

INTERNATIONAL STANDARD



**Maritime navigation and radiocommunication equipment and systems –
Digital interfaces –
Part 450: Multiple talkers and multiple listeners – Ethernet interconnection**



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**Maritime navigation and radiocommunication equipment and systems –
Digital interfaces –
Part 450: Multiple talkers and multiple listeners – Ethernet interconnection**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MARITIME NAVIGATION AND RADIOCOMMUNICATION
EQUIPMENT AND SYSTEMS –
DIGITAL INTERFACES –****Part 450: Multiple talkers and multiple listeners –
Ethernet interconnection**

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International Standard IEC 61162-450 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

This second edition of IEC 61162-450 cancels and replaces the first edition published in 2011 and Amendment 1:2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) network traffic filtering based on IGMP snooping added;
- b) network traffic balancing added;
- c) new encapsulation of IEC 61162-3 PGNs added;
- d) new alternative for binary file transfer added: TCP/IP based on Annex H of IEC 62388:2007 on radars;
- e) general authentication tag "a:" added to support managing of cyber security risk.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
80/880/FDIS	80/885/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

A list of all parts in the IEC 61162 series, published 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 this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

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MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DIGITAL INTERFACES –

Part 450: Multiple talkers and multiple listeners – Ethernet interconnection

1 Scope

This part of IEC 61162 specifies interface requirements and methods of test for high speed communication between shipboard navigation and radiocommunication equipment as well as between such systems and other ship systems that need to communicate with navigation and radio-communication equipment. This document is based on the application of an appropriate suite of existing international standards to provide a framework for implementing data transfer between devices on a shipboard Ethernet network.

~~This standard provides a higher speed and higher capacity alternative to the IEC 61162-1 and IEC 61162-2 standards while retaining these standards' basic data format. This standard provides a higher data capacity than IEC 61162-3.~~

This document specifies an Ethernet based bus type network where any listener ~~may~~ can receive messages from any sender with the following properties.

- This document includes provisions for multicast distribution of information formatted according to IEC 61162-1, for example position fixes and other measurements, as well as provisions for transmission of general data blocks (binary ~~image~~ file), for example between radar and VDR, ~~and also includes provisions for multicast distribution of information formatted according to IEC 61162-3, for example position fixes and other measurements.~~
- This document is limited to protocols for equipment (network nodes) connected to a single Ethernet network consisting only of OSI level one or two devices and cables (Network infrastructure).
- This document provides requirements only for equipment interfaces. By specifying protocols for transmission of IEC 61162-1 sentences, ~~IEC 61162-3 PGN messages~~ and general binary ~~image~~ file data, these requirements will guarantee interoperability between equipment implementing this document as well as a certain level of safe behaviour of the equipment itself.
- This document permits equipment using other protocols than those specified in this document to share a network infrastructure, provided that it is supplied with interfaces which satisfy the requirements described for ONF ~~(see 4.6).~~
- ~~This document includes provisions for filtering of the network traffic in order to limit the amount of traffic to manageable level for each individual equipment.~~

This document does not contain any system requirements other than the ones that can be inferred from the sum of individual equipment requirements. ~~Thus, to ascertain system properties that cannot be derived from equipment requirements alone, additional analysis or standards will be required. In particular, this applies to requirements to maintain system functionality in the face of a single point failure in equipment or networks. Informative Annex D contains guidance on how to address such issues.~~ An associated standard, IEC 61162-460, further addresses system requirements.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60825-2, *Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS)*

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

IEC 61162-1:2016, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 1: Single talker and multiple listeners*

IEC 61162-3:2008, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 3: Serial data instrument network*

~~IEEE 802.3, IEEE Standards for Local Area Networks: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications~~

IEEE Std 802.3-2015, *IEEE Standard for Ethernet*

ISOC RFC 768, *User Datagram Protocol*, Standard STD0006

ISOC RFC 791, *Internet Protocol (IP)*, Standard STD0005 (and updates)

ISOC RFC 792, *Internet Control Message Protocol (ICMP)*, Standard STD0005 (and updates)

RFC 793:1981, *Transmission Control Protocol (TCP)*

ISOC RFC 826, *An ethernet Address Resolution Protocol*

ISOC RFC 1112, *Host Extensions for IP Multicasting*, Standard STD0005 (and updates), (include IGMP version 1)

ISOC RFC 1918, *Address Allocation for Private Internets*, Best Current Practice BCP0005

ISOC RFC 2236, *Internet Group Management Protocol, Version 2*

ISOC RFC 2474, *Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers*

ISOC RFC 3376, *Internet Group Management Protocol, Version 3*

ISOC RFC 5000, *Internet Official Protocol Standards*, Standard 0001

ISOC RFC 5227, *IPv4 Address Conflict Detection*

ISOC RFC 5424, *The Syslog Protocol*

NMEA 0183:2008, *Standard for interfacing marine electronic devices*, Version 4.00

NOTE The standards of the Internet Society (ISOC) are available on the IETF websites <http://www.ietf.org>. Later updates can be tracked at <http://www.rfc-editor.org/rfcsearch.html>.

3 Terms and definitions

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

3.1

ASCII

printable 7 bit character encoded in one byte

3.2

binary ~~image~~ file

data block without formatting known to this protocol, i.e., non IEC 61162-1 formatted data, that can be transmitted with the protocol defined in 7.3 or in 7.5

Note 1 to entry: The term "binary ~~image~~ file" is used to differentiate the general data transfer protocol (which may or may not be in ordinary text format) from the transmission of sentences that is always in 7 bit ASCII format.

3.3

byte

group of 8 bits treated as one unit

Note 1 to entry: This corresponds to what is also sometimes called an octet.

3.4

command-response pair

CRP

messages exchanged between parties that synchronize state changes on both sides through the exchange

Note 1 to entry: CRP are defined in Annex A.

Note 2 to entry: Both the command and the reply message may also be used as a sensor broadcast message in some cases. Thus, the implementation of the semantics of the message exchange is somewhat different between different users of the exchange.

3.5

datagram

atomic UDP transmission unit on the Ethernet as defined in ISOC RFC 768 and as constrained elsewhere in this document

3.6

Ethernet

carrier sense, multiple access collision detect (CSMA/CD) local area network protocol standard as defined in IEEE Std 802.3 and later revisions and additions to IEEE 802

Note 1 to entry: The types of Ethernet media that can be used for implementation of this document are defined in Clause 5.

3.7

function block

specified functionality implemented by equipment

Note 1 to entry: Equipment normally implements multiple function blocks. Requirements to equipment are the sum of requirements to the function blocks it implements. Function blocks are defined in Clause 4. ~~Types of function blocks are System Function Block (SF), Other Network Function Block (ONF), Network Function Block (NF) and Serial-to-Network Gateway Function Block (SNGF).~~

3.8**Internet Group Management Protocol****IGMP**

communications protocol used by hosts and adjacent routers on IPv4 networks to establish multicast group memberships

Note 1 to entry: The IGMP is an integral part of IP multicast.

3.9**IGMP snooping**

process of listening to Internet Group Management Protocol (IGMP) network traffic

3.10**Internet assigned number authority****IANA**

global coordination of the Domain Name Server (DNS) Root, IP addressing, and other Internet protocol resources, including UDP and TCP port numbers

Note 1 to entry: The currently assigned numbers are listed in <http://www.iana.org/assignments/port-numbers>.

3.11**Internet protocol****IP**

signalling protocol used and defined in ISOC RFC 791 (and updates)

3.12**message**

collection of one or more sentences that are grouped by mechanisms internal to the sentence, for instance by sequence numbers as in the TXT sentence

Note 1 to entry: A stand-alone sentence is a message.

3.13**message type**

classification of IEC 61162-1 sentence formatters into ~~SMB~~ SBM, MSM and CRP types

Note 1 to entry: SBM, MSM and CRP types are defined in Annex A.

Note 2 to entry: This document defines different requirements to the transmission of different message types.

3.14**multi-sentence message****MSM**

logical group of messages and/or sentences where the full meaning of the group is dependent on the receiver reading the full group

Note 1 to entry: Multi-sentence messages that are grouped together with a TAG construct are also a sentence group.

Note 2 to entry: MSM are defined in Annex A.

3.15**network**

physical Ethernet network with one Internet address space, consisting only of the network nodes, switches, cables and supporting equipment such as power supply units

3.16**network function block****NF**

function block responsible for physical connectivity to the network and connectivity to the transport layer as described in 4.3

3.17**network infrastructure**

part of the network that provides a transmission path between network nodes

Note 1 to entry: The network nodes are not part of the network infrastructure.

3.18**network node**

physical device connected to the network and which have an Internet address

Note 1 to entry: It is also called an Internet host.

Note 2 to entry: A network node will normally correspond to equipment. "Equipment" is used in this document.

3.19**other network function block****ONF**

function block that interfaces to the network, but which is not using the protocol definition in Clauses 5, 6 and 7 ~~of this standard (for example real time streaming of Radar and CCTV image transfer, VDR sound transfer, etc.)~~

Note 1 to entry: For example, real time streaming of radar and CCTV image transfer, or VDR sound transfer.

