IEC 61162-3

Edition 1.2 2014-07

CONSOLIDATED VERSION

colour inside

Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 3: Serial data instrument network

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Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 3: Serial data instrument network

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 40.020.70

ISBN 978-2-8322-1755-9

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IEC 61162-3

Edition 1.2 2014-07

REDLINE VERSION

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Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 3: Serial data instrument network

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MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DIGITAL INTERFACES –

Part 3: Serial data instrument network

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This Consolidated version of IEC 61162-3 bears the edition number 1.2. It consists of the first edition (2008-05) [documents 80/496/CDV and 80/526/RVC], its amendment 1 (2010-06) [documents 80/580/CDV and 80/594/RVC] and its amendment 2 (2014-07) [documents 80/714/CDV and 80/734/RVC]. The technical content is identical to the base edition and its amendments.

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendments 1 and 2. Additions and deletions are displayed in red, with deletions being struck through. A separate Final version with all changes accepted is available in this publication.

This publication has been prepared for user convenience.

International Standard IEC 61162-3 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61162 series, under the general title *Maritime navigation and radiocommunication equipment and systems – Digital interfaces,* can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

This part of IEC 61162 has been developed by the IEC technical committee 80 working group 6, to meet the requirement for a versatile and economic means of connecting a wide range of marine navigation and radiocommunications equipment aboard SOLAS vessels. The National Marine Electronics Association's Standard Committee has developed the NMEA 2000®[1] standard. The NMEA[2] 2000 Standard provides for capabilities across all classes of vessels. The development of NMEA 2000 began in 1994 and was completed in 1999. More than a dozen manufacturers worldwide conducted a two-year beta test. The finalised NMEA 2000 standard version 1.000 was published in 2001. IEC and NMEA have worked together since 1999 to ensure that the NMEA 2000 standard fully supports SOLAS applications. NMEA 2000 version 1.200 was published in 2004, with expanded support for redundant messaging and for equipments such as AIS.

The need for an improved standard, compared with IEC 61162-1 and IEC 61162-2, has arisen due to the increased complexity of the latest equipment and systems. This requires multiple links between equipment and greatly improved communication speed.

The parts 400 of the IEC 61162 series have already been issued and cater for the most complex systems to be found on board a ship.

This new part 3 of IEC 61162 adopts the controller area network (CAN) technology, already well established for many industrial systems. This permits a versatile system to be established with the minimum of effort and reasonable cost. The equipment types supported and the sentence data content developed for IEC 61162-1 has been retained.

IEC 61162-3 describes a low cost, moderate capacity, bi-directional multi-transmitter/multi-receiver instrument network to interconnect marine electronic equipment. The connectors and cables used are compatible with industrial bus systems for instance DeviceNet™[3] and Profibus™[4].

IEC 61162-3 provides for the application of NMEA 2000 aboard SOLAS vessels. Exceptions, additions and specific requirements for implementation upon SOLAS vessels are contained in this document.

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1 NMEA 2000® is the registered trademark of the National Marine Electronics Association, Inc. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance to this profile does not require use of the trade name. Use of the trade name requires permission of the trade holder.

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INTRODUCTION to Amendment 1

The amendment updates the normative reference for NMEA 2000 Appendix B to a later version which includes five new sentences: PGN # 129807 - AIS Class B Group Assignment, PGN # 129809 - AIS Class B "CS" Static Report Part A, PGN # 129810 - AIS Class B, PGN # 129039 - AIS Class B Position Report, and PGN # 129040 - AIS Class B Extended Position Report.

INTRODUCTION to Amendment 2

The amendment updates the normative references for NMEA 2000 Main Document, NMEA 2000 Appendix A and NMEA 2000 Appendix D to a later version.

The amendment further updates the normative reference for NMEA 2000 Appendix B to a later version which includes the following new parameter groups:

126983– Alert
126984– Alert response
129041– AIS Aids to Navigation (AtoN) report
130316– Temperature- extended range

and the following revised parameter groups:

126992– System time
128259– Speed, water referenced
128267– Water depth
129285– Navigation – Route/WP information
129033– Time and date
129038– AIS Class A position report
129039– AIS Class B position report
129040– AIS Class B extended position report
129550– GNSS differential correction receiver
129793– AIS UTC and date report
129794– AIS Class A static and voyage related data
129796– AIS acknowledge
129798– AIS SAR aircraft position report
129800– AIS UTC/date inquiry
129801– AIS addressed safety related message
129802– AIS safety related broadcast message
129803– AIS interrogation
129804– AIS assignment mode command
129805– AIS data link management message
129806– AIS channel management
129807– AIS group assignment
129809– AIS Class B “CS” static data report, Part A
129810– AIS Class B “CS” static data report, Part B

The amendment further adds a new informative Annex B which shows the relationships between IEC 61162-1 sentences and IEC 61162-3 parameter group numbers.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DIGITAL INTERFACES –

Part 3: Serial data instrument network

1 Scope

This part of IEC 61162 is based upon the NMEA 2000 standard. The NMEA 2000 standard contains the requirements for the minimum implementation of a serial-data communications network to interconnect marine electronic equipment onboard vessels. Equipment designed to this standard will have the ability to share data, including commands and status, with other compatible equipment over a single signalling channel.

Data messages are transmitted as a series of data frames, each with robust error check confirmed frame delivery and guaranteed latency times. As the actual data content of a data frame is at best 50 % of the transmitted bits, this standard is primarily intended to support relatively brief data messages, which may be periodic, transmitted as needed, or on-demand by use of query commands. Typical data includes discrete parameters such as position latitude and longitude, GPS status values, steering commands to autopilots, finite parameter lists such as waypoints, and moderately sized blocks of data such as electronic chart database updates. This standard is not necessarily intended to support high-bandwidth applications such as radar, electronic chart or other video data, or other intensive database or file transfer applications.

This standard defines all of the pertinent layers of the International Standards Organisation Open Systems Interconnect (ISO/OSI) model, from the application layer to the physical layer, necessary to implement the required IEC 61162-3 network functionality.

This standard defines data formats, network protocol, and the minimum physical layer necessary for devices to interface. SOLAS applications shall employ redundant designs (for instance dual networks, redundant network interface circuits) to reduce the impact of single point failures. The NMEA 2000 standard provides the fundamental tools and methods to support redundant equipment, buses and messaging. Specific shipboard installation designs are beyond the scope of this standard, however some guidance is given in Annex A.

Relationships between IEC 61162-1 sentences and IEC 61162-3 parameter group numbers are given in Annex B.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60945, *Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results*

ISO 11783 (all parts), *Tractors and machinery for agriculture and forestry – Serial control and communications data network*

ISO 11783-3, *Tractors and machinery for agriculture and forestry – Serial control and communications data network – Part 3: Data link layer*

ISO 11783-5:2001, *Tractors and machinery for agriculture and forestry – Serial control and communications data network – Part 5 Network management (including its corrigendum 1 (2002)*

NMEA 2000 Main document, Version ~~1.200~~ 1.210: ~~October 2004~~ January 2013, *Serial-Data Networking Of Marine Electronic Devices*[5]

NMEA 2000, Appendix A, Version ~~1.200~~ 2.000: ~~October 2004~~ January 2013, *Serial-Data Networking Of Marine Electronic Devices – Application Layer (Parameter Group Definitions)*)

NMEA 2000, Appendix B, Version ~~1.210~~ 2.000: ~~September 2006~~ January 2013 *Serial-Data Networking Of Marine Electronic Devices – Data Base*)

NMEA 2000, Appendix C, Version 1.200: October 2004, *Serial-Data Networking Of Marine Electronic Devices – Certification Criteria and Test Methods*)

NMEA 2000, Appendix D, Version ~~1.200~~ 1.210: ~~October 2004~~ January 2013, *Serial-Data Networking Of Marine Electronic Devices – Application Notes*)

IMO 1974, *International Convention for the Safety of Life at Sea (SOLAS), as amended – Chapter V – Safety of navigation*

3 Terms, definitions and conventions

3.1 Terms and definitions

For the purposes of this document, the following definitions apply.

3.1.1
bit
the smallest element of information on the communication channel

NOTE Bits are grouped into bit fields of one or more bits. A bit is of constant time duration set by the signalling rate specified in this standard and has one of two logical values, dominant or recessive. When dominant and recessive levels are impressed on the communications channel at the same time the resulting level is dominant.

3.1.2
bridge
device that joins two network segments using the same network protocol and address space

NOTE Data rate and physical media may differ on the two sides of a bridge. A bridge may perform message filtering.

3.1.3
byte
eight bits

3.1.4
Controller area network (CAN) frame
series of bits transmitted on the communications channel

NOTE CAN frames convey the following types of information:

- data frame. Carries data from a transmitter to the receivers.
- error frame. Transmitted by a unit detecting a bus error.
- overload frame. Transmitted to provide a delay between preceding and succeeding data frames.

5 Available from National Marine Electronics Association (USA), www.nmea.org.

The CAN data frame has defined start of frame and end of frame bit fields and is separated from preceding fields by an interframe space. CAN error and overload frames, when used, are appended directly to the preceding frame without an interframe space.

3.1.5
class 1 devices
refers to devices that have a single level A or level B network interface connection

3.1.6
class 2 devices
describes devices that have two level A or two level B network interface connections

NOTE Class 2 devices are intended for use on dual redundant bus systems. In addition to providing either level A or level B capabilities, class 2 devices provide a means to identify messages that are received from redundant buses as being the same or different.

