc.
ICO	Icom of America, Inc.	MQS	Marquis Industries, Inc.
IFD	International Fishing Devices	MRC	Marinecomp, Inc.
IFI	Instruments for Industry	MRE	Morad Electronics Corporation
IME	Imperial Marine Equipment	MRP	Mooring Products of New England
IMI	I.M.I.	MRR	Il Morrow, Inc.
IMM	ITT MacKay Marine	MRS	Marine Radio Service
IMP	Impulse Manufacturing, Inc.	MSB	Mitsubishi Electric Company, Ltd.
IMT	International Marketing and Trading, Inc.	MSE	Master Electronics
INM	Inmar Electronic and Sales, Inc.	MSM	Master Mariner, Inc.
INT	Intech, Inc.	MST	Mesotech Systems, Ltd.
IRT	Intera Technologies, Ltd.	MTA	Marine Technical Associates
IST	Innerspace Technology, Inc.	MTG	Narine Technical Assistance Group
ITM	Intermarine Electronics, Inc.	MTK	Martech, Inc.
ITR	Itera, Limited	MTR	Mitre Corporation, Inc.
JAN	Jan Crystals	MTS	Mets, Inc.
JFR	Ray Jefferson	MUR	Murata Erie North America
JMT	Japan Marine Telecommunications	MVX	Magnavox Advanced Products and Systems Company
JRC	Japan Radio Company, Inc.		
JRI	J-R Industries, Inc.	MXX	Maxxima Marine
JTC	J-Tech Associates, Inc.	MES	Marine Electronics Service, Inc.
JTR	Jotron Radiosearch, Ltd.	NAT	Nautech, Limited
KBE	KB Electronics, Ltd.	NEF	New England Fishing Gear, Inc.
KBM	Kennebec Marine Company	NMR	Newmar
KLA	Klein Associates, Inc.	NGS	Navigation Sciences, Inc.
KMR	King Marine Radio Corporation	NOM	Nav-Com, Inc.
KNG	King Radio Corporation	NOV	NovAtel Communications, Ltd.
KOD	Koden Electronics Company, Ltd.	NSM	Northstar Marine
KRP	Krupp International, Inc.	NTK	Novatech Designs, Ltd.
KVH	KVH Company	NVC	Navico
KYI	Kyocera International, Inc.	NVS	Navstar
LAT	Latitude Corporation	NVO	Navionics, s.p.a.
LEC	Lorain Electronics Corporation	OAR	O.A.R. Corporation
LMM	Lamarche Manufacturing Company	ODE	Ocean Data Equipment Corporation
LRD	Lorad	ODN	Odin Electronics, Inc.
LSE	Littlemore Scientific Engineering	OIN	Ocean instruments, Inc.
LSP	Laser Plot, Inc.	OKI	Oki Electronic Industry Company
LTF	Littlefuse, Inc.	OLY	Navstar Limited (Polytechnic Electronics)
LWR	Lowrance Electronics Corporation	OMN	Omnetics
MCL	Micrologic, Inc.	ORE	Ocean Research

OTK	Ocean Technology	SRS	Shipmate, Rauff & Sorensen, A/S
PCE	Pace	TBB	Thompson Brothers Boat Manufacturing Company
PDM	Prodelco Marine Systems	TCN	Trade Commission of Norway (THE)
PLA	Plath, C. Division of Litton	TDL	Tideland Signal
PLI	Pilot Instruments	THR	Thrane and Thrane A/A
PMI	Pernicka Marine Products	TLS	Telesystems
PMP	Pacific Marine Products	TMT	Tamtech, Ltd.
PRK	Perko, Inc.	TNL	Trimble Navigation
PSM	Pearce-Simpson	TRC	Tracor, Inc.
PTC	Petro-Com	TSI	Techsonic Industries, Inc.
PTG	P.T.I./Guest	TTK	Talon Technology Corporation
PTH	Pathcom, Inc.	TTS	Transtector Systems
RAC	Racal Marine, Inc.	TWC	Transworld Communications, Inc.
RAE	RCA Astro-Electronics	TXI	Texas Instruments, Inc.
RAY	Raytheon Marine Company	UME	Umec
RCA	RCA Service Company	UNI	Uniden Corporation of America
RCH	Roach Engineering	UNP	Unipas, Inc.
RCI	Rochester Instruments, Inc.	UNF	Uniforce Electronics Company
RDI	Radar Devices	VAN	Vanner, Inc.
RDM	Ray-Dar Manufacturing Company	VAR	Varian Eimac Associates
REC	Ross Engineering Company	VCM	Videocom
RFP	Rolfite Products, Inc.	VEX	Vexillar
RGC	RCS Global Communications, Inc.	VIS	Vessel Information Systems, Inc.
RGY	Regency Electronics, Inc.	VMR	Vast Marketing Corporation
RMR	RCA Missile and Surface Radar	WAL	Walport USA
RSL	Ross Laboratories, Inc.	WBG	Westberg Manufacturing, Inc.
RSM	Robertson-Shipmate, USA	WEC	Westinghouse Electric Corporation
RWI	Rockwell International	WHA	W-H Autopilots
RME	Racal Marine Electronics	WMM	Wait Manufacturing and Marine Sales Company
RTN	Robertson Tritech Nyaskaian A/S	WMR	Wesmar Electronics
SAI	SAIT, Inc.	WNG	Winegard Company
SBR	Sea-Bird electronics, Inc.	WSE	Wilson Electronics Corporation
SCR	Signalcrafters, Inc.	WTC	Watercom
SEA	SEA	WST	West Electronics Ltd.
SEC	Sercel Electronics of Canada	YAS	Yaesu Electronics
SEP	Steel and Engine Products, Inc.		
SFN	Seafarer Navigation International		
SGC	SGC, Inc.		
SIG	Signet, Inc.		
SIM	Simrad, Inc.		
SKA	Skantek Corporation		
SKP	Skipper Electronics A/S		
SLI	Starlink, Inc.		
SME	Shakespeare Marine Electronics		
SMF	Seattle Marine and Fishing Supply Co.		
SML	Simerl Instruments		
SMI	Sperry Marine, Inc.		
SNV	Starnav Corporation		
SOM	Sound Marine Electronics, Inc.		
SOV	Sell Overseas America		
SPL	Spelmar		
SPT	Sound Powered Telephone		
SRD	SRD Labs		
SRS	Scientific Radio Systems, Inc.		
SRT	Standard Radio and Telefon AB		
SSI	Sea Scout Industries		
STC	Standard Communications		
STI	Sea-Temp Instrument Corporation		
STM	Si-Tex Marine Electronics		
SVY	Savoy Electronics		
SWI	Swoffer Marine Instruments, Inc.		

8. References

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- [4] Data Transmission Protocol Specification for Magellan Products. Revision 1.0. Magellan Corporation, Santa Clara 1999. Available at: <http://magellangps.com>
This document describes the protocol used by Magellan's consumer GPS units, including a number of NMEA 0183 proprietary sentences.
- [5] SBA-1 Interfacing Manual. Revision 0.0. Communications Systems International, Inc, Calgary, 1999. Available at: www.csi-dgps.com.
This manual explains the interfacing of the SBA-1 DGPS beacon receiver to numerous GPS units as well as the CSI proprietary sentences used.