Note 2 to entry: Requirements as defined in 4.7 ensure that an ONF can co-reside with SF network nodes and function blocks that make use of this document's protocol.

3.20**PGN to network gateway function block****PNGF**

function block that enables transfer of sentences between the network and devices that are compliant with the IEC 61162-3 serial data instrument network interface

3.21**PGN message****parameter group number message**

message consisting of an 8-bit or 16-bit number that identifies each parameter group

Note 1 to entry: 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.

[SOURCE: IEC 61162-3:2008, 3.1.21, modified – The word "message" has been added to the term, and the definition has been rephrased.]

3.22**sensor broadcast message****SBM**

message consisting of only one sentence

Note 1 to entry: SBMs are sent with a sufficiently high update rate to ensure that the receiver can maintain the correct status even in environments where some messages may be lost.

Note 2 to entry: SBMs are defined in Annex A.

3.23**sentence**

standard information carrying unit as ~~defined~~ described in IEC 61162-1

3.24**sentence group**

logical group of sentences (which may consist of only one) that need to be processed together to give full meaning to the information contained in the sentence(s)

Note 1 to entry: The grouping of sentences into sentence group is done by TAG block mechanisms. ~~The sentences in a sentence group may or may not have the same formatter. A multi-sentence message grouped by this mechanism is also a sentence group.~~

Note 2 to entry: This document allows the explicit grouping of sentences by using coding in a datagram. This document does not enforce any relationship between datagram and sentence group. Thus a datagram may contain more than one sentence group, or a sentence group may be split over two or more datagrams.

3.25

serial to network gateway function block

SNGF

function block that enables transfer of sentences between the network and devices that are compliant with the IEC 61162-1 and IEC 61162-2 serial line interface

3.26

system function block

SF

function block, identified by a unique system function ID (SFI), that is the only function block that can send information in a datagram format as defined in Clause 7

3.27

system function ID

SFI

parameter string as defined in 4.4.2

3.28

transmission group

pair of a multicast address and a port number that are used by an SF to transmit sentences

Note 1 to entry: The transmission groups are defined in Table 4, and Annex A defines default transmission groups for the SF.

3.29

transport annotate and group

TAG

formatted block of data, defined in NMEA 0183, that adds parameters to IEC 61162-1 sentences

Note 1 to entry: **Informative** Annex B gives an overview of the TAG blocks used in this document.

3.30

user datagram protocol

UDP

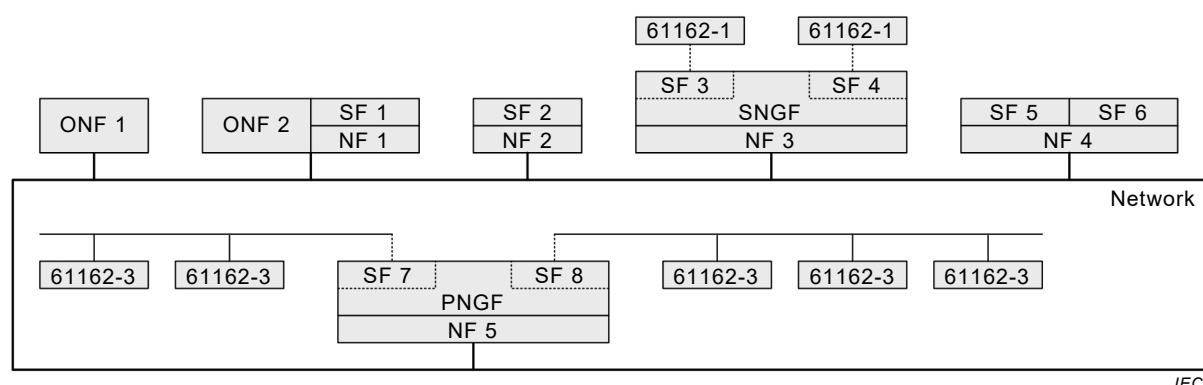
connection-less datagram protocol defined by ISOC RFC 768

Note 1 to entry: ISOC RFC 768 makes no provision for transport-layer acknowledgement of packets received.

4 General network and equipment requirements

4.1 Network topology example

Figure 1 shows a possible IEC 61162-450 network topology consisting of one IP local area network (LAN) and a number of different network nodes, each containing different function blocks. This diagram is informal and does not imply any requirements other than the ones defined in Clause 4.



Key

- SF system function block
- NF network function block
- SNGF serial to network gateway function block
- ONF other network function block
- PNGF PGN to network gateway function block

Figure 1 – Network topology example

Some examples of network nodes are (see Figure 1):

- a sensor, for example a GNSS receiver that is also a network node (SF2 and NF2);
- a device that sends or receives IEC 61162-450 compliant data (sentences and/or binary ~~image~~ file) as well as other types of information onto the network, for example an ECDIS that can also load chart data from another device (SF1, ONF2 and NF1);
- two independent functions, such as a gyrocompass also approved as a rate of turn sensor that are implemented in one network node (SF5, SF6 and NF4);
- a system device function block represented by an IEC 61162-1 compliant equipment connected to a serial to network gateway function (SNGF); in this case, the SNGF will format outgoing sentences according to requirements in this document (SF3, SF4, SNGF and NF3);
- a system device function block presented by an IEC 61162-3 compliant equipment connected to network gateway function (PNGF); in this case, the PNGF will format outgoing sentences according to requirements of this document (SF7, SF8, PNGF and NF5);
- a device that does not send or receive IEC 61162-450 compliant data (sentences and/or binary ~~image~~ file), but which satisfies minimum requirements for compatible use of the same network (ONF1).

4.2 Basic requirements

4.2.1 Requirements for equipment to be connected to the network

(see 8.2.1)

The requirements for equipment connected to the network are as follows.

- All equipment connected to the network, including network infrastructure equipment, shall satisfy the relevant physical and electrical requirements defined in 5.1.
- All equipment that implements one or more of SF and/or SNGF shall implement the NF. This equipment shall satisfy the requirements to the function blocks they implement as defined in 4.3 (NF), 4.4 (SF), 4.5 (SNGF) and 4.6 (PNGF).

- All other equipment that is not network infrastructure equipment and that shares the network infrastructure shall comply with requirements to an ONF as defined in 4.7.
- Network infrastructure equipment, i.e., switches, shall satisfy requirements in 4.2.2.
- All equipment connected to a network shall satisfy the requirements of IEC 60945.

NOTE This requirement only applies to devices on the network when the network is in normal operation. During commissioning or maintenance, when the system is not being used for safety-related navigation, other equipment can be temporarily connected to the network that does not comply with IEC 60945.

Any other equipment is not allowed to be connected to the network.

4.2.2 Additional requirements for network infrastructure equipment

(see 8.2.2)

~~The following requirements are included to avoid potential problems with certain network infrastructure equipment:~~

- ~~routers and repeater hubs shall not be used to interconnect components of an IEC 61162-450 network;~~
- ~~switches that are used to interconnect equipment compliant with IEC 61162-450 shall not implement multicast filtering techniques, such as IGMP snooping or CGMP.~~

~~**NOTE** IGMP is Internet Group Management Protocol and CGMP is Cisco Group Management Protocol. If switches are capable of implementing multicast filtering techniques, then this functionality should be disabled.~~

~~**NOTE** Routers are network infrastructure devices that can forward datagrams between networks.~~

To avoid potential problems with certain network infrastructure equipment, repeater hubs shall not be used to interconnect components of an IEC 61162-450 network.

NOTE 1 Repeater hubs are network infrastructure devices without internal storage that repeat incoming datagrams onto all outgoing connections.

NOTE 2 Switches are network infrastructure devices that based on forwarding tables can process, and forward datagrams between nodes on the same network, using intermediate storage in the switch before retransmission.

Switches used in an IEC 61162-450 network shall have means to filter network traffic using IGMP snooping. When the IGMP snooping is enabled and when a multicast datagram is received, the switch shall forward it only to the ports which have joined the same multicast group. The means which shall be provided to support multicast data filtering using IGMP snooping are the following:

- IGMP snooping shall be provided based on IGMPv1, IGMPv2 or IGMPv3; the selection of the IGMP version shall be based on highest version supported by all the connected nodes;
- multicast traffic filtering shall be provided based on IP multicast address;
- multicast data filtering shall not be enabled for the address range of 224.0.0.1 to 224.0.0.255 as recommended in RFC 4541.

In addition to or instead of multicast filtering techniques, such as IGMP snooping, it is also permitted to configure manually individual ports of the switches to block unnecessary traffic flow (for example to isolate simple sensors from ECDIS and radar).

See Annex D for IGMP snooping compatibility issues of nodes based on IEC 61162-450:2011.

Another possible method to filter and control network traffic is described in Annex E.

4.3 Network function (NF) requirements

4.3.1 General requirements

All equipment that implements a NF shall satisfy the requirements in Clauses 5 and 6.

4.3.2 Maximum data rate requirements

(see 8.3.1)

The manufacturer shall specify the maximum input rate under which the equipment can still perform all functions required by its performance standards.

Maximum input rate shall be specified as

- a) the maximum number of datagrams per second received, intended for and processed by the equipment,
- b) the maximum number of datagrams per second received by, but not intended for, the equipment, and
- c) the maximum number of datagrams per second received by, but not intended for, the equipment at 50 % of the maximum load for item a).