3.1.7
default operation
operation or settings that exist when standard equipment is first shipped from the manufacturer

3.1.8
device
a product or equipment which, through a node, is connected to an IEC 61162-3 network

3.1.9
gateway
device that joins a network to another network or system

3.1.10
interframe space
bit field that separates data frames from preceding frames

3.1.11
level A devices
support the ISO transport layer and the complete set of network management parameter groups

3.1.12
level B devices
support address claim, ISO request PGN, and the product information parameter group

3.1.13
listen only device
device on the network that receives messages but does not participate in bus activity

NOTE This device cannot send any frames on the network (data, error, or acknowledge).

3.1.14
load equivalency number
a node’s power rating reported in units of network load

3.1.15
message
consists of one or more data frames, as specified in this standard, that contain the parameter group information to be communicated from a network address

NOTE A message contains the message priority code, parameter group number, destination network address, source network address, and data fields. The destination network address may be a specific address or global.

3.1.16
network address
identifier of a functional entity on the network

3.1.17
network load
one network load is a unit of measure defined as 50 mA

NOTE This is used to determine loading of network.

3.1.18
node
a physical connection to the network

NOTE A node may have more than one network address, see virtual nodes.

3.1.19
node power
power supplied from the network

3.1.20
parameter group (PG)
set of associated variables, commands, status, or other information to be transmitted on the network

3.1.21
parameter group number (PGN)
an 8-bit or 16-bit number that identifies each parameter group

NOTE The parameter group number (PGN) is analogous to the three-character sentence formatter in IEC 61162-1. By definition, parameter groups identified by 16-bit parameter group numbers are broadcast to all addresses on the network. Parameter groups identified by 8-bit parameter group numbers may be used to direct data for use by a specific address.

3.1.22
receiver
recipient of a message if the bus is not idle and the device is not a transmitter

3.1.23
router
device that joins two network segments with the same network protocol

NOTE On each side of a router address space, data rate and physical media may differ.

3.1.24
transmitter
originator of a message

NOTE The unit remains a transmitter until it loses arbitration or until the bus becomes idle.

3.1.25
virtual nodes
functional entities within a device that share a physical connection to the network

NOTE Each virtual node within a device has a unique address on the network.

3.2 Conventions

3.2.1
may
In this document “may” when relating to network requirements applies to alternatives and optional items that are allowed in a network. An implementation that does not include an alternative shall be prepared to tolerate another implementation that does.

3.2.2
shall
In this document “shall” when relating to network requirements signifies items that are required in a network.

3.2.3
shall not
In this document “shall not” when relating to network requirements signifies items that are prohibited in a network.

3.2.4
should
In this document “should” when relating to network requirements signifies a recommendation that, if followed, could ease development or improve the operation of the network in some manner.

4 Physical layer

The physical layer of this standard is as described in the NMEA 2000 Main document.

4.1 CAN transceiver

Devices shall utilize CAN transceivers that include a “transmit dominant timeout” timer circuit (babbling idiot protection).

4.2 Environmental

Components and circuits shall be designed to meet the durability and resistance to environmental conditions of IEC 60945, Clause 8. The requirements of 8.8 (rain and spray) apply only to those network components actually intended to be exposed to rain and/or spray.

4.3 Radio frequency interference

4.3.1 Unwanted electromagnetic emissions

Components and circuits shall be designed to meet the unwanted electromagnetic emission requirements of IEC 60945, Clause 9.

4.3.2 Immunity to electromagnetic environment

Components and circuits shall be designed to meet the Immunity to electromagnetic environment conditions of IEC 60945, Clause 10.

4.4 Cables

Network cables shall meet the electrical and minimum physical characteristics specified in the NMEA 2000 Main document.

4.5 Interface power

A class 2 IEC device load equivalency number shall represent the larger power rating of the two network connections, if different.

4.6 Network power source

The network shall have an independent power source for each bus.

5 Data link layer

The data link layer of this standard is defined in ISO 11783-3 with additional requirements specified in the NMEA 2000 Main Document, Section 3.0.

6 Network layer

The network layer is defined in the NMEA 2000 Main Document, Section 4.0.

7 Network management

Network management is defined in ISO 11783-5 with additional requirements specified in the NMEA 2000 Main Document, Section 8.0.

7.1 Address configuration method

Devices shall provide a method (not specified in this standard) to configure a preferred address. A device being configured in this manner shall not transmit data on the bus until completing the address claim process. This capability is only provided for use during initial shipboard installation and configuration, not during normal operations of networks. Reconfiguring the preferred address shall override the retained address.

7.2 Address retention

Devices shall retain the last successfully claimed address as the preferred address for use on the next power up.

8 Application layer

The application layer (messaging) supported by this standard consists of the parameter group structure and the parameter group number contents. The structure is defined in the NMEA 2000, Appendix A and the contents are defined by the NMEA 2000, Appendix B.

8.1 Parameter groups

Parameter groups contain predefined default values for message priority and broadcast rates. The predefined default values provide a level of expectation and consistency of operations. Though the predefined values are intended to meet the needs of the majority of shipboard network configurations, it is recognized that some installations or equipment standards may require different values for optimum performance. Methods to adjust these values to suit specific installations are provided.

8.1.1 Parameter group priority

Any change to the default parameter group priority values shall be retained, using means such as non-volatile memory.

8.1.2 Parameter group broadcast rate

Any change to the default parameter group broadcast rates shall be retained, using means such as non-volatile memory.

9 Test criteria

Test criteria of this standard are defined in NMEA 2000, Appendix C, certification and test criteria.

Devices not tested to this standard (for instance devices designed to only ISO 11783, NMEA 2000, or SAE J1939) shall not be connected to the network during normal operations.

10 Application notes

Application notes for this standard are defined in NMEA 2000, Appendix D.

11 Manufacturer's documentation

Operator manuals or other appropriate literature provided for equipment that is intended to meet the requirements of this standard shall contain the following information:

- manufacturer's code;
- product code;
- identification of the interface connector(s);
- the load equivalency number for the device for each interface (if more than one);
- a list of transmitted approved parameter group numbers and names, noting unused fields, proprietary parameter group numbers and names;
- a list of parameter group numbers and names and associated data fields that are required as input to the device;
- the current software and hardware revision if this is relevant to the interface;
- the version number and date of update of the standard for which compliance is sought.

Annex A
(informative)

System integration

A.1 Installation documentation

System configuration documentation for a specific shipboard installation should include the following information:

A.1.1 Device specific information

- Model name
- Function
- Serial number
- Manufacturer
- Installation location
- Device class (1 or 2)
- Device level (A, B, listen only)
- Configured preferred network address
- Configured PGN broadcast rates
- Configured PGN priorities
- Load equivalency number
- Network drop cable length for each node connection
- Configured to provide network power (yes, no)?
- Network power source output current capacity

A.1.2 Network specific information

- Over all bus load
- Number of devices
- Length of network backbone cable
- Backbone cable specification
- Location of network terminators
- Location of all T-connectors and barrier strips
- Number of network power sources
- Location of network power sources
- Results of network backbone cable test
- Network layout drawing

A.2 Installation validation

A.2.1 Initial installation observations

Ensure the terminators are properly installed on both ends of the network backbone cables.

A.2.2 Network backbone cable test

Perform backbone cable test before connecting any devices. These measurements shall be made before connecting any IEC 61162-3 devices to the backbone cable. The only connections to the backbone cable should be the network power sources. The backbone power should be energized. Measure the characteristics identified in the test characteristics table below. The measurements should be made at each end of the backbone in the last drop connection before the terminating resistor. If the last drop connection is the power connection, measure the characteristics at the second to last drop connection from the terminator.

Table A.1 – Test characteristics

Test	Pin / signal	Measurement	Nominal value	Tolerance
1	(1) Shield	Resistance between shield and pin (3) NET-C (Gnd)	0 Ω	≤15 Ω
2	(2) NET-S	Voltage between NET-S and pin (3) NET-C (Gnd)	12 V	≥9 V ≤16 V
3	(4) NET-H (5) NET-L	Resistance between NET-H and NET-L	60 Ω	≥57 Ω ≤68 Ω

Upon completion, de-energize the network and connect the IEC 61162-3 devices. Refer to the device manufacturer's documentation for specific device installation information. Ensure that all nodes connected to the same backbone cable are configured to have the same system instance value in their NAME.

A.2.3 Operational test

Verify that all devices operate in accordance with manufacturer instructions.

With all devices active, monitor that the bus error rate (error frames/second) is not more than one per second on each network backbone.

A.3 Redundancy

SOLAS Chapter V contains the requirement for integrated bridge systems: "*A failure of one part should not affect the functionality of other parts except for those functions directly dependant upon the information from the defective part.*" This standard should be implemented with redundant network buses in order to meet these requirements and provide safe systems. Any number of redundant buses may be implemented, though typically two will satisfy the requirements above.

This standard specifies two types of devices, those with one interface (class 1) and those with two interfaces (class 2). Redundancy may be achieved with two buses, with functions duplicated on each bus, thus providing function and bus redundancy at the system level. Duplication of function on a single bus provides function redundancy at bus level only. System redundancy requires two buses. Function redundancy may be met by having multiple class 1 devices on each bus or class 2 devices on both buses. Function redundancy can also be achieved with a combination of class 1 and class 2 devices across redundant buses. Figure A.1 and Figure A.2 illustrate two of many possible configurations.

