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colour inside

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DIGITAL INTERFACES –

Part 3: Serial data instrument network

FOREWORD

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The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience. A vertical line in the margin shows where the base publication has been modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through.

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

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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.

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.

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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.

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: October 2004, *Serial-Data Networking Of Marine Electronic Devices*[5]

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

NMEA 2000, Appendix B, Version ~~1.210: September 2006~~ 1.300: May 2009, *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: October 2004, *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.

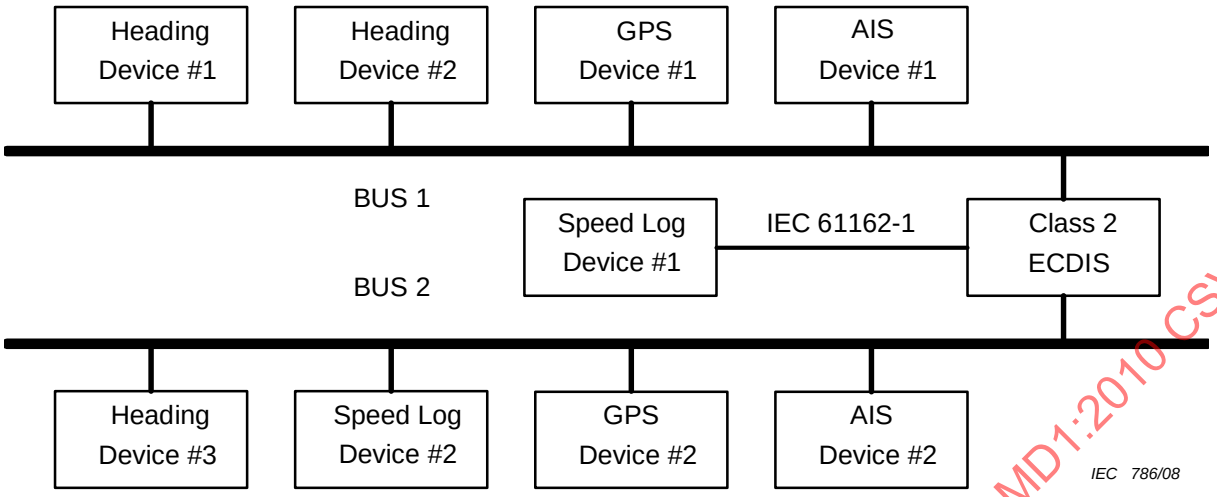

Figure A.1 – Example of configuration

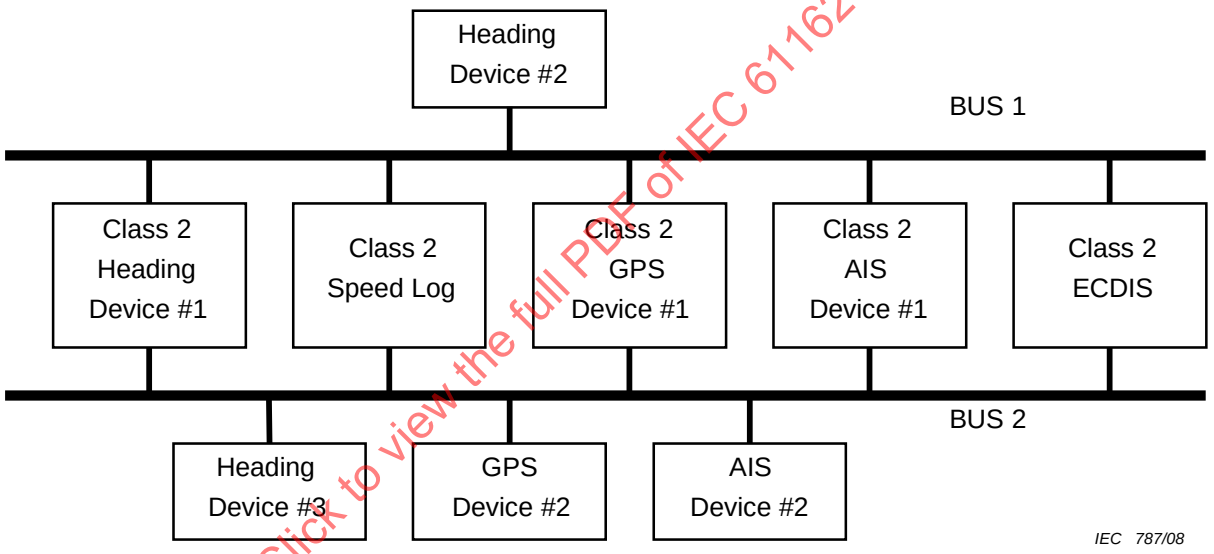

Figure A.2 – Example of configuration

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.