NOTE 1 "Received by" means datagrams that are received on all transmission groups that the equipment listens to.

NOTE 2 "Intended for" are datagrams that are processed by the equipment as part of its specified function.

The maximum data rates shall be the mean rate over a 10 s measurement period.

4.3.3 Error logging function

(see 8.3.2)

4.3.3.1 Internal logging

Means shall be provided in each NF to record errors that occur in the NF itself as well as SF and SNGF using it. Subclauses 4.5.2, 7.1.2, 7.2.5 and 7.3.9 give minimum requirements as to what shall be logged.

As a minimum, the manufacturer shall provide mechanisms by which error logs can be inspected by a human operator, for example by trained service engineer. It is allowed that the inspection is done through a simple network mechanism, such as a terminal emulator, ~~a datagram~~ as defined in this document or any other reasonable method.

The minimum requirements for the log are to count the number of each occurrence. The counter may reset itself by a manufacturer specified method.

4.3.3.2 External logging

A NF may be configured to support external logging, where non-trivial information is sent to a logging server. In this case, a "syslog" message as defined in ISOC RFC 5424 shall be used.

Syslog messages shall be formatted as ASCII text messages and sent as UDP packets on port 514 and the multicast address defined in Table 6. Error messages defined in this document shall be reported through a simplified message as described in Table 1, where italicised words are place-holders for data explained in the right hand column. Other characters shall be transmitted as shown, including spaces.

Table 1 – Syslog message format

Element	Description
<pri>	The combined priority and facility code (number from 0 to 199 inclusive) enclosed in pointed brackets. For the errors defined in this document, the value 131 shall be used (facility "local use 0" and priority "error condition").
Version	The version code. The code 1 (one) shall be used for messages from this document.
Space	One space character.
Timestamp	Timestamp, containing date and time and optional UTC offset, in a valid format, for example 1985-04-12T23:20:50-03:00. The example shows date, followed by upper case "T", then local time and finally offset from UTC (3 hours west – negative, east offsets shall be prefixed by a "+". UTC offset can be abbreviated to a single upper case "Z", without leading "-" or "+"). Alternatively, the timestamp field may be nil ("-", a single dash character).
Space	One space character.
Hostname	The host name of the network node, represented as the IP address in dotted decimal notation. Alternatively, this field may be nil ("-", a single dash character).
Space	A space character.
Appname	The application name. This shall be the string "450-" followed by the configured SFI code if the error originates in the SF or SNGF, "NF" if the error originates from the network function block or "ONF" if it originates in the ONF function block.
Space	A space character.
Procid	Normally, this field should be nil ("-" a dash character). Other values as defined in the syslog standard may be used.
Space	A space character.
Msgid	For errors defined in this document, this field shall be the error code as defined in Table 2.
Space	A space character.
Structured	This field can be nil ('-', a single dash character) or contain information as defined in ISOC RFC 5424.
Space	A space character.
Msg	A free format message in ASCII format.

A "syslog" packet shall not exceed 480 bytes and shall be sent as a single UDP datagram. The "syslog" packet for multiple occurrence of same message identity shall not be reported more often than once per minute. The "syslog" packet for any occurrence of message identity shall not be delayed more than 10 min.

NOTE This document does not specify requirements for equipment receiving syslog messages. This type of equipment would fall into the category of ONF. As Table 1 is a subset of the full ISOC RFC 5424 specification, implementers of such equipment ~~should~~ shall refer to ISOC RFC 5424 and make sure that syslog messages from other ONF can be received and processed without problems.

To facilitate the use of the syslog protocol, the errors defined in this document have been assigned a message identity as defined in Table 2.

Table 2 – Syslog error message codes

Message identity	Description	Subclause
101	SNGF buffer overflow	4.5.2
102	Datagram header error	7.1.2
103	TAG or sentence format error	7.2.5
104	Binary image file error	7.3.9
201	PNGF buffer overflow	4.6.2
202	PGN message errors	7.4.2 and 7.4.4
203	No available address for devices	7.4.3.2

Additional information can be given in the "Msg" field, if available.

4.3.4 Provisions for network traffic filtering – IGMP

NOTE The purpose of the IGMP for this document is to provide the possibility to perform network traffic filtering based on IGMP snooping.

The manufacturer shall specify the version of IGMP as defined in ISOC RFC 1112, RFC 2236 and RFC 3376 that the NF supports. At least version 1 as defined in ISOC RFC 1112 shall be implemented.

See Annex D for compatibility issues of nodes based on IEC 61162-450:2011.

4.4 System function **block** (SF) requirements

4.4.1 General requirements

(see 8.4.1 and 8.2.3)

Equipment that implements an SF shall satisfy the following requirements:

- requirements in 6.2 shall be satisfied for all equipment implementing SF;
- implements at least one of the datagram types defined in Clause 7, but does not have to implement all of them;
- implemented datagram types shall be specified in the manufacture's documentation (see 7.1.1);
- requirements in 7.2 shall be satisfied for all equipment implementing IEC 61162-1 sentence transmitting or receiving function blocks;

~~**NOTE**—This also includes function blocks with the ability to send heartbeat (HBT) sentences.~~

- requirements in 7.3 shall be satisfied for equipment that implements an SF that can transmit or receive binary ~~image~~ file data;
- requirements in 7.4 shall be satisfied for all equipment implementing IEC 61162-3 PGN message transmitting or receiving function blocks.

4.4.2 Assignment of unique system function ID (SFI)

(see 8.4.2)

The format of the SFI parameter string shall be "ccxxxx"

where "cc" is two valid characters as defined in IEC 61162-1 and "xxxx" is four numeric characters.

An SF implementing the functionality of an equipment that has been given a talker mnemonic code in IEC 61162-1 shall use this talker mnemonic as the "cc" characters in the SFI. If the

talker mnemonic is proprietary (i.e. consists of character "P" followed by a three-character manufacturer's mnemonic code), then two first characters are used as the "cc" characters in the SFI.

NOTE Other SF may have their SFI string format defined in other standards or the manufacturer may have to choose a code. In the latter case, the already defined talker mnemonic codes ~~should~~ shall be avoided.

The numeric character string "xxxx" will be an instance number in the range ~~"0000"~~ "0001" to "9999". The numeric character string "9999" is reserved for an un-configured SF and shall not be used by any transmitting SF during normal operation. However, all receiving equipment shall accept the "9999" string.

During normal operation, the SFI parameter string shall be unique for all SF in an IEC 61162-450 network.

NOTE It is recommended that all SF on a ship, independent on whether they are residing on one common network or not, are given a ship unique SFI.

There may be multiple SF, each communication with their own SFI, assigned to a single IP address or MAC address.

Means shall be provided by the manufacturer to configure the SFI for each SF (see 7.2.3.4).

4.4.3 Implementing configurable transmission groups

(see 8.4.3)

As default, each SF shall be assigned a single transmission group/multicast address for all outgoing messages. The default for this transmission group is determined by the SFI as described in Annex A.

For each SF that the equipment implements, the manufacturer shall document the default transmission groups the SF listens to and what sentences it expects to receive on each group. The default transmission groups can be selected by the manufacturer from the list of groups in 6.2.2.

~~Means shall be provided to configure all transmission groups to another than the default. Only the transmission groups listed in 6.2.2 are allowed to be configured.~~

~~NOTE All transmission groups can be used for configuration, i.e., a system integrator may use, for instance the NAVD group also for non-navigational SFs, if desired. However, an overall load analysis of the network needs to take the actual configuration into consideration.~~

Means shall be provided to configure all transmission groups and the SFs which are assigned to them within the valid range of multicast addresses defined in 5.4. A system integrator may, for example, split an SF into different transmission groups to support optimal load balancing for a given system. Where non-default configurations of SF and transmission groups are utilised, the details should be documented by the system integrator.

4.5 Serial to network gateway function (SNGF) requirements

4.5.1 General requirements

(see 8.5.1)

The SNGF shall implement all relevant functionality defined in 4.4 for each SF it supports.

The SNGF may support one or more serial ports. Unless the SNGF implements multi-SF serial port, each serial port shall be implemented as a separate SF and assigned a separate SFI. If

practical, the "cc" part of the SFI shall be based on the talker identifier in use by the serial port.

All sentences, including those with unidentified or illegal content, as well as proprietary sentences shall be transmitted from the SF associated with the serial port. Sentences with unidentified or illegal content shall be sent with a legal transport annotate and group (TAG) block as defined in 7.2.3, but with the raw received serial data following the TAG block.

As a destination, each serial port shall be associated with the corresponding SFI. Outgoing sentences shall be transmitted exactly as received in the datagram.

The SNGF may support one or more sources distinguished by different talker mnemonics at each serial port. Each ~~serial port~~ source in a shared serial port shall be implemented as a separate SF and assigned a separate SFI. If practical, the "cc" part of the SFI shall be based on the talker mnemonic in use by each source in a shared serial port. As a destination, each source in a shared serial port shall be based on the SFI. Proprietary sentences include no talker identifier and based on setup parameters they shall use the same SFI as standardized sentences from the same source. The STN sentence is an additional qualifier for the following sentence. The STN sentence and the following sentence belong to the same SF and shall use the same SFI.