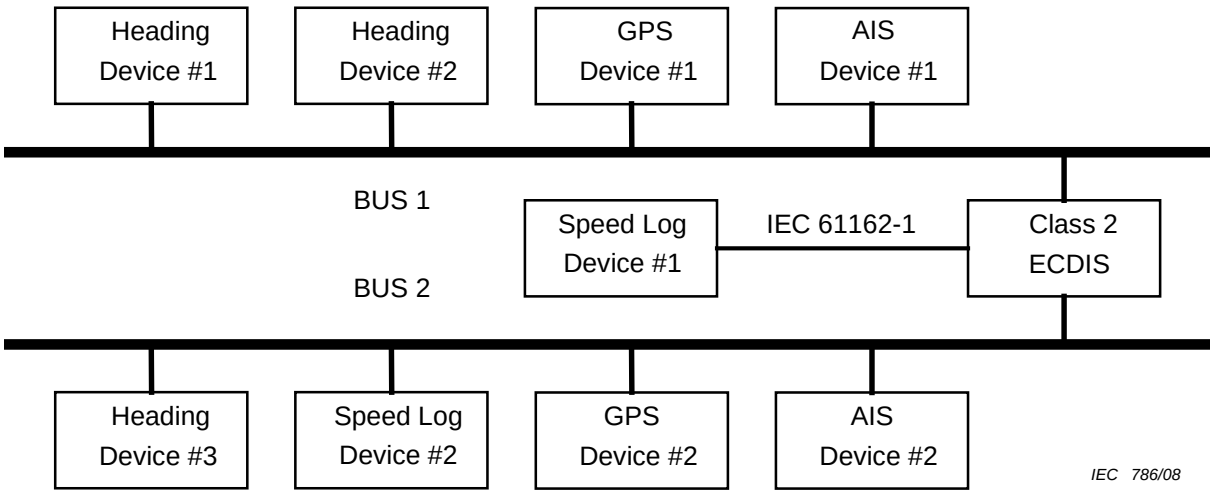

Figure A.1 – Example of configuration

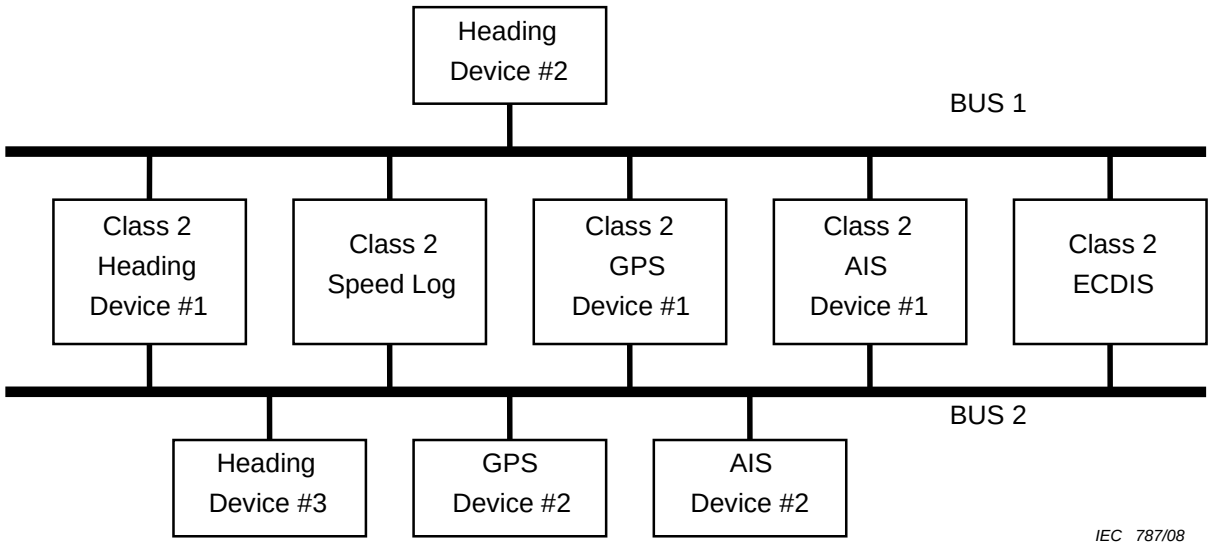

Figure A.2 – Example of configuration

A.4 Implementation recommendations

A.4.1 Message de-fragmentation and duplicate filtering

Correct assembly of fragmented messages relies on correct use of sequence, frame numbers and the DLC.

- Assembly should be performed independently on each bus before comparing DLC numbers for duplication filtering.
- Stop assembly immediately if there is any inconsistency in frame or sequence numbers. Reassembly can only start again when frame counter starts at zero, regardless of sequence number.
- Assembly errors as defined above should be monitored and/or logged.

A.4.2 ISO transport protocol usage

- The fast packet sequence counter for a PGN is not incremented when the PGN is transmitted using the ISO transport protocol.
- Class 2 devices using the ISO transport protocol should consider that
  - the request to send (RTS), broadcast announce message (BAM), and data transfer (DT) frames use the same modified DLC for a given transmission,
  - the modified DLC is based upon the enclosed PGN's DLC series,
  - the DLC value in the ABORT, clear to send (CTS), and end of message (EOM) frames is set to a value of eight.

A.4.3 Class 2 device tracking

The NAME to address relationship information maintained within a class 2 device should include the class type (1 or 2) for each entry. This is useful in determining the proper behaviour when receiving an ISO request PGN 059904.

Annex B
(informative)

Relationship between IEC 61162-1 sentences and IEC 61162-3 parameter group numbers

Table B.1 and Table B.2 give equivalents for transferring data over IEC 61162-1 interfaces and IEC 61162-3 interfaces.

Table B.1 – Conversion from IEC 61162-1 to IEC 61162-3

IEC 61162-1 sentence		IEC 61162-3 PGN	
AAM	Waypoint arrival alarm	129284	Navigation data
ABK	AIS addressed and binary broadcast acknowledgement	129796	AIS acknowledge
ABM	AIS addressed binary and safety related message	129801	AIS addressed safety related message
		129795	AIS addressed binary message
ACA	AIS regional channel assignment message	129806	AIS channel management
ACK	Acknowledge alarm	126984	Alert response
ACS	AIS channel management information source	129806	AIS channel management
AIR	AIS interrogation request	129083	AIS interrogation
AKD	Acknowledge detail alarm condition	126984	Alert response
ALA	Set detail alarm condition	126983	Alert
ALR	Set alarm state	126983	Alert
APB	Heading/Track Controller (Autopilot) Sentence B	127237	Heading/track control
		129283	Cross track error
		129284	Navigation data
BBM	AIS broadcast binary message	129797	AIS binary broadcast message
		129802	AIS safety related broadcast message
BEC	Bearing and distance to waypoint – Dead reckoning	129284	Navigation data
BOD	Bearing – Origin to destination	129284	Navigation data
BWC	Bearing and distance to waypoint – Great circle	129284	Navigation data
BWR	Bearing and distance to waypoint – Rhumb line	129284	Navigation data
BWW	Bearing – Waypoint to Waypoint	129302	Bearing and distance between two marks
		129284	Navigation data
CUR	Water current layer	130577	Direction data
DBT	Depth below transducer	128267	Water depth
DPT	Depth	128267	Water depth
DSC	Digital selective calling information	129808	DSC call information
DSE	Expanded digital selective calling	129808	DSC call information
DTM	Datum reference	129044	Datum
		129045	User datum setting

IEC 61162-1 sentence		IEC 61162-3 PGN	
FSI	Frequency set status or command	129799	Radio frequency/mode/power
GBS	GNSS satellite fault detection	129545	GNSS RAIM output
GFA	GNSS fix accuracy and Integrity	129540	GNSS satellites in view
GGA	Global positioning system (GPS) fix data	129025	Position, rapid update
		129029	GNSS position data
GLL	Geographic position – Latitude/longitude	129025	Position, rapid update
		129029	GNSS position data
GNS	GNSS fix data	129025	Position, rapid update
		129029	GNSS position data
GSA	GNSS DOP and active satellites	129029	GNSS position data
		129539	GNSS DOPs
GST	GNSS pseudorange error statistics	129547	GNSS pseudorange error statistics
GSV	GNSS satellites in view	129540	GNSS satellites in view
HDG	Heading, deviation and variation	127250	Vessel heading
		127258	Magnetic variation
HDT	Heading true	127250	Vessel heading
HSC	Heading steering command	127237	Heading track control
HTC	Heading/track control command	127237	Heading track control
HTD	Heading/track control data	127237	Heading track control
MSK	MSK receiver interface command	129550	GNSS differential correction receiver interface
MSS	MSK receiver signal	129551	GNSS differential correction receiver signal
MTW	Water temperature	130316	Temperature extended range
MWD	Wind direction and speed	130306	Wind data
MWV	Wind speed and angle	130306	Wind data
OSD	Own ship data	127250	Vessel heading
		128259	Speed, water referenced
		129026	COG, SOG rapid update
		129291	Set and drift, rapid update
		130577	Direction data
RMB	Recommended minimum navigation information	129283	Cross track error
		129284	Navigation data
RMC	Recommended minimum specific GNSS data	129025	Position, rapid update
		129026	COG and SOG, rapid update
		129029	GNSS position data
ROR	Rudder order status	127245	Rudder
ROT	Rate of turn	127251	Rate of turn
RSA	Rudder sensor angle	127245	Rudder
RTE	Routes	129285	Navigation – Route/WP information
SSD	AIS ship static data	129794	AIS Class A static and voyage related data

