

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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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:

```
$t t s s s , d 1 , d 2 , . . . <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,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

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

\$--BWC,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

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

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

\$--BWR,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

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

[illegible]

- 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,	x,x,x,x	,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, yyyyy.yy, a, hmmmss.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