Proprietary sentences belong to the default SF of the associated serial port or to the SF determined by the preceding STN sentence.

The TAG block for source identification (s:) shall be based on the SFI. If available, routing from a 450-network to serial ports shall be based on the TAG block for destination identification (d:).

The default SFI of an SNGF used for administrative purposes, such as syslog, shall use the talker mnemonic "SI".

The SNGF may implement different types of filtering with regard to what serial line sentences are retransmitted as datagrams and what datagrams will result in a serial line sentence being sent. Any filtering methods shall be described in the manufacturer's documentation.

NOTE A typical filtering method would be to use the destination TAG "d" to determine what sentences in incoming datagrams are to be sent on the serial line.

4.5.2 Serial line output buffer management

(see 8.5.2)

An SNGF function block shall provide an independent buffer for each **separate SF implemented for each** serial port it can send sentences onto. The manufacturer shall specify the maximum buffer capacity for each port. The maximum capacity may be configurable at installation.

The buffer shall be implemented as a FIFO (first in, first out) buffer. In case of a full buffer, newly arrived sentences shall be discarded, unless these sentences are specified as prioritized (see below). Newly arrived sentences will be inserted into the buffer when buffer space is available. The method of treatment of sentences grouped by the TAG g (see 7.2.3.3) may be configurable or specified in the manufacturer's documentation.

The SNGF may implement a priority-based functionality for some sentences with specified sentence formatters. The prioritised formatters may be configurable or specified in the manufacturer's documentation.

Processing of prioritized sentences shall be as follows.

- Only one sentence with identical talker ID and sentence formatter shall exist in the buffer. **Exception is a multi sentence message or a TAG block group of sentences: they shall only be replaced in their entirety.**

NOTE When prioritizing AIS VDM and VDO sentences, the string beginning with the "!" character and ending with the 7th character of the encapsulation field ~~should be~~ is used for comparison to identify identical sentences. A match of this string from a newly arrived sentence with one in the buffer means the sentence contains the same ITU-R M.1371 message from the same MMSI as the sentence already in the buffer, and can then replace the older sentence at its position in the queue.

- If a **single sentence, multi sentence message** or a TAG block grouped sentences, with identical talker ID and sentence formatter exists in the buffer, the new sentence or sentences will replace the existing sentence **or sentences** at its position in the queue. **This replacing shall not cause logging of an error nor sending anything to syslog.**

NOTE When prioritizing TAG block grouped sentences, several fields within the TAG block need to be compared as well as the sentence comparisons. All of the compared components should match those of the current TAG block group in order to the replace TAG block group in the queue. The components to compare are: the TAG block source parameter code value, the "number of lines" portion of the TAG block group parameter code, and the sentences within the TAG block group.

- Otherwise, the new sentence shall follow the FIFO principle as described above.

If a sentence is discarded from the queue, this event shall be logged as an error internally in the equipment as defined in 4.3.3. The equipment shall have separate error counts for each serial port.

4.5.3 Datagram output requirements

(see 8.5.3)

The SNGF shall format outgoing datagrams as defined in 7.2.

The SNGF shall **either transmit one IEC 61162-1 sentence or, if part of a multi sentence sequence, may transmit multiple IEC 61162-1 sentences per outgoing IEC 61162-450 datagram** ~~to minimise delays~~. The multi sentence sequence includes the case described in IEC 61162-1:2016, 7.3.9, and the cases for which IEC 61162-1 requires a sentence sent prior sending another sentence. The datagram shall include the correct SFI, source identification (s:) and, if required, destination identification (d:).

4.5.4 Multi SF serial port

(see 8.5.4)

The SNGF is allowed to implement more than one SFs for any single serial line. Received sentences on this serial line with a valid talker mnemonic will be transmitted from one of the associated SFs dependent on the talker mnemonics. Each SF shall be assigned a separate SFI and, as a destination, transmit outgoing sentences on the serial line according to the rules in 4.5.1.

Proprietary sentences received on the serial line include no talker identifier. It shall be determined by setup parameters from what SF they shall be transmitted.

Unidentified data from the serial line shall be sent from all SFs associated with the serial port. This sending of unidentified data shall not cause logging of an error nor sending anything to syslog.

4.5.5 Handling malformed data received on serial line

(see 8.5.5)

The SNGF is intended as a remote serial data converter with minimum data processing. For each of the cases below, the SNGF shall send a datagram with the malformed data as required by 4.5.1 and 4.5.4. If the formatted message exceeds the maximum datagram length,

the data shall be truncated from the end. The following cases shall cause a message containing the malformed data to be sent:

- 1) if data has been received before a start character;
- 2) if data has been received after a valid start character and the maximum sentence and TAG block length has been exceeded;
- 3) if data has been received after a valid start character and end of line (CR,LF) has not been received after 1 s;
- 4) if a reserved character has been received and not having been appropriately escaped;
- 5) if random binary data is received on the serial line.

"Start character" is a valid start of sentence ("\$", "!") or TAG block start character.

4.6 PGN to network gateway function (PNGF) requirements

(see 8.12)

4.6.1 General requirements

(see 8.12)

The PNGF shall implement all relevant functionality for each SF it supports as defined in 4.4.

The default SFI of a PNGF used for administrative purposes, such as syslog, shall use the talker mnemonic "SI".

The PNGF may implement different types of filtering based on the PGN messages from and to IEC 61162-3 network. Any filtering methods shall be described in the manufacturer's documentation.

NOTE The accurate timing between PGN messages available in the IEC 61162-3 network is not supported when the same is converted into IEC 61162-450 network.

4.6.2 Output buffer management from IEC 61162-450 network to IEC 61162-3 network

(see 8.12)

A PNGF function block shall provide an independent buffer for each IEC 61162-3 network it can send into. The manufacturer shall specify the maximum buffer capacity for each port. The maximum capacity may be configurable at installation.

PNGF buffer management shall be based on the IEC 61162-3 priority included into each message. The manufacturer shall describe the method in documentation.

If the buffer is full and a PGN message is discarded, it shall be recorded as specified in 4.3.3.

4.6.3 Datagram output requirements

(see 8.12)

The PNGF shall format outgoing messages as defined in 7.4.1.

The PNGF shall transmit one IEC 61162-3 PGN message per outgoing IEC 61162-450 datagram to minimise delays.

4.6.4 PGN group number

(see 8.12)

A PGN group is defined as a logical group of devices that can share the information and message. A message from a device is broadcasted to all devices that belong to the same PGN group. A device may belong to more than one PGN groups. The maximum number of PGN groups is no more than four. The PGN group may be used for filtering of messages (see 4.6.1).

4.7 Other network function (ONF) requirements

(see 8.6)

The ONF represents a function that is allowed to share the same network infrastructure as the network function blocks (NF) on an IEC 61162-450 network.

The ONF shall conform to the requirements given in 4.2.1.

The ONF equipment shall not use any IP multicast address reserved by this document as defined in 5.4.

Documentation shall be provided describing the network protocols used by the ONF to send datagrams or byte streams, for instance UDP, TCP/IP or other.

Documentation shall be provided ~~demonstrating that the ONF cannot negatively impact the normal performance of the network or other equipment connected~~ describing the impact of the ONF to the network.

5 Low level network requirements

5.1 Electrical and mechanical requirements

(see 8.7.1)

The cable and connectors used shall at least meet the specifications listed in Table 3 when used in protected environment as defined in IEC 60945.

The safety requirements and installation practices specified in IEEE Std 802.3TM-2015, 14.7 and Clause 27, shall be followed. Also refer to IEEE Std 802.3-2015, informative Annex 67.

Fibre optic interfaces shall comply with the laser safety requirements for Class 1 devices specified in IEC 60825-2.

The physical layer requirement for IEC 61162-3 ports of the PNGF shall be compliant with IEC 61162-3:2008, Clause 4.