IEC 61162-1 sentence		IEC 61162-3 PGN	
THS	True heading and status	127250	Vessel heading
		130577	Direction data
TLB	Target label	128520	Tracked target data
TLL	Target latitude and longitude	128520	Tracked target data
TTM	Tracked target message	128520	Tracked target data
VBW	Dual ground/water speed	128259	Speed, water referenced
		130577	Direction data
		130578	Vessel speed components
VDM	AIS VHF data-link message	129038	AIS Class A position report
		129039	AIS Class B position report
		129040	AIS Class B extended position report
		129041	AIS Aids to Navigation (AtoN) report
		129792	AIS DGNSS broadcast binary message
		129793	AIS UTC and date report
		129794	AIS Class A static and voyage related data
		129795	AIS addressed binary message
		129796	AIS acknowledge
		129797	AIS binary broadcast message
		129798	AIS SAR aircraft position report
		129800	AIS UTC/date Inquiry
		129801	AIS addressed safety related message
		129802	AIS safety related broadcast message
		129803	AIS interrogation
		129804	AIS assignment mode command
		129805	AIS data link management message
		129806	AIS channel management
		129807	AIS group assignment
		129809	AIS Class B "CS" static data report, Part A
		129810	AIS Class B "CS" static data report, Part B
VDR	Set and drift	129291	Set and drift, rapid update
		130577	Direction data

IEC 61162-1 sentence		IEC 61162-3 PGN	
VDO	AIS VHF data-link own vessel report	129308	AIS Class A position report
		129039	AIS Class B position report
		129040	AIS Class B extended position report
		129041	AIS Aids to Navigation (AtoN) report
		129792	AIS DGNSS broadcast binary message
		129793	AIS UTC and date report
		129794	AIS Class A static and voyage related data
		129795	AIS addressed binary message
		129796	AIS acknowledge
		129797	AIS binary broadcast message
		129798	AIS SAR aircraft position report
		129800	AIS UTC/date Inquiry
		129801	AIS addressed safety related message
		129802	AIS safety related broadcast message
		129803	AIS interrogation
		129804	AIS assignment mode command
		129805	AIS data link management message
		129086	AIS channel management
		129807	AIS group assignment
		129809	AIS Class B "CS" static data report, Part A
		129810	AIS Class B "CS" static data report, Part B
VHW	Water speed and heading	127250	Vessel heading
		128259	Speed, water referenced
		130577	Direction data
VLW	Dual ground/water distance	128275	Distance log
VPW	Speed – Measured parallel to wind	130306	Wind data
VSD	AIS voyage static data	129794	AIS Class A static and voyage related data
VTG	Course over ground and ground speed	129026	COG and SOG, rapid update
		130577	Direction data
WAT	Water level detection	130320	Tide station data
WCV	Waypoint closure velocity	129284	Navigation data
WNC	Distance – Waypoint to waypoint	129302	Bearing and distance between two marks
WPL	Waypoint location	129284	Navigation data
		130074	Route and WP service
XTE	Cross track error, measured	129283	Cross track error
XTR	Cross track error – Dead reckoning	129283	Cross track error

IEC 61162-1 sentence		IEC 61162-3 PGN	
ZDA	Time and date	126992	System time
		129033	Time and date
ZDL	Time and distance to variable point	129301	Time to/from mark
ZFO	UTC and time from origin waypoint	129301	Time to/from mark
ZTG	UTC and time to destination waypoint	129284	Navigation data
		129301	Time to/from mark

Table B.2 – Conversion from IEC 61162-3 to IEC 61162-1

IEC 61162-3 PGN		IEC 61162-1 sentence	
126983	Alert	ALA	Set detail alarm condition
		ALR	Set alarm state
126984	Alert response	ACK	Acknowledge alarm
		AKD	Acknowledge detail alarm condition
126992	System time	ZDA	Time and date
127237	Heading track control	APB	Heading/track controller (autopilot) sentence B
		HSC	Heading steering command
		HTC	Heading/track control command
		HTD	Heading/track control data
127245	Rudder	ROR	Rudder order status
		RSA	Rudder sensor angle
127250	Vessel heading	HDG	Heading, deviation and variation
		HDT	Heading true
		OSD	Own ship data
		THS	True heading and status
		VHW	Water speed and heading
127251	Rate of turn	ROT	Rate of turn
127258	Magnetic variation	HDG	Heading, deviation and variation
127809	AIS Class B “CS” static data report, Part A	VDM	AIS VHF data-link message
127810	AIS Class B “CS” static data report, Part B	VDM	AIS VHF data-link message
128259	Speed, water referenced	OSD	Own ship data
		VBW	Dual ground/water speed
		VHW	Water speed and heading
128267	Water depth	DBT	Depth below transducer
		DPT	Depth
128275	Distance log	VLW	Dual ground/water distance
128520	Tracked target data	TLB	Target label
		TLL	Target latitude and longitude
		TTM	Tracked target message

IEC 61162-3 PGN		IEC 61162-1 sentence	
129025	Position, rapid update	GGA	Global positioning system (GPS) fix data
		GLL	Geographic position – Latitude/longitude
		GNS	GNSS fix data
		RMC	Recommended minimum specific GNSS data
129026	COG and SOG, rapid update	OSD	Own ship data
		RMC	Recommended minimum specific GNSS data
		VTG	Course over ground and ground speed
129029	GNSS position data	GGA	Global positioning system (GPS) fix data
		GLL	Geographic position – Latitude/longitude
		GNS	GNSS fix data
		GSA	GNSS DOP and active satellites
		RMC	Recommended minimum specific GNSS data
129033	Time and Date	ZDA	Time and date
129038	AIS Class A position report	VDM	AIS VHF data-link message
129039	AIS Class B position report	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129040	AIS Class B extended position report	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129041	AIS AtoN	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129044	Datum	DTM	Datum reference
129045	User datum setting	DTM	Datum reference
129083	AIS interrogation	AIR	AIS interrogation request
129283	Cross track error	APB	Heading/track controller (Autopilot) Sentence B
		RMB	Recommended minimum navigation information
		XTE	Cross track error, measured
		XTR	Cross track error – Dead reckoning
129284	Navigation data	AAM	Waypoint arrival alarm
		APB	Recommended minimum navigation Information
		BEC	Bearing and distance to waypoint – Dead reckoning
		BOD	Bearing – Origin to destination
		BWC	Bearing and distance to waypoint – Great circle
		BWR	Bearing and distance to waypoint – Rhumb line
		BWW	Bearing – Waypoint to waypoint
		RMB	Recommended minimum navigation information
		WCV	Waypoint closure velocity
		WPL	Waypoint location
		ZTG	UTC and time to destination waypoint
129285	Navigation – Route/WP information	RTE	Routes
129291	Set and drift, rapid update	OSD	Own ship data
		VDR	Set and drift
129301	Time to/from mark	ZDL	Time and distance to variable point
		ZFO	UTC and time from origin waypoint
		ZTG	UTC and time to destination waypoint

IEC 61162-3 PGN		IEC 61162-1 sentence	
129302	Bearing and distance between two marks	BWW	Bearing – Waypoint to waypoint
		WNC	Distance – Waypoint to waypoint
129308	AIS Class A position report	VDO	AIS VHF data-link own vessel report
129539	GNSS DOPs	GSA	GNSSS DOP and active satellite
129540	GNSS satellites in view	GFA	GNSS fix accuracy and integrity
		GSV	GNSS satellites in view
129545	GNSS RAIM output	GBS	GNSS satellite fault detection
129547	GNSS pseudorange error statistics	GST	GNSS pseudorange error statistics
129550	GNSS differential correction receiver interface	MSK	MSK receiver interface command
129551	GNSS differential correction receiver signal	MSS	MSK receiver signal
129708	AIS SAR aircraft position report	VDM	AIS VHF data-link message
129724	AIS Class A static and voyage related data	SSD	AIS ship static data
129792	AIS DGNSS broadcast binary message	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129793	AIS UTC and date report	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129794	AIS Class A static and voyage related data	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
		VSD	AIS voyage static data
129795	AIS addressed binary message	ABM	AIS addressed binary and safety related message
		VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129796	AIS acknowledge	ABK	AIS addressed and binary broadcast acknowledgement
		VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129797	AIS binary broadcast message	BBM	AIS broadcast binary message
		VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129798	AIS SAR aircraft position report	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129799	Radio frequency/mode/power	FSI	Frequency set status or command
129800	AIS UTC date/enquiry	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129801	AIS addressed safety related message	ABM	AIS addressed binary and safety related message
		VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129802	AIS safety related broadcast message	BBM	AIS broadcast binary message
		VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129803	AIS interrogation	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report

IEC 61162-3 PGN		IEC 61162-1 sentence	
129804	AIS Assignment mode command	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129805	AIS data link management message	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129806	AIS channel management	ACA	AIS regional channel assignment message
		ACS	AIS channel management information source
		VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129807	AIS group assignment	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129808	DSC call information	DSC	Digital selective calling information
		DSE	Expanded digital selective calling
129809	AIS Class “B” static data report, Part A	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129810	AIS Class “B” static data report, Part B	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
130074	Route and WP service	WPL	Waypoint location
130306	Wind data	MWD	Wind direction and speed
		MWV	Wind speed and angle
		VPW	Speed – Measured parallel to wind
130316	Temperature extended range	MTW	Water temperature
130320	Tide station data	WAT	Water level detection
130577	Direction data	CUR	Water current layer
		OSD	Own ship data
		THS	True heading and status
		VBW	Dual ground/water speed
		VDR	Set and drift
		VHW	Water speed and heading
		VTG	Course over ground and ground speed
130578	Vessel speed components	VBW	Dual ground/water speed

Bibliography

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ISO 11898-2:2003, *Road vehicles – Controller area network (CAN) – Part 2: High speed medium access unit*

NMEA 2000, Appendix H, Version 1.000: April 2010, *Serial-Data Networking Of Marine Electronic Devices – Third Party Gateway Requirements and Testing*

SAE[6] J1939. *Recommended Practice for a Serial Control and Communications Vehicle Network.*

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IEC 61162-3

Edition 1.2 2014-07

FINAL VERSION

Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 3: Serial data instrument network

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DIGITAL INTERFACES –

Part 3: Serial data instrument network

FOREWORD

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This Consolidated version of IEC 61162-3 bears the edition number 1.2. It consists of the first edition (2008-05) [documents 80/496/CDV and 80/526/RVC], its amendment 1 (2010-06) [documents 80/580/CDV and 80/594/RVC] and its amendment 2 (2014-07) [documents 80/714/CDV and 80/734/RVC]. The technical content is identical to the base edition and its amendments.

