

# The NMEA 0183 Protocol

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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\$).

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New Bern NC 28564-3435  
USA  
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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  $\pm 5$  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---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,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

**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

```

1 2 3 4 5 6 7 8 9 10 11 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

```

- 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**

[illegible]

- 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,1111.11,	a,yyyyy.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^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	,...*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*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**

```

                                12
      1 2       3 4       5 6   7   8   9   10 11 |
      | |       | |       | |   |   |   |   | |
$--RMA,A,llll.ll,a,yyyy.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,  $\mu$ S
- 7) Time Difference B,  $\mu$ 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 |
|  |   |   |   |   |   |

\$--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,yyyy.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 | 11 | 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<sup>-9</sup> 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

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

\$PGRMF,x.x,x.x,ddmmyy,hmmss,x.x,ddmm.mmmm,c,dddmm.mmmm,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,hmmss\*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, feet
- 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                | CME | Cushman Electronics, Inc.                 |
| ACE | Auto-Comm Engineering Corporation       | CMP | C-Map, s.r.l.                             |
| ACR | ACR Electronics, Inc.                   | CMS | Coastal Marine Sales Company              |
| ACS | Arco Solar, Inc.                        | CMV | CourseMaster USA, Inc.                    |
| ACT | Advanced Control Technology             | CNV | Coastal Navigator                         |
| AGI | Airguide Instrument Company             | CNX | Cynex Manufacturing Company               |
| AHA | Autohelm of America                     | CPL | Computrol, Inc.                           |
| AIP | Aiphone Corporation                     | CPN | Compunav                                  |
| ALD | Alden Electronics, Inc.                 | CPS | Columbus Positioning, Inc.                |
| AMR | AMR Systems                             | CPT | CPT, Inc.                                 |
| AMT | Airmar Technology                       | CRE | Crystal Electronics, Limited              |
| ANS | Antenna Specialists                     | CRO | The Caro Group                            |
| ANX | Analytix Electronic Systems             | CRY | Crystek Crystals Corporation              |
| ANZ | Anschutz of America                     | CSI | Communication Systems International, Inc. |
| APC | Apelco                                  | CSM | Comsat Maritime Services                  |
| APN | American Pioneer, Inc.                  | CST | Cast, Inc.                                |
| APX | Amperex, Inc.                           | CSV | Combined Services                         |
| AQC | Aqua-Chem, Inc.                         | CTA | Current Alternatives                      |
| AQD | Aquadynamics, Inc.                      | CTB | Cetec Benmar                              |
| AQM | Aqua Meter Instrument Company           | CTC | Cell-tech Communications                  |
| ASP | American Solar Power                    | CTE | Castle Electronics                        |
| ATE | Aetna Engineering                       | CTL | C-Tech, Limited                           |
| ATM | Atlantic Marketing Company, Inc.        | CNI | Continental Instruments                   |
| ATR | Airtron                                 | CWD | Cubic Western Data                        |
| ATV | Activation, Inc.                        | CWV | Celwave R.F., Inc.                        |
| AVN | Advanced Navigation, Inc.               | CYZ | cYz, Inc.                                 |
| AWA | Awa New Zealand, Limited                | DCC | Dolphin Components Corporation            |
| BBL | BBL Industries, Inc.                    | DEB | Debeg GmbH                                |
| BBR | BBR and Associates                      | DFI | Defender Industries, Inc.                 |
| BDV | Brisson Development, Inc.               | DGC | Digicourse, Inc.                          |
| BEC | Boat Electric Company                   | DME | Digital Marine Electronics Corp.          |
| BGS | Barringer Geoservice                    | DMI | Datamarine International, Inc.            |
| BGT | Brookes and Gatehouse, Inc.             | DNS | Dornier System GmbH                       |
| BHE | BH Electronics                          | DNT | Del Norte Technology, Inc.                |
| BHR | Bahr Technologies, Inc.                 | DPS | Danaplug, Inc.                            |
| BLB | Bay Laboratories                        | DRL | R.L. Drake Company                        |
| BME | Bartel Marine Electronics               | DSC | Dynascan Corporation                      |
| BNI | Neil Brown Instrument Systems           | DYN | Dynamote Corporation                      |
| BNS | Bowditch Navigation Systems             | DYT | Dytek Laboratories, Inc.                  |
| BRM | Mel Barr Company                        | EBC | Emergency Beacon Corporation              |
| BRY | Byrd Industries                         | ECT | Echotec, Inc.                             |
| BTH | Benthos, Inc.                           | EEV | EEV, Inc.                                 |
| BTK | Baltek Corporation                      | EFC | Efcom Communication Systems               |
| BTS | Boat Sentry, Inc.                       | ELD | Electronic Devices, Inc.                  |
| BXA | Bendix-Avalex, Inc.                     | EMC | Electric Motion Company                   |
| CAT | Catel                                   | EMS | Electro Marine Systems, Inc.              |
| CBN | Cybernet Marine Products                | ENA | Energy Analysts, Inc.                     |
| CCA | Copal Corporation of America            | ENC | Encron, Inc.                              |
| CCC | Coastal Communications Company          | EPM | Epsco Marine                              |
| CCL | Coastal Climate Company                 | EPT | Eastprint, Inc.                           |
| CCM | Coastal Communications                  | ERC | The Ericsson Corporation                  |
| CDC | Cordic Company                          | ESA | European Space Agency                     |
| CEC | Ceco Communications, Inc.               | FDN | Fluiddyne                                 |
| CHI | Charles Industries, Limited             | FHE | Fish Hawk Electronics                     |
| CKM | Cinkel Marine Electronics Industries    | FJN | Jon Fluke Company                         |
| CMA | Societe Nouvelle D'Equiment du Calvados | FMM | First Mate Marine Autopilots              |
| CMC | Coe Manufacturing Company               | 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              | MFW | 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 Nyaskaiaen 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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- [5] SBA-1 Interfacing Manual. Revision 0.0. Communications Systems International, Inc, Calgary, 1999. Available at: [www.csi-dgps.com](http://www.csi-dgps.com).  
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