Table 3 – Interfaces, connectors and cables

IEEE 802.3 Interface	Max network segment link distance	Mechanical device interface connector type (protected environment)	Pin assignment	Cable category, minimum
100BASE-TXS IEEE Std 802.3-2015, 14.7 and Clauses 24 and 25	100 m	IEC 60603-7-3, 8-way shielded modular connector Refer to IEEE Std 802.3-2015, Clause 3, IEC 60603-7, Figures 1 through 5, and IEEE Std 802.3/25	^b	CAT5 STP Two shielded twisted pairs ANSI/TIA/EIA-568-A-1995, ANSI/TIA/EIA-568-B or ISO/IEC 11801-1995 (Class D).
(not specified)	^a	Terminal block	^b	CAT5 STP Two shielded twisted pairs
100BASE-SX IEEE Std 802.3-2015, Clauses 24 and 26	550 m	IEC 61754-20 LC type duplex optical connector ^d		Two multimode optical fibres Short wavelength 850 nm
1000BASE-T IEEE Std 802.3-2015, Clause 40 (802.3ab)	100 m	IEC 60603-7-7, 8-way shielded modular connector Refer to IEEE Std 802.3-2015, Clause 3, and IEC 60603-7, Figures 1 through 5. See IEEE Std 802.3/25	^c	CAT5 STP Four shielded twisted pairs ANSI/TIA/EIA-568-A-1995, ANSI/TIA/EIA-568-B or ISO/IEC 11801-1995 (Class D).
1000BASE-SX IEEE Std 802.3-2015, Clause 38 (802.3z)	220 m (62/125 µm, low modal bw) 550 m (50/125 µm, high modal bw)	IEC 61754-20 LC type duplex optical connector ^d		Two multimode optical fibres Short wavelength 850 nm
For use in exposed environments, additional provisions are necessary. Consideration should be given to the M12-type specified in IEC 61076-2-101, Amendment 1 for copper network cable. And similar rugged connector should be considered for external fibre optic-connectorization connections.				
^a In this case, the maximum operating distance should be specified by the manufacturer. ^b The 8-way modular connector specified in IEC 60603-7 is the "8P8C" type that has commonly been used in desktop computer LAN connections and incorrectly but widely referred to as "RJ45". Wires are in the order 1, 2, 3, 6, 4, 5, 7, 8 on the modular jack; the same at each end of a cable. The color-order from wire 1 to 7 8 shall be green/white, green, orange/white, blue, blue/white, orange, brown/white, brown; the same at both ends of the cable. Refer to IEEE Std 802.3-2015, 25.4.3, and IEC 60603-7-3. ^c The 8-way modular connector specified in IEC 60603-7 is the "8P8C" type that has commonly been used in desktop computer LAN connections and incorrectly but widely referred to as "RJ45". Wires are in the order 1, 2, 3, 6, 4, 5, 7, 8 on the modular jack; the same at each end of a cable. The color-order from wire 1 to 7 8 shall be green/white, green, orange/white, blue, blue/white, orange, brown/white, brown; the same at both ends of the cable. Refer to IEEE Std 802.3-2015, 40.8.1 and IEC 60603-7-7. ^d See TIA/EIA-604-10-A:2002.				

5.2 Network protocol requirements

(see 8.7.2)

Equipment shall implement IPv4 as generally described in ISOC RFC 5000 with a minimum requirement of support for the following specific network protocols:

- ARP – Address Resolution Protocol as described in ISOC RFC 826 and as updated in ISOC RFC 5227;

- IP – Internet Protocol as described in ISOC RFC 791 and as updated in ISOC RFC 2474;
- UDP – User datagram Protocol as described in ISOC RFC 768;
- UDP Multicast – Host groups as described in ISOC RFC 966 and Host extensions as described in ISOC RFC 1112;
- TCP – Transmission Control Protocol as described in ISOC RFC 793;
- ICMP – Internet Control Message Protocol as described in ISOC RFC 792;
- IGMP – Internet Group Management Protocol as described in ISOC RFC 1112, RFC 2236 or RFC 3376;

5.3 IP address assignment for equipment

(see 8.7.3)

Means shall be provided to configure the equipment to ~~an address in the range 172.16.0.1 to 172.31.255.254 (B type private addresses as described in ISOC RFC 1918) with a 16 bit~~ any of the addresses reserved for use in private networks as described in ISOC RFC 1918 with any valid network address mask. The default sub-net mask shall be set appropriately for 192.168.0.0/24 (legacy Class C). The assigned IP address shall remain fixed during normal operation of the equipment, including powering the equipment down and up.

Specific 450-Nodes may choose to exclude a few sub-nets to facilitate internal sub-nets (internal to the equipment) which shall be documented. The following sub-nets shall always be available to the IEC 61162-450 network: 192.168.0.0/24 – 192.168.10.0/24 and 172.16.0.0/16 (Class B).

5.4 Multicast address range

(see 8.7.4)

The range 239.192.0.1 to 239.192.0.64 is reserved for current and future use in the application layer protocols (see 6.2.2).

The multicast address range 239.192.0.57 to 239.192.0.64 is used for interconnection with IEC 61162-3 networks.

ONF equipment shall not use multicast addresses in the range 239.192.0.1 to 239.192.0.64.

NOTE 1 ISOC RFC 2365 defines the multicast address range 239.192.0.0 to 239.192.63.255 as the IPv4 Organization Local Scope, and is the space from which an organization should allocate sub-ranges when defining scopes for private use. ~~The specified range of IP multicast addresses map to Ethernet MAC addresses 01005E400001 to 01005E400040 (Hexadecimal).~~

NOTE 2 The default TTL (i.e. number of hops) is 1 for multicast. The sub-net mask is set appropriately for class C (local area network).

5.5 Device address for instrument networks

Means shall be provided to assign a device address range from 0 to 251 when the PNGF transmits to an IEC 61162-3 network. The device address may be set automatically.

6 Transport layer specification

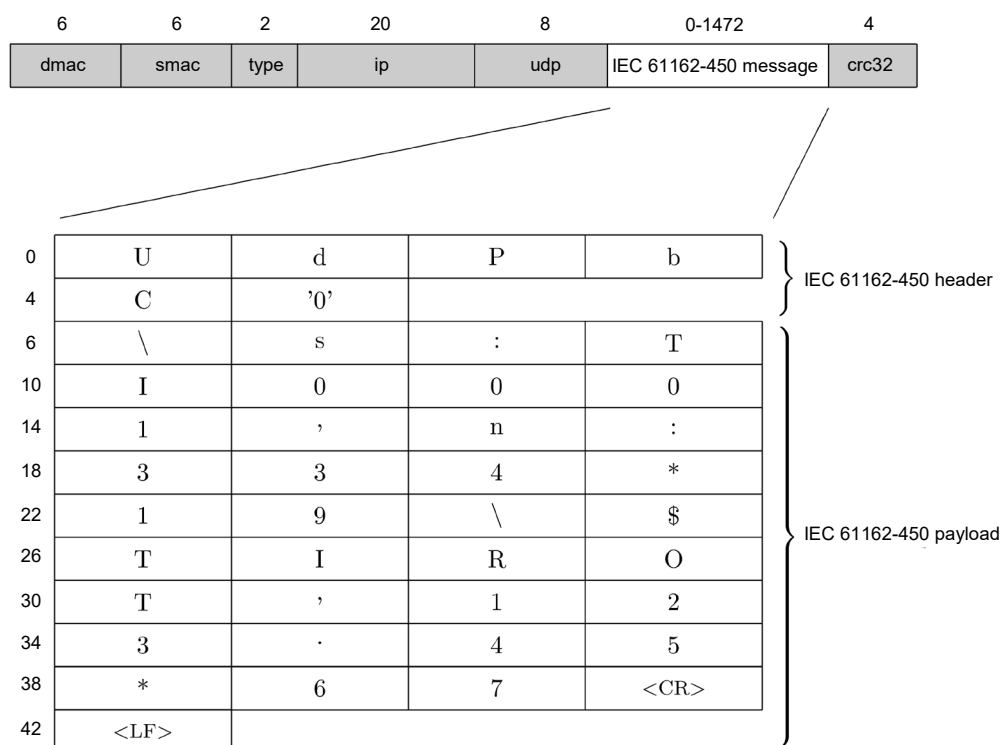
(see 8.8)

6.1 General

Clause 6 specifies how UDP multicast messages are used to communicate between equipment over an Ethernet network.

Equipment may implement functionality for sending, receiving or both. The provisions of Clause 6 applies to both, but shall be tested independently as described in 7.6.

An example of the structure of an Ethernet frame with a IEC 61162-450 sentence is given in Figure 2. The uppermost block shows the full Ethernet frame with the UDP user available data block shown in white. The IP and UDP headers are included in the grey blocks. The lower block shows the UDP user available data block with an IEC 61162-450 formatted sentence included. The numbers above the Ethernet frame gives the size of each block. The numbers in front of the UDP user data block gives the offset from the start of the block (0 – zero).



\s:TI0001,n:334*19\ \$TIROT,123.45*67<CR><LF>

IEC

Figure 2 – Ethernet frame example for a SBM from a rate of turn sensor

6.2 UDP messages

6.2.1 UDP multicast protocol

UDP Multicast – IP multicast is a technique for many-to-many communication over an IP infrastructure in a network. The destination nodes send join and may send leave messages. IP multicast scales to a larger receiver population by not requiring prior knowledge of who or how many receivers there are. Multicast uses network infrastructure efficiently by requiring the source to send a packet only once, even if it needs to be delivered to a large number of receivers. The nodes in the network take care of replicating the packet to reach multiple receivers only when necessary. The most common transport layer protocol to use multicast addressing is User Datagram Protocol (UDP).

Senders and receivers shall as a minimum be able to use ~~the UDP protocol~~ as defined by ISOC RFC 768 and as further specified in this document.

6.2.2 Use of multicast addresses and port numbers

Port numbers shall be allocated from the dynamic port range that the internet assigned number authority (IANA) has reserved for dynamic and/or private port numbers (range 49152 to 65535, inclusive).