This Final version does not show where the technical content is modified by amendments 1 and 2. A separate Redline version with all changes highlighted is available in this publication.

This publication has been prepared for user convenience.

International Standard IEC 61162-3 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61162 series, under the general title *Maritime navigation and radiocommunication equipment and systems – Digital interfaces,* can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

This part of IEC 61162 has been developed by the IEC technical committee 80 working group 6, to meet the requirement for a versatile and economic means of connecting a wide range of marine navigation and radiocommunications equipment aboard SOLAS vessels. The National Marine Electronics Association's Standard Committee has developed the NMEA 2000®[1] standard. The NMEA[2] 2000 Standard provides for capabilities across all classes of vessels. The development of NMEA 2000 began in 1994 and was completed in 1999. More than a dozen manufacturers worldwide conducted a two-year beta test. The finalised NMEA 2000 standard version 1.000 was published in 2001. IEC and NMEA have worked together since 1999 to ensure that the NMEA 2000 standard fully supports SOLAS applications. NMEA 2000 version 1.200 was published in 2004, with expanded support for redundant messaging and for equipments such as AIS.

The need for an improved standard, compared with IEC 61162-1 and IEC 61162-2, has arisen due to the increased complexity of the latest equipment and systems. This requires multiple links between equipment and greatly improved communication speed.

The parts 400 of the IEC 61162 series have already been issued and cater for the most complex systems to be found on board a ship.

This new part 3 of IEC 61162 adopts the controller area network (CAN) technology, already well established for many industrial systems. This permits a versatile system to be established with the minimum of effort and reasonable cost. The equipment types supported and the sentence data content developed for IEC 61162-1 has been retained.

IEC 61162-3 describes a low cost, moderate capacity, bi-directional multi-transmitter/multi-receiver instrument network to interconnect marine electronic equipment. The connectors and cables used are compatible with industrial bus systems for instance DeviceNet™[3] and Profibus™[4].

IEC 61162-3 provides for the application of NMEA 2000 aboard SOLAS vessels. Exceptions, additions and specific requirements for implementation upon SOLAS vessels are contained in this document.

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1 NMEA 2000® is the registered trademark of the National Marine Electronics Association, Inc. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance to this profile does not require use of the trade name. Use of the trade name requires permission of the trade holder.

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INTRODUCTION to Amendment 1

The amendment updates the normative reference for NMEA 2000 Appendix B to a later version which includes five new sentences: PGN # 129807 - AIS Class B Group Assignment, PGN # 129809 - AIS Class B "CS" Static Report Part A, PGN # 129810 - AIS Class B, PGN # 129039 - AIS Class B Position Report, and PGN # 129040 - AIS Class B Extended Position Report.

INTRODUCTION to Amendment 2

The amendment updates the normative references for NMEA 2000 Main Document, NMEA 2000 Appendix A and NMEA 2000 Appendix D to a later version.

The amendment further updates the normative reference for NMEA 2000 Appendix B to a later version which includes the following new parameter groups:

126983– Alert
126984– Alert response
129041– AIS Aids to Navigation (AtoN) report
130316– Temperature- extended range

and the following revised parameter groups:

126992– System time
128259– Speed, water referenced
128267– Water depth
129285– Navigation – Route/WP information
129033– Time and date
129038– AIS Class A position report
129039– AIS Class B position report
129040– AIS Class B extended position report
129550– GNSS differential correction receiver
129793– AIS UTC and date report
129794– AIS Class A static and voyage related data
129796– AIS acknowledge
129798– AIS SAR aircraft position report
129800– AIS UTC/date inquiry
129801– AIS addressed safety related message
129802– AIS safety related broadcast message
129803– AIS interrogation
129804– AIS assignment mode command
129805– AIS data link management message
129806– AIS channel management
129807– AIS group assignment
129809– AIS Class B “CS” static data report, Part A
129810– AIS Class B “CS” static data report, Part B

The amendment further adds a new informative Annex B which shows the relationships between IEC 61162-1 sentences and IEC 61162-3 parameter group numbers.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DIGITAL INTERFACES –

Part 3: Serial data instrument network

1 Scope

This part of IEC 61162 is based upon the NMEA 2000 standard. The NMEA 2000 standard contains the requirements for the minimum implementation of a serial-data communications network to interconnect marine electronic equipment onboard vessels. Equipment designed to this standard will have the ability to share data, including commands and status, with other compatible equipment over a single signalling channel.

Data messages are transmitted as a series of data frames, each with robust error check confirmed frame delivery and guaranteed latency times. As the actual data content of a data frame is at best 50 % of the transmitted bits, this standard is primarily intended to support relatively brief data messages, which may be periodic, transmitted as needed, or on-demand by use of query commands. Typical data includes discrete parameters such as position latitude and longitude, GPS status values, steering commands to autopilots, finite parameter lists such as waypoints, and moderately sized blocks of data such as electronic chart database updates. This standard is not necessarily intended to support high-bandwidth applications such as radar, electronic chart or other video data, or other intensive database or file transfer applications.

This standard defines all of the pertinent layers of the International Standards Organisation Open Systems Interconnect (ISO/OSI) model, from the application layer to the physical layer, necessary to implement the required IEC 61162-3 network functionality.

This standard defines data formats, network protocol, and the minimum physical layer necessary for devices to interface. SOLAS applications shall employ redundant designs (for instance dual networks, redundant network interface circuits) to reduce the impact of single point failures. The NMEA 2000 standard provides the fundamental tools and methods to support redundant equipment, buses and messaging. Specific shipboard installation designs are beyond the scope of this standard, however some guidance is given in Annex A.

Relationships between IEC 61162-1 sentences and IEC 61162-3 parameter group numbers are given in Annex B.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60945, *Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results*

ISO 11783 (all parts), *Tractors and machinery for agriculture and forestry – Serial control and communications data network*

ISO 11783-3, *Tractors and machinery for agriculture and forestry – Serial control and communications data network – Part 3: Data link layer*

ISO 11783-5:2001, *Tractors and machinery for agriculture and forestry – Serial control and communications data network – Part 5 Network management (including its corrigendum 1 (2002)*

NMEA 2000 Main document, Version 1.210: January 2013, *Serial-Data Networking Of Marine Electronic Devices*[5]

NMEA 2000, Appendix A, Version 2.000: January 2013, *Serial-Data Networking Of Marine Electronic Devices – Application Layer (Parameter Group Definitions)*)

NMEA 2000, Appendix B, Version 2.000: January 2013 *Serial-Data Networking Of Marine Electronic Devices – Data Base*)

NMEA 2000, Appendix C, Version 1.200: October 2004, *Serial-Data Networking Of Marine Electronic Devices – Certification Criteria and Test Methods*)

NMEA 2000, Appendix D, Version 1.210: January 2013, *Serial-Data Networking Of Marine Electronic Devices – Application Notes*)

IMO 1974, *International Convention for the Safety of Life at Sea (SOLAS), as amended – Chapter V – Safety of navigation*

3 Terms, definitions and conventions

3.1 Terms and definitions

For the purposes of this document, the following definitions apply.

3.1.1
bit
the smallest element of information on the communication channel

NOTE Bits are grouped into bit fields of one or more bits. A bit is of constant time duration set by the signalling rate specified in this standard and has one of two logical values, dominant or recessive. When dominant and recessive levels are impressed on the communications channel at the same time the resulting level is dominant.

3.1.2
bridge
device that joins two network segments using the same network protocol and address space

NOTE Data rate and physical media may differ on the two sides of a bridge. A bridge may perform message filtering.

3.1.3
byte
eight bits

3.1.4
Controller area network (CAN) frame
series of bits transmitted on the communications channel

NOTE CAN frames convey the following types of information:

- data frame. Carries data from a transmitter to the receivers.
- error frame. Transmitted by a unit detecting a bus error.
- overload frame. Transmitted to provide a delay between preceding and succeeding data frames.

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5 Available from National Marine Electronics Association (USA), www.nmea.org.

The CAN data frame has defined start of frame and end of frame bit fields and is separated from preceding fields by an interframe space. CAN error and overload frames, when used, are appended directly to the preceding frame without an interframe space.

3.1.5
class 1 devices
refers to devices that have a single level A or level B network interface connection

3.1.6
class 2 devices
describes devices that have two level A or two level B network interface connections

NOTE Class 2 devices are intended for use on dual redundant bus systems. In addition to providing either level A or level B capabilities, class 2 devices provide a means to identify messages that are received from redundant buses as being the same or different.

3.1.7
default operation
operation or settings that exist when standard equipment is first shipped from the manufacturer

3.1.8
device
a product or equipment which, through a node, is connected to an IEC 61162-3 network

3.1.9
gateway
device that joins a network to another network or system

3.1.10
interframe space
bit field that separates data frames from preceding frames

3.1.11
level A devices
support the ISO transport layer and the complete set of network management parameter groups

3.1.12
level B devices
support address claim, ISO request PGN, and the product information parameter group

3.1.13
listen only device
device on the network that receives messages but does not participate in bus activity

NOTE This device cannot send any frames on the network (data, error, or acknowledge).

3.1.14
load equivalency number
a node's power rating reported in units of network load

3.1.15
message
consists of one or more data frames, as specified in this standard, that contain the parameter group information to be communicated from a network address

NOTE A message contains the message priority code, parameter group number, destination network address, source network address, and data fields. The destination network address may be a specific address or global.

3.1.16
network address
identifier of a functional entity on the network

3.1.17
network load
one network load is a unit of measure defined as 50 mA

NOTE This is used to determine loading of network.

3.1.18
node
a physical connection to the network

NOTE A node may have more than one network address, see virtual nodes.

3.1.19
node power
power supplied from the network

3.1.20
parameter group (PG)
set of associated variables, commands, status, or other information to be transmitted on the network

3.1.21
parameter group number (PGN)
an 8-bit or 16-bit number that identifies each parameter group

NOTE The parameter group number (PGN) is analogous to the three-character sentence formatter in IEC 61162-1. By definition, parameter groups identified by 16-bit parameter group numbers are broadcast to all addresses on the network. Parameter groups identified by 8-bit parameter group numbers may be used to direct data for use by a specific address.

3.1.22
receiver
recipient of a message if the bus is not idle and the device is not a transmitter

3.1.23
router
device that joins two network segments with the same network protocol

NOTE On each side of a router address space, data rate and physical media may differ.

3.1.24
transmitter
originator of a message

NOTE The unit remains a transmitter until it loses arbitration or until the bus becomes idle.

3.1.25
virtual nodes
functional entities within a device that share a physical connection to the network

NOTE Each virtual node within a device has a unique address on the network.

3.2 Conventions

3.2.1
may
In this document “may” when relating to network requirements applies to alternatives and optional items that are allowed in a network. An implementation that does not include an alternative shall be prepared to tolerate another implementation that does.

3.2.2
shall
In this document “shall” when relating to network requirements signifies items that are required in a network.

3.2.3
shall not
In this document “shall not” when relating to network requirements signifies items that are prohibited in a network.

3.2.4
should
In this document “should” when relating to network requirements signifies a recommendation that, if followed, could ease development or improve the operation of the network in some manner.

4 Physical layer

The physical layer of this standard is as described in the NMEA 2000 Main document.

4.1 CAN transceiver

Devices shall utilize CAN transceivers that include a “transmit dominant timeout” timer circuit (babbling idiot protection).

4.2 Environmental

Components and circuits shall be designed to meet the durability and resistance to environmental conditions of IEC 60945, Clause 8. The requirements of 8.8 (rain and spray) apply only to those network components actually intended to be exposed to rain and/or spray.

4.3 Radio frequency interference

4.3.1 Unwanted electromagnetic emissions

Components and circuits shall be designed to meet the unwanted electromagnetic emission requirements of IEC 60945, Clause 9.

4.3.2 Immunity to electromagnetic environment

Components and circuits shall be designed to meet the Immunity to electromagnetic environment conditions of IEC 60945, Clause 10.

4.4 Cables

Network cables shall meet the electrical and minimum physical characteristics specified in the NMEA 2000 Main document.

4.5 Interface power

A class 2 IEC device load equivalency number shall represent the larger power rating of the two network connections, if different.

4.6 Network power source

The network shall have an independent power source for each bus.

5 Data link layer

The data link layer of this standard is defined in ISO 11783-3 with additional requirements specified in the NMEA 2000 Main Document, Section 3.0.

6 Network layer

The network layer is defined in the NMEA 2000 Main Document, Section 4.0.

7 Network management

Network management is defined in ISO 11783-5 with additional requirements specified in the NMEA 2000 Main Document, Section 8.0.

7.1 Address configuration method

Devices shall provide a method (not specified in this standard) to configure a preferred address. A device being configured in this manner shall not transmit data on the bus until completing the address claim process. This capability is only provided for use during initial shipboard installation and configuration, not during normal operations of networks. Reconfiguring the preferred address shall override the retained address.

7.2 Address retention

Devices shall retain the last successfully claimed address as the preferred address for use on the next power up.

8 Application layer

The application layer (messaging) supported by this standard consists of the parameter group structure and the parameter group number contents. The structure is defined in the NMEA 2000, Appendix A and the contents are defined by the NMEA 2000, Appendix B.

8.1 Parameter groups

Parameter groups contain predefined default values for message priority and broadcast rates. The predefined default values provide a level of expectation and consistency of operations. Though the predefined values are intended to meet the needs of the majority of shipboard network configurations, it is recognized that some installations or equipment standards may require different values for optimum performance. Methods to adjust these values to suit specific installations are provided.

8.1.1 Parameter group priority

Any change to the default parameter group priority values shall be retained, using means such as non-volatile memory.

8.1.2 Parameter group broadcast rate

Any change to the default parameter group broadcast rates shall be retained, using means such as non-volatile memory.

9 Test criteria

Test criteria of this standard are defined in NMEA 2000, Appendix C, certification and test criteria.

Devices not tested to this standard (for instance devices designed to only ISO 11783, NMEA 2000, or SAE J1939) shall not be connected to the network during normal operations.

10 Application notes

Application notes for this standard are defined in NMEA 2000, Appendix D.

11 Manufacturer's documentation

Operator manuals or other appropriate literature provided for equipment that is intended to meet the requirements of this standard shall contain the following information:

- manufacturer's code;
- product code;
- identification of the interface connector(s);
- the load equivalency number for the device for each interface (if more than one);
- a list of transmitted approved parameter group numbers and names, noting unused fields, proprietary parameter group numbers and names;
- a list of parameter group numbers and names and associated data fields that are required as input to the device;
- the current software and hardware revision if this is relevant to the interface;
- the version number and date of update of the standard for which compliance is sought.

Annex A
(informative)

System integration

A.1 Installation documentation

System configuration documentation for a specific shipboard installation should include the following information:

A.1.1 Device specific information

- Model name
- Function
- Serial number
- Manufacturer
- Installation location
- Device class (1 or 2)
- Device level (A, B, listen only)
- Configured preferred network address
- Configured PGN broadcast rates
- Configured PGN priorities
- Load equivalency number
- Network drop cable length for each node connection
- Configured to provide network power (yes, no)?
- Network power source output current capacity

A.1.2 Network specific information

- Over all bus load
- Number of devices
- Length of network backbone cable
- Backbone cable specification
- Location of network terminators
- Location of all T-connectors and barrier strips
- Number of network power sources
- Location of network power sources
- Results of network backbone cable test
- Network layout drawing

A.2 Installation validation

A.2.1 Initial installation observations

Ensure the terminators are properly installed on both ends of the network backbone cables.

A.2.2 Network backbone cable test

Perform backbone cable test before connecting any devices. These measurements shall be made before connecting any IEC 61162-3 devices to the backbone cable. The only connections to the backbone cable should be the network power sources. The backbone power should be energized. Measure the characteristics identified in the test characteristics table below. The measurements should be made at each end of the backbone in the last drop connection before the terminating resistor. If the last drop connection is the power connection, measure the characteristics at the second to last drop connection from the terminator.

Table A.1 – Test characteristics

Test	Pin / signal	Measurement	Nominal value	Tolerance
1	(1) Shield	Resistance between shield and pin (3) NET-C (Gnd)	0 Ω	≤15 Ω
2	(2) NET-S	Voltage between NET-S and pin (3) NET-C (Gnd)	12 V	≥9 V ≤16 V
3	(4) NET-H (5) NET-L	Resistance between NET-H and NET-L	60 Ω	≥57 Ω ≤68 Ω

Upon completion, de-energize the network and connect the IEC 61162-3 devices. Refer to the device manufacturer's documentation for specific device installation information. Ensure that all nodes connected to the same backbone cable are configured to have the same system instance value in their NAME.

A.2.3 Operational test

Verify that all devices operate in accordance with manufacturer instructions.

With all devices active, monitor that the bus error rate (error frames/second) is not more than one per second on each network backbone.

A.3 Redundancy

SOLAS Chapter V contains the requirement for integrated bridge systems: "*A failure of one part should not affect the functionality of other parts except for those functions directly dependant upon the information from the defective part.*" This standard should be implemented with redundant network buses in order to meet these requirements and provide safe systems. Any number of redundant buses may be implemented, though typically two will satisfy the requirements above.

This standard specifies two types of devices, those with one interface (class 1) and those with two interfaces (class 2). Redundancy may be achieved with two buses, with functions duplicated on each bus, thus providing function and bus redundancy at the system level. Duplication of function on a single bus provides function redundancy at bus level only. System redundancy requires two buses. Function redundancy may be met by having multiple class 1 devices on each bus or class 2 devices on both buses. Function redundancy can also be achieved with a combination of class 1 and class 2 devices across redundant buses. Figure A.1 and Figure A.2 illustrate two of many possible configurations.