Table 4 defines multicast addresses and destination port numbers that shall be used when transmitting sentences from a system function block. The mapping of SFI to default transmission group is described in Annex A. If provided by the equipment, the default multicast address or destination port number can be changed by the parameter setup system of the equipment to the multicast addresses or destination port numbers of the transmission groups USR1 to USR8, RCOM, PROP in Table 4 or any in Table 5 (for example to support use of same transmission group for both "binary file" and related sentences, for example ECDIS route exchange and RRT-sentence).

NOTE The purpose of the port differentiation is to provide a mechanism that allows a certain level of load reduction for the receiving equipment.

Table 4 – Destination multicast addresses and port numbers

Transmission group	Category	Multicast address	Destination port
MISC	SF not explicitly listed below	239.192.0.1	60001
TGTD	Target data (AIS), tracked target messages (Radar)	239.192.0.2	60002
SATD	High update rate, for example ship heading, attitude data.	239.192.0.3	60003
NAVD	Navigational output other than that of TGTD and SATD groups	239.192.0.4	60004
VDRD	Data required for the VDR according to IEC 61996	239.192.0.5	60005
RCOM	Radio communication equipment	239.192.0.6	60006
TIME	Time transmitting equipment	239.192.0.7	60007
PROP	Proprietary and user specified SFs	239.192.0.8	60008
USR1 to USR8	User defined transmission group 1 to 8	239.192.0.9 to 239.192.0.16	60009 to 60016
BAM1 to BAM2	Optionally, BAM compliant alert source reporting to CAM	239.192.0.17 to 239.192.0.18	60017 to 60018
CAM1 to CAM2	CAM of the BAM	239.192.0.19 to 239.192.0.20	60019 to 60020
NETA	Network administration, e.g. SFI collision detection	239.192.0.56	60056
PGP1 to PGP4	Primary PGN Group 1 to PGN Group 4	239.192.0.57 to 239.192.0.60	60057 to 60060
PGB1 to PGB4	Backup PGN Group 1 to PGN Group 4	239.192.0.61 to 239.192.0.64	60061 to 60064
NOTE 1 The USR1 to USR8 transmission groups can be used, for example, for proprietary data in binary format.			
NOTE 2 BAM1/BAM2 and CAM1/CAM2 are available for system integrators to balance the traffic, for example higher volume radar in BAM1/CAM1 and low volume sensor, for example gyro, in BAM2/CAM2.			

Table 5 defines multicast addresses and destination port numbers that shall be used when transmitting binary ~~image~~ file data. If provided by the equipment, the default multicast address or destination port number can be changed by the parameter setup system of the equipment to the multicast addresses or destination port numbers of the transmission groups USR1 to USR8, RCOM, PROP in Table 4 or any in Table 5 (for example to support use of same transmission group for both "binary file" and related sentences).

Table 5 – Destination multicast addresses and port numbers for binary data transfer

Category	Multicast address	Destination port
Simple Binary image transfer	239.192.0.21 to 239.192.0.25	60021 to 60025
Re-transmittable binary image transfer	239.192.0.26 to 239.192.0.30	60026 to 60030

Category	Multicast address	Destination port
Non re-transmittable binary file transfer ^a	239.192.0.21 to 239.192.0.25	60021 to 60025
Re-transmittable binary file transfer ^b	239.192.0.26 to 239.192.0.30	60026 to 60030
^a Address 239.192.0.25, port 60025 is the default for ECDIS route transfer (see IEC 61174). ^b Address 239.192.0.26, port 60026 is the default for VDR image transfer (see IEC 61996-1). Address 239.192.0.30, port 60030 is the default for ECDIS re-transmittable data blocks for route transfer (see IEC 61174).		

Table 6 lists other multicast addresses and ports reserved by this document.

Table 6 – Destination multicast addresses and port numbers for other services

Category	Multicast address	Destination port
Syslog	239.192.0.254	514
Sending to syslog can use multicast or UDP unicast. Some switches can support only UDP unicast.		

The addresses ~~239.192.0.17 to 239.192.0.20 and~~ 239.192.0.31 to ~~239.192.0.64~~ 239.192.0.55 are reserved for future expansion.

It may be noted that IANA has defined that port range 49152 to 65535 is reserved for dynamic and private use. The specific ports for this document are within this IANA range. It should be noted that operating systems also use this IANA range for their internal use as ephemeral ports. This double use may cause port number conflicts resulting for lost communication of IEC 61162-450 messages. It is recommended to consider limiting the ephemeral port range of the operating system of equipment connected to an IEC 61162-450 network to avoid port number conflicts.

6.2.3 UDP checksum

All devices shall calculate and check the UDP checksum as defined by ISOC RFC 768. It is not permitted to set the checksum field to zero (no checksum).

A datagram that has an incorrect or missing checksum shall be discarded by the receiver.

6.2.4 Datagram size

The network function block shall not transmit more than 1 472 bytes of data in each datagram, including header as defined in Clause 7.

Receiving equipment is allowed to discard datagrams that have a size larger than the maximum specified size.

NOTE UDP datagrams can be up to 64 kB in size when they are sent as a number of IP fragments.

7 Application layer specification

7.1 Datagram header

(see 8.9.2)

7.1.1 Valid header

All UDP multicast datagrams shall contain one of the following strings, followed by a null character (all bits set to zero) as the first six bytes of the datagram:

- "UdPbC" for transmission of IEC 61162-1 formatted sentences as described in 7.2;
- "RaUdP" for transmission of binary ~~images~~ files as described in 7.3;
- "RrUdP" for transmission of re-transmittable binary ~~images~~ files as described in 7.3;
- "NkPgN" for transmission of IEC 61162-3 PGN messages as described in 7.4;

All TCP/IP datagrams shall contain the following string, followed by a null character (all bits set to zero) as the first six bytes of the datagram:

- "RrTcP" for transmission of binary files as described in 7.6;

NOTE 1 Datagram means packet in this context.

Incoming datagrams with an unknown header should be discarded without processing the content beyond the header.

NOTE 2 Future editions of this document ~~may~~ can define other header codes. Any such header code will be different from the ones already in use and will at least contain six bytes, possibly including a trailing null character.

7.1.2 Error logging

The equipment shall maintain a count of received datagrams that do not have a valid header and make this available as defined in 4.3.3.

7.2 General IEC 61162-1 sentence transmissions

7.2.1 Application of this protocol

(see 8.9.1)

This protocol provides a mechanism by which IEC 61162-1 sentences can be sent to one or more receivers on the network. The protocol allows several sentences to be merged into one datagram.

7.2.2 Types of messages for which this protocol can be used

(see 8.9.3)

This protocol shall be used for SBM and MSM (see Annex A) type messages. The protocol shall also be used for CRP message exchanges with provisions specified in Annex C.

7.2.3 TAG block parameters for sentences transmitted in the datagram

(see 8.9.4)

7.2.3.1 Valid TAG block

Each sentence shall be preceded with one or more TAG blocks as defined in NMEA 0183:2008, Section 7 (see also Annex B), containing the parameter codes described in 7.2.3.3 to 7.2.3.8. **Adding of TAG blocks with parameter codes happens between existing TAG blocks with parameter codes and the start of IEC 61162-1 sentence.** If a parameter code is assigned a value more than once in the TAG blocks and only one value is expected, the last parameter value (**i.e. parameter value closest to the start of IEC 61162-1 sentence**) shall be used.

In this document, all identities are set at the time of installation and shall not be dynamically configurable during normal operation. The control sentences for changing parameter codes in NMEA 0183 shall not be used during normal operation.

7.2.3.2 TAG block checking

Only sentences preceded by valid TAG blocks as defined in 7.2.3.1 shall be processed by the receiver.

NOTE ~~Receivers need to parse all TAG blocks and should ignore parameters that are not understood by the receiver. For the processing specified in this standard, only the last TAG block should be used.~~

7.2.3.3 Grouping control – g

The g parameter code shall be used by talkers to group TAG blocks and/or sentences. As a minimum, it shall be used to group sentences that are classified as belonging to message type "MSM" in Table A.2, when the multi-sentence group consists of more than one message. It is not required to include the g parameter code for single line sentences.

Receivers shall accept the g parameter code for all message types.

A valid MSM type sentence where internal data fields specifies that it belongs to a group of more than one message shall be discarded if the g group is missing or contains inconsistent information.

The group code is determined by the sending device. The initial group code value shall be one ("1") and the group code increment value shall be one ("1"). The group code shall be reset to one ("1") after it reaches 100, i.e., the valid range is 1-99, inclusive.

The following example shows the g parameter code used to group sentences in two different groups, each consisting of two sentences:

```
\g:1-2-34*59,s:IN0001*3A\!ABVDM,1,1,1,B,100000?0?wJm4:`GMUrf40g604:4,0*2504
\g:2-2-34*5A,s:IN0001*39\!ABVSI,r3669961,1,013536.96326433,1386,-98,,*3014
\g:1-2-46*5C,s:IN0001*3F\!ABVDM,1,1,1,B,15N1u<PP1cJnFj:GV4>:Mow:0<02,0*002D
\g:2-2-46*5F,s:IN0001*3C\!ABVSI,r3669962,1,013538.05654921,1427,-101,,*0420
```

7.2.3.4 Source identification – s

The s parameter code is mandatory for talkers and shall contain the system function ID (SFI, see 4.4.2) corresponding to the function block from where the sentence originates.