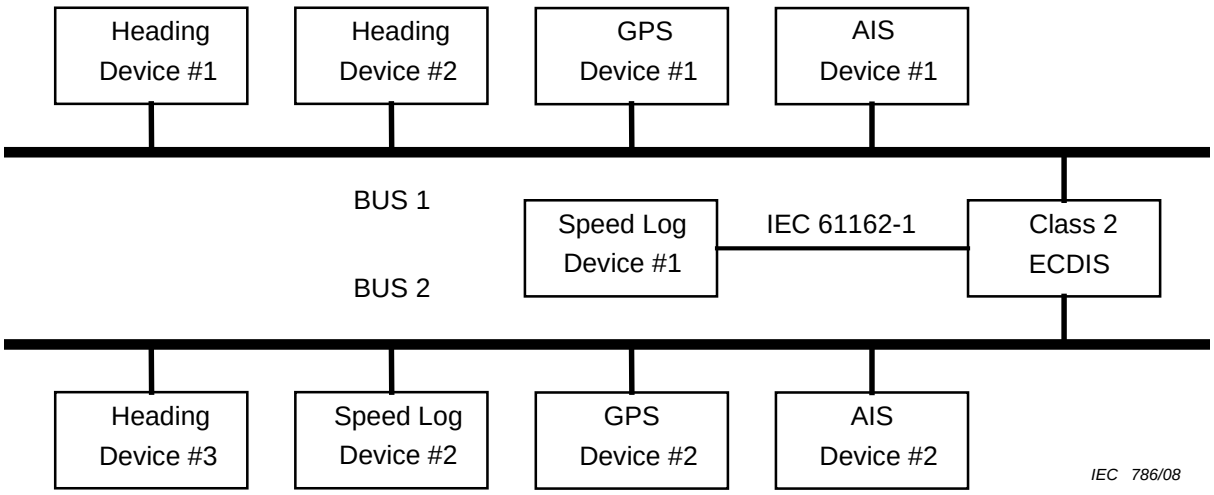

Figure A.1 – Example of configuration

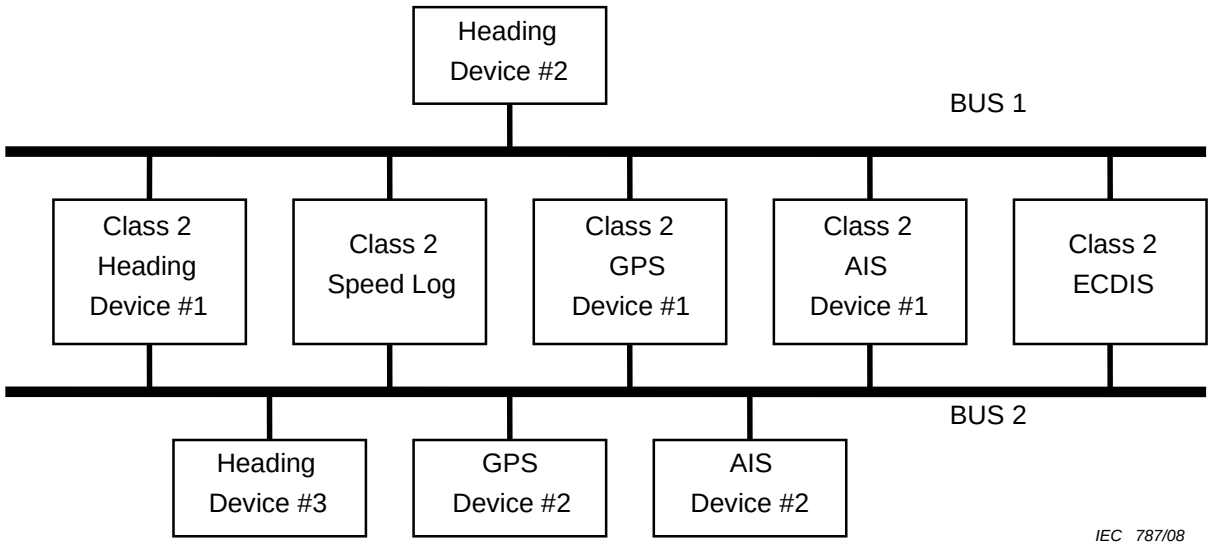

Figure A.2 – Example of configuration

A.4 Implementation recommendations

A.4.1 Message de-fragmentation and duplicate filtering

Correct assembly of fragmented messages relies on correct use of sequence, frame numbers and the DLC.

- Assembly should be performed independently on each bus before comparing DLC numbers for duplication filtering.
- Stop assembly immediately if there is any inconsistency in frame or sequence numbers. Reassembly can only start again when frame counter starts at zero, regardless of sequence number.
- Assembly errors as defined above should be monitored and/or logged.

A.4.2 ISO transport protocol usage

- The fast packet sequence counter for a PGN is not incremented when the PGN is transmitted using the ISO transport protocol.
- Class 2 devices using the ISO transport protocol should consider that
  - the request to send (RTS), broadcast announce message (BAM), and data transfer (DT) frames use the same modified DLC for a given transmission,
  - the modified DLC is based upon the enclosed PGN's DLC series,
  - the DLC value in the ABORT, clear to send (CTS), and end of message (EOM) frames is set to a value of eight.

A.4.3 Class 2 device tracking

The NAME to address relationship information maintained within a class 2 device should include the class type (1 or 2) for each entry. This is useful in determining the proper behaviour when receiving an ISO request PGN 059904.

Annex B
(informative)

Relationship between IEC 61162-1 sentences and IEC 61162-3 parameter group numbers

Table B.1 and Table B.2 give equivalents for transferring data over IEC 61162-1 interfaces and IEC 61162-3 interfaces.

Table B.1 – Conversion from IEC 61162-1 to IEC 61162-3

IEC 61162-1 sentence		IEC 61162-3 PGN	
AAM	Waypoint arrival alarm	129284	Navigation data
ABK	AIS addressed and binary broadcast acknowledgement	129796	AIS acknowledge
ABM	AIS addressed binary and safety related message	129801	AIS addressed safety related message
		129795	AIS addressed binary message
ACA	AIS regional channel assignment message	129806	AIS channel management
ACK	Acknowledge alarm	126984	Alert response
ACS	AIS channel management information source	129806	AIS channel management
AIR	AIS interrogation request	129083	AIS interrogation
AKD	Acknowledge detail alarm condition	126984	Alert response
ALA	Set detail alarm condition	126983	Alert
ALR	Set alarm state	126983	Alert
APB	Heading/Track Controller (Autopilot) Sentence B	127237	Heading/track control
		129283	Cross track error
		129284	Navigation data
BBM	AIS broadcast binary message	129797	AIS binary broadcast message
		129802	AIS safety related broadcast message
BEC	Bearing and distance to waypoint – Dead reckoning	129284	Navigation data
BOD	Bearing – Origin to destination	129284	Navigation data
BWC	Bearing and distance to waypoint – Great circle	129284	Navigation data
BWR	Bearing and distance to waypoint – Rhumb line	129284	Navigation data
BWW	Bearing – Waypoint to Waypoint	129302	Bearing and distance between two marks
		129284	Navigation data
CUR	Water current layer	130577	Direction data
DBT	Depth below transducer	128267	Water depth
DPT	Depth	128267	Water depth
DSC	Digital selective calling information	129808	DSC call information
DSE	Expanded digital selective calling	129808	DSC call information
DTM	Datum reference	129044	Datum
		129045	User datum setting

IEC 61162-1 sentence		IEC 61162-3 PGN	
FSI	Frequency set status or command	129799	Radio frequency/mode/power
GBS	GNSS satellite fault detection	129545	GNSS RAIM output
GFA	GNSS fix accuracy and Integrity	129540	GNSS satellites in view
GGA	Global positioning system (GPS) fix data	129025	Position, rapid update
		129029	GNSS position data
GLL	Geographic position – Latitude/longitude	129025	Position, rapid update
		129029	GNSS position data
GNS	GNSS fix data	129025	Position, rapid update
		129029	GNSS position data
GSA	GNSS DOP and active satellites	129029	GNSS position data
		129539	GNSS DOPs
GST	GNSS pseudorange error statistics	129547	GNSS pseudorange error statistics
GSV	GNSS satellites in view	129540	GNSS satellites in view
HDG	Heading, deviation and variation	127250	Vessel heading
		127258	Magnetic variation
HDT	Heading true	127250	Vessel heading
HSC	Heading steering command	127237	Heading track control
HTC	Heading/track control command	127237	Heading track control
HTD	Heading/track control data	127237	Heading track control
MSK	MSK receiver interface command	129550	GNSS differential correction receiver interface
MSS	MSK receiver signal	129551	GNSS differential correction receiver signal
MTW	Water temperature	130316	Temperature extended range
MWD	Wind direction and speed	130306	Wind data
MWV	Wind speed and angle	130306	Wind data
OSD	Own ship data	127250	Vessel heading
		128259	Speed, water referenced
		129026	COG, SOG rapid update
		129291	Set and drift, rapid update
		130577	Direction data
RMB	Recommended minimum navigation information	129283	Cross track error
		129284	Navigation data
RMC	Recommended minimum specific GNSS data	129025	Position, rapid update
		129026	COG and SOG, rapid update
		129029	GNSS position data
ROR	Rudder order status	127245	Rudder
ROT	Rate of turn	127251	Rate of turn
RSA	Rudder sensor angle	127245	Rudder
RTE	Routes	129285	Navigation – Route/WP information
SSD	AIS ship static data	129794	AIS Class A static and voyage related data