7.2.3.5 Destination identification – d

The d parameter code is optional and shall, if used, contain the system function ID (SFI, see 4.4.2) corresponding to the intended recipient of the sentence. **If no destination parameter code is present, then all devices that receive this sentence shall process it.**

Multiple d parameters may be specified, if more than one receiver exists.

NOTE This ~~may~~ can be the case for redundant control functions.

For CRP type sentences, the destination code shall be read and processed to ensure that only the intended recipients take action on the content of the sentence. Other receivers may also read the message, for example for voyage data recording purposes, but shall not take any further action on the contents.

7.2.3.6 Line-count parameter – n

The n parameter code ~~shall~~ may be used to assign a sequence number to each sentence transmitted from a system function block. The format of the parameter value is a positive integer. The value shall start at one ("1") and shall be incremented by one ("1") for each sentence or TAG block transmitted from this system function block. The parameter value shall be reset to one ("1") when it reaches 1 000, i.e., the valid range is 1-999, inclusive.

For function blocks that transmit datagram to more than one transmission group destination, separate line counters shall be maintained for each transmission group (see 6.2.2).

7.2.3.7 Text string parameter – t (proprietary data)

The t parameter code is a free text field. This document reserves coding for proprietary TAG-codes with the fields defined below where the leading p and the three letter manufacturer mnemonic code is required for this type of text string.

t:p<manufacturer mnemonic code in lower case><proprietary data>

An example used for proprietary authentication of lines using grouping and source for manufacturer "mmm" might be

```
\g:1-2-34,s:TI0001,n:333*686B\ $TIROT,123.45*6B67
\g:2-2-34,s:TI0001,n:334,t:pmmma;MD5;0x12345678*0D\
```

7.2.3.8 General authentication – a

(see 8.9.5)

The authentication parameter code is used to sign a message with a password. Just sending a password with the message would reveal the password to anyone listening to the traffic. Sending a signature digest instead keeps the password secret.

Any kind of messages may be signed using the authentication parameter code. The authentication parameter code does not change the original message in any way. It is always possible to ignore this tag and use the rest of the message.

NOTE 1 For example, one can sign configuration commands for devices or commands to the autopilot.

The authentication parameter code provides a standardized mechanism for passing the digest with the message. Password management is outside of the scope of this document. One way is to use pre-shared keys (PSK) on the participating devices.

NOTE 2 The pre-shared key could be 32 alphanumeric characters, for example "Alea iacta est 1234567890".

This parameter code is optional and should only be used where special safety concerns make it useful. If this tag is provided then the manufacturer's documentation shall describe which of the optional types of methods to calculate a signature are supported by the equipment and shall describe how to share keys.

The format of the tag block is:

\a:c-h--h*hh\

In which

c

Type of optional method to calculate signature

1) MD5

P) Proprietary

h-h

Hexadecimal representation of the signature, for example 32 hexacodes for MD5

An example of the tag block is:

\a:1-123456789abcdef67890123456789012*hh\

Types of methods to calculate signature:

1) MD5

The signature is a MD5 digest of the password plus the message. MD5 is a one-way message-digest algorithm (RFC 1321). The full length of the signature is 128 bits or 32 hexadecimal codes. The MD5 is commonly used for storing passwords in Unix-systems. Revealing the digest does not expose the password.

NOTE 3 See <http://tools.ietf.org/html/rfc1321> and <http://en.wikipedia.org/wiki/MD5>.

P) Proprietary

The signature is a proprietary digest of the password plus the message. This alternative requires that both parties use the same manufacturer specified proprietary method.

The authentication parameter code value is calculated by concatenating pre-shared key and all TAG blocks and sentences in the message as a single string to be used by the method of the signature calculation to produce the signature digest. "Carriage returns" and "line feeds" from the sentences are not included into the input string.

When the authentication parameter code "a:" is used, it shall be in its own authentication TAG block, with no other parameter codes. For a grouped message consisting of several lines of TAG blocks and sentences, the authentication TAG block shall be placed on the first line of the group. Within the first line, the authentication TAG block shall be placed as the last TAG block, and before any sentence on that line. This also applies to a single line TAG block and sentence with no grouping.

An example of use of authentication TAG block:

Message consisting of two grouped sentences to be protected by authentication:

\g:1-2-23,s:IN0001*3C\!ABVDM,1,1,1,B,15N1u<PP1cJnFj:GV4>:MOw:0<02,0*2D

\g:2-2-23,s:IN0001*3F\!ABVSI,r3669962,1,013538.05654921,1427,-101,,*20

Pre-shared key to be used for signature calculation:

Alea iacta est 1234567890

Resulting input string for signature calculation:

Alea iacta est 1234567890\g:1-2-23,s:IN0001*3C\!ABVDM,1,1,1,B,15N1u<PP1cJnFj:GV4>:MOw:0<02,0*2D\g:2-2-23,s:IN0001*3F\!ABVSI,r3669962,1,013538.05654921,1427,-101,,*20

Message to be sent including signature, method MD5:

\g:1-2-23,s:IN0001*3C\!a:2-851E40CC1CB7E3B39D961D7CF10BD8D3*44\!ABVDM,1,1,1,B,15N1u<PP1cJnFj:GV4>:MOw:0<02,0*2D

\g:2-2-23,s:IN0001*3F\!ABVSI,r3669962,1,013538.05654921,1427,-101,,*20

Messages without authentication parameter codes are accepted unless the set-up parameters of the receiver are explicitly set to require authentication on incoming packets.

If the device is set to require authentication on incoming packets, then packets without valid authentication shall be dropped.

NOTE 4 SNGF are advised to avoid transmitting passwords in the clear from SPW sentences received over a serial connection.

7.2.4 Requirements for processing incoming datagrams

For datagrams intended for processing by the SF, any syntax error in a TAG block or in a sentence shall make the receiving equipment discard the complete datagram without any other further processing than specified in 7.2.5. The exception is an SNGF which shall retransmit the faulty sentences to the appropriate serial SF, if it can be determined from a valid destination field, or to all connected serial SFs, if no destination field is specified.

7.2.5 Error logging for processing incoming datagrams

(see 8.10)

The equipment shall maintain counts of errors detected in processing datagrams containing IEC 61162-1 sentences ~~or binary images~~. As a minimum, the following errors shall be counted and made available as defined in 4.3.3:

- any TAG block formatting errors as defined in 7.2.3.1;
- TAG checksum error;
- TAG syntax error (line length, use of delimiters, invalid characters);
- TAG framing error (incorrect start or termination of TAG block);
- any sentence syntax errors, including formatting, length or checksum as defined in 7.2.4.

7.3 Binary ~~image~~ file transfer using UDP multicast – Single transmitter, multiple receivers

(see 8.11)

7.3.1 Application of this protocol

This protocol provides a mechanism by which non IEC 61162-1 formatted data, for instance radar images ~~as files~~, can be transmitted to one or more receivers. This protocol supports the transmission of ~~images~~ files from zero bytes up to 4 billion ~~image~~ files blocks.

Equipment using this mechanism shall be able to use one or both of the following ~~two~~ forms of ~~image~~ binary file transfer:

- non re-transmittable transfers where sender sends the complete binary ~~image~~ file without any feed-back from receiver;
- re-transmittable transfers where limited feed-back from one receiver identified by DestID can be used to re-transmit certain parts of the ~~image~~ binary file while other parallel receivers operate as passive receive-only receivers of the binary file.

~~NOTE The two transmission forms use the same protocol. If any party to the transmission does not use the re-transmittable features, the protocol will automatically revert to non re-transmittable transfer mode.~~

NOTE The advantage of non-re-transmittable and re-transmittable binary file transfer methods over the TCP/IP is the possibility of multiple parallel receivers of the same transmission.

Table 7 gives a description of terms used in this application.

Table 7 – Description of terms

Term	Description
DWORD	Double Word. One unsigned 32-bit integer (in range 0 to 4294967295). The DWORD is constructed from four consecutively transmitted BYTE, where the transmission order on the network is most significant BYTE first followed by next most significant BYTE until the least significant BYTE.
Null character	A BYTE with the value zero.
Reserved bytes	A number of bytes in the datagram that may be ignored by the receiver. The reserved bytes may be additional header information that only has meaning for newer versions of the protocol or they may also be used for manufacturer specific purposes.
WORD	One unsigned 16-bit integer (in range 0 to 65535). The WORD is constructed from two consecutively transmitted BYTES, where the transmission order on the network is the most significant BYTE followed by the least significant BYTE.
STRING[n]	A sequence of exactly <i>n</i> BYTE, interpreted as a string of characters. The transmission order on the network is left-most character first. If the string is shorter than <i>n</i> , additional trailing bytes shall be set to null character. All strings in the header are encoded in ISO-18859-1 ISO/IEC 8859-1 (ISO Latin 1).

7.3.2 Binary ~~image~~ file structure

7.3.2.1 General

The binary ~~images~~ files are transmitted over the network in one or more datagrams. The binary ~~image~~ file structure is a sequential and unpadded stream of bytes divided into three main groups: header, binary ~~image~~ file descriptor and binary ~~image~~ file data (see Table 8 and Table 9). The header is needed for synchronisation and data integrity validation. The binary ~~image~~ file descriptor is needed for the description of the binary ~~image~~ file data and is only used in the first datagram for each ~~image~~ binary file transfer.

7.3.2.2 Non re-transmittable and re-transmittable transfers

Table 8 – Binary ~~image~~ file structure

61162-450 header (see 7.3.4)
Binary image file descriptor (only in first datagram) (see 7.3.6)
Binary image file data fragment (see 7.3.7)
61162-450 header (zero or more)
Binary image file data fragment (zero or more)

A minimum binary ~~image~~ file transmission using non re-transmittable or re-transmittable transfer will consist of the three first blocks where the binary ~~image~~ file fragment may have zero length.

The header shall be repeated as the first element of any datagram that contains binary ~~image~~ file data fragments.

7.3.3 61162-450 header

7.3.3.1 Header format

The purpose of the header is to provide the data transfer status to receivers. This allows a receiver to identify if there is any data loss during ~~image~~ binary file transfers, and how much data loss occurs. In addition, the header is used to provide a re-transmission mechanism for re-transmittable ~~image~~ binary file transfer.

The 61162-450 header format is defined in Table 9.

Table 9 – 61162-450 header format

Data item	TYPE	Description
Token	STRING[6]	Identifier as ASCII string with a length of 5 bytes followed by a null character (see 7.1.1).
Version	WORD	Defines the header version. The header version with value 1 2 is defined in this document. Extensions and/or modified versions may update this value.
HeaderLength	WORD	Defines the length of the header in bytes. This is at least the length of the header. Future editions of this document may append additional fields to this header as long as these additional fields are compatible with the definition of the header in this document. Receivers which are not aware of these additional fields shall ignore them.
SrcID	STRING[6]	Define the source system identifier in format "ccxxxx" (see 4.4.2).
DestID	STRING[6]	For re-transmittable, defines the destination system identifier in format "ccxxxx", for example "VR0001" for VDR (see 4.4.2). When Destid = "XXXXXX", then any device can be a there is no assigned destination.
Type	WORD	Identifies the information in the Header.
BlockID	DWORD	Binary image file block identifier. The initial value is randomly generated within a range 0 to ($2^{32} - 1 = 4294967295$) and is incremented by 1 after a whole block is transmitted.
SequenceNum	DWORD	Defines the sequence number of the binary image file block. In ACK, this is used to inform the sender what block was last received.
MaxSequence	DWORD	The number of datagrams needed for the transmission of this image binary file data block. When SequenceNum is equal to MaxSequence, it means that this datagram is the last datagram of the data block. The Maxseq is used only for DATA type message. For other messages (QUERY,ACK), this field shall be 0.
Device	BYTE	Data source (device) as binary value, 1 => equipment 1, 2 => equipment 2, etc. The value can be between 1 and 255
Channel	BYTE	Subdivision according to data source (device), values from 1 to 255, default = 1

The Device and Channel fields are defined by the application and may be used by receivers to determine how to process the binary file data.

7.3.3.2 Use of header token

Header token is used to identify both the type of data block and transfer mode ~~but shall~~ not be used to accept or reject transmissions. Two tokens are defined in 7.1.1:

- "RaUDP" – Simple binary ~~image~~ file transfer service with UDP Multicast;
- "RrUDP" – Re-transmittable binary ~~image~~ file transfer service with UDP Multicast.

7.3.3.3 Version

Defines the header version. It shall be set to ~~one~~ 2 for this document.

7.3.3.4 Source and Destination identifier

For transmissions to one specific receiver, the field shall contain the destination SFI. The field shall be "XXXXXX" ~~otherwise~~ for no specific destination.

7.3.3.5 Message type

Message type gives the information about which information is contained in the datagram:

- DATA (0x01) – This type is used for transmission of binary ~~image~~ file data including ~~image~~ file descriptor.
- QUERY (0x02) – This type is used by the sender to query the reception status from the receiver. The length of this message payload is always zero (0). It is recommended that ~~an image~~ a binary file sender sends a QUERY message if there is no ACK message for 1 s after a last datagram of the ~~image~~ binary file block is sent or after a QUERY message is sent.
- ACK (0x03) – This message is used as an acknowledgement from the receiver. This message is transmitted by the receiver either when a whole binary ~~image~~ file is received without any error or when errors occurred during the binary ~~image~~ file reception, for example one sequence number is skipped. Also, when a receiver receives a QUERY message from the sender, it also responds with an ACK message.

Non re-transmittable transfer makes use of only DATA message but re-transmittable transfer uses all messages.

7.3.3.6 ~~Image~~ Binary file block identifier

Block identifier is used to identify each ~~image~~ binary file block. Since ~~an image~~ a binary file block is fragmented into several datagrams, the block identifier is used to assemble one or more datagrams into ~~an image~~ a binary file block in a receiver.

7.3.3.7 Sequence number and maximum sequence number

Sequence number (SequenceNum) and maximum sequence number (MaxSequence) is used for segmentation and re-assembly purposes. When a receiver gets a datagram, it checks the sequence number and maximum sequence number to determine if any errors have occurred or if it has received a whole message.

The sequence number is also used in ACK messages. In ACK messages, the sequence number identifies the last message the receiver receives without any error. The maximum sequence number is not used for control (Query) messages.

7.3.3.8 Identification of separate binary file transfer

Each single binary file transfer shall be identified by a unique combination of SrcID, Device, Channel and BlockID (see Table 9).

NOTE If a single SrcID has multiple needs to send binary files (e.g. ECDIS sending screen image, chart source information and route exchange), then each single binary file transfer is identified, for example: ECDIS number 1 send screen image as Device = 1 and Channel = 1, and Chart source information as Device = 1 and Channel = 2.

7.3.4 Binary ~~image~~ file descriptor structure

The binary ~~image~~ file descriptor format is defined in Table 10.

Table 10 – Binary ~~image~~ file descriptor format

Data item	TYPE	Description
Length	DWORD	Defines the binary image file descriptor length in bytes. This is at least the length of the header as defined in this clause including the reserved bytes. Future editions of this document may append additional fields to this file descriptor as long as these additional fields are compatible with the definition of the file descriptor in this document. Receivers which are not aware of these additional fields shall ignore them.
image fileLength	DWORD	Defines the length of the full image binary file content in bytes, excluding headers and descriptor.
Status of acquisition	WORD	The status for the data return. A zero is returned for normal operation. Non-zero value is used to indicate an error condition. A descriptive text may be put in the status and information text field.
Device	BYTE	Data source (device) as binary value, 1 => equipment 1, 2 => equipment 2, etc. The value can be between 1 and 255
Channel	BYTE	Subdivision according to data source (device), values from 1 to 255, default = 1
AckDestPort	WORD	Port number to be used to acknowledge. Allowed port numbers are within the range from 60006, 60008 to 60016, 60021 to 60030 (see 7.3.8.9).
TypeLength	BYTE	The length of the DataType field.
DataType	STRING[n]	This string defines the data block encoding by assigning a MIME content type to the data block for the server followed by null character. For example, "image/jpeg" is used for JPEG image type. The image quality shall comply with the image test of IEC 61996-1
StatusLength	WORD	The length of the "Status and information text" field in bytes.
Status and information text	STRING[n]	Status information (e.g. successful operation or error codes). This may be one or more strings, each terminated by a binary null
NOTE 1 There is no error check for the binary image file header contents as this is handled by the UDP layer. In this document, UDP header checksum is mandatory.		
NOTE 2 MIME is Multipart Internet Mail Extensions. The MIME content type was originally used for email services but is widely used for many other applications including Web. Also, it has flexibility to support new media types. The specification of the MIME content type and registration is defined in ISOC RFC 4288 and ISOC RFC 4289.		

~~The Device and Channel fields are defined by the application and may be used by receivers to determine how to process the image data.~~

DataType shall be encoded by the MIME content-type which is "type/sub-type", and is defined by IANA. Table 11 illustrates some examples of MIME content type for ~~image~~ binary file and compressed data. More updated information is available on the IANA web site, <http://www.iana.org/assignments/media-types/>.

Table 11 – Examples of MIME content type for DataType codes

Content type	File extension	MIME type/sub-type
GIF	gif	image/gif
Microsoft Windows bitmap	bmp	image/x-ms-bmp
Gnu tar format	gtar	application/x-gtar
4.3BSD tar format	tar	application/x-tar
DOS/PC – Pkzipped archive	zip	application/zip
XML	xml	application/xml

7.3.5 Binary ~~image~~ file data fragment

The package data format is defined in Table 12.

Table 12 – Binary ~~image~~ file data fragment format

Data item	TYPE	Description
Datablock	BYTE[datalength]	This item is the data either split into pieces or in one block.

The length of the ~~image~~ binary file fragment is the length of the UDP datagram (as obtained from the UDP header) minus any headers that are inserted in front of the ~~image~~ binary file fragment. All datagrams, except the first datagram of the ~~image~~ binary file which requires two headers (Header + ~~Image~~ binary File Descriptor), carry only one header (Header).

The ~~image~~ binary file fragment length is allowed to be zero for one or more datagrams.