IEC 61162-1 sentence		IEC 61162-3 PGN	
THS	True heading and status	127250	Vessel heading
		130577	Direction data
TLB	Target label	128520	Tracked target data
TLL	Target latitude and longitude	128520	Tracked target data
TTM	Tracked target message	128520	Tracked target data
VBW	Dual ground/water speed	128259	Speed, water referenced
		130577	Direction data
		130578	Vessel speed components
VDM	AIS VHF data-link message	129038	AIS Class A position report
		129039	AIS Class B position report
		129040	AIS Class B extended position report
		129041	AIS Aids to Navigation (AtoN) report
		129792	AIS DGNSS broadcast binary message
		129793	AIS UTC and date report
		129794	AIS Class A static and voyage related data
		129795	AIS addressed binary message
		129796	AIS acknowledge
		129797	AIS binary broadcast message
		129798	AIS SAR aircraft position report
		129800	AIS UTC/date Inquiry
		129801	AIS addressed safety related message
		129802	AIS safety related broadcast message
		129803	AIS interrogation
		129804	AIS assignment mode command
		129805	AIS data link management message
		129806	AIS channel management
		129807	AIS group assignment
		129809	AIS Class B "CS" static data report, Part A
		129810	AIS Class B "CS" static data report, Part B
VDR	Set and drift	129291	Set and drift, rapid update
		130577	Direction data

IEC 61162-1 sentence		IEC 61162-3 PGN	
VDO	AIS VHF data-link own vessel report	129308	AIS Class A position report
		129039	AIS Class B position report
		129040	AIS Class B extended position report
		129041	AIS Aids to Navigation (AtoN) report
		129792	AIS DGNSS broadcast binary message
		129793	AIS UTC and date report
		129794	AIS Class A static and voyage related data
		129795	AIS addressed binary message
		129796	AIS acknowledge
		129797	AIS binary broadcast message
		129798	AIS SAR aircraft position report
		129800	AIS UTC/date Inquiry
		129801	AIS addressed safety related message
		129802	AIS safety related broadcast message
		129803	AIS interrogation
		129804	AIS assignment mode command
		129805	AIS data link management message
		129086	AIS channel management
		129807	AIS group assignment
		129809	AIS Class B "CS" static data report, Part A
		129810	AIS Class B "CS" static data report, Part B
VHW	Water speed and heading	127250	Vessel heading
		128259	Speed, water referenced
		130577	Direction data
VLW	Dual ground/water distance	128275	Distance log
VPW	Speed – Measured parallel to wind	130306	Wind data
VSD	AIS voyage static data	129794	AIS Class A static and voyage related data
VTG	Course over ground and ground speed	129026	COG and SOG, rapid update
		130577	Direction data
WAT	Water level detection	130320	Tide station data
WCV	Waypoint closure velocity	129284	Navigation data
WNC	Distance – Waypoint to waypoint	129302	Bearing and distance between two marks
WPL	Waypoint location	129284	Navigation data
		130074	Route and WP service
XTE	Cross track error, measured	129283	Cross track error
XTR	Cross track error – Dead reckoning	129283	Cross track error

IEC 61162-1 sentence		IEC 61162-3 PGN	
ZDA	Time and date	126992	System time
		129033	Time and date
ZDL	Time and distance to variable point	129301	Time to/from mark
ZFO	UTC and time from origin waypoint	129301	Time to/from mark
ZTG	UTC and time to destination waypoint	129284	Navigation data
		129301	Time to/from mark

Table B.2 – Conversion from IEC 61162-3 to IEC 61162-1

IEC 61162-3 PGN		IEC 61162-1 sentence	
126983	Alert	ALA	Set detail alarm condition
		ALR	Set alarm state
126984	Alert response	ACK	Acknowledge alarm
		AKD	Acknowledge detail alarm condition
126992	System time	ZDA	Time and date
127237	Heading track control	APB	Heading/track controller (autopilot) sentence B
		HSC	Heading steering command
		HTC	Heading/track control command
		HTD	Heading/track control data
127245	Rudder	ROR	Rudder order status
		RSA	Rudder sensor angle
127250	Vessel heading	HDG	Heading, deviation and variation
		HDT	Heading true
		OSD	Own ship data
		THS	True heading and status
		VHW	Water speed and heading
127251	Rate of turn	ROT	Rate of turn
127258	Magnetic variation	HDG	Heading, deviation and variation
127809	AIS Class B “CS” static data report, Part A	VDM	AIS VHF data-link message
127810	AIS Class B “CS” static data report, Part B	VDM	AIS VHF data-link message
128259	Speed, water referenced	OSD	Own ship data
		VBW	Dual ground/water speed
		VHW	Water speed and heading
128267	Water depth	DBT	Depth below transducer
		DPT	Depth
128275	Distance log	VLW	Dual ground/water distance
128520	Tracked target data	TLB	Target label
		TLL	Target latitude and longitude
		TTM	Tracked target message

IEC 61162-3 PGN		IEC 61162-1 sentence	
129025	Position, rapid update	GGA	Global positioning system (GPS) fix data
		GLL	Geographic position – Latitude/longitude
		GNS	GNSS fix data
		RMC	Recommended minimum specific GNSS data
129026	COG and SOG, rapid update	OSD	Own ship data
		RMC	Recommended minimum specific GNSS data
		VTG	Course over ground and ground speed
129029	GNSS position data	GGA	Global positioning system (GPS) fix data
		GLL	Geographic position – Latitude/longitude
		GNS	GNSS fix data
		GSA	GNSS DOP and active satellites
		RMC	Recommended minimum specific GNSS data
129033	Time and Date	ZDA	Time and date
129038	AIS Class A position report	VDM	AIS VHF data-link message
129039	AIS Class B position report	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129040	AIS Class B extended position report	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129041	AIS AtoN	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129044	Datum	DTM	Datum reference
129045	User datum setting	DTM	Datum reference
129083	AIS interrogation	AIR	AIS interrogation request
129283	Cross track error	APB	Heading/track controller (Autopilot) Sentence B
		RMB	Recommended minimum navigation information
		XTE	Cross track error, measured
		XTR	Cross track error – Dead reckoning
129284	Navigation data	AAM	Waypoint arrival alarm
		APB	Recommended minimum navigation Information
		BEC	Bearing and distance to waypoint – Dead reckoning
		BOD	Bearing – Origin to destination
		BWC	Bearing and distance to waypoint – Great circle
		BWR	Bearing and distance to waypoint – Rhumb line
		BWW	Bearing – Waypoint to waypoint
		RMB	Recommended minimum navigation information
		WCV	Waypoint closure velocity
		WPL	Waypoint location
		ZTG	UTC and time to destination waypoint
129285	Navigation – Route/WP information	RTE	Routes
129291	Set and drift, rapid update	OSD	Own ship data
		VDR	Set and drift
129301	Time to/from mark	ZDL	Time and distance to variable point
		ZFO	UTC and time from origin waypoint
		ZTG	UTC and time to destination waypoint

IEC 61162-3 PGN		IEC 61162-1 sentence	
129302	Bearing and distance between two marks	BWW	Bearing – Waypoint to waypoint
		WNC	Distance – Waypoint to waypoint
129308	AIS Class A position report	VDO	AIS VHF data-link own vessel report
129539	GNSS DOPs	GSA	GNSSS DOP and active satellite
129540	GNSS satellites in view	GFA	GNSS fix accuracy and integrity
		GSV	GNSS satellites in view
129545	GNSS RAIM output	GBS	GNSS satellite fault detection
129547	GNSS pseudorange error statistics	GST	GNSS pseudorange error statistics
129550	GNSS differential correction receiver interface	MSK	MSK receiver interface command
129551	GNSS differential correction receiver signal	MSS	MSK receiver signal
129708	AIS SAR aircraft position report	VDM	AIS VHF data-link message
129724	AIS Class A static and voyage related data	SSD	AIS ship static data
129792	AIS DGNSS broadcast binary message	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129793	AIS UTC and date report	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129794	AIS Class A static and voyage related data	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
		VSD	AIS voyage static data
129795	AIS addressed binary message	ABM	AIS addressed binary and safety related message
		VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129796	AIS acknowledge	ABK	AIS addressed and binary broadcast acknowledgement
		VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129797	AIS binary broadcast message	BBM	AIS broadcast binary message
		VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129798	AIS SAR aircraft position report	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129799	Radio frequency/mode/power	FSI	Frequency set status or command
129800	AIS UTC date/enquiry	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129801	AIS addressed safety related message	ABM	AIS addressed binary and safety related message
		VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129802	AIS safety related broadcast message	BBM	AIS broadcast binary message
		VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129803	AIS interrogation	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report

IEC 61162-3 PGN		IEC 61162-1 sentence	
129804	AIS Assignment mode command	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129805	AIS data link management message	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129806	AIS channel management	ACA	AIS regional channel assignment message
		ACS	AIS channel management information source
		VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129807	AIS group assignment	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129808	DSC call information	DSC	Digital selective calling information
		DSE	Expanded digital selective calling
129809	AIS Class “B” static data report, Part A	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
129810	AIS Class “B” static data report, Part B	VDM	AIS VHF data-link message
		VDO	AIS VHF data-link own vessel report
130074	Route and WP service	WPL	Waypoint location
130306	Wind data	MWD	Wind direction and speed
		MWV	Wind speed and angle
		VPW	Speed – Measured parallel to wind
130316	Temperature extended range	MTW	Water temperature
130320	Tide station data	WAT	Water level detection
130577	Direction data	CUR	Water current layer
		OSD	Own ship data
		THS	True heading and status
		VBW	Dual ground/water speed
		VDR	Set and drift
		VHW	Water speed and heading
		VTG	Course over ground and ground speed
130578	Vessel speed components	VBW	Dual ground/water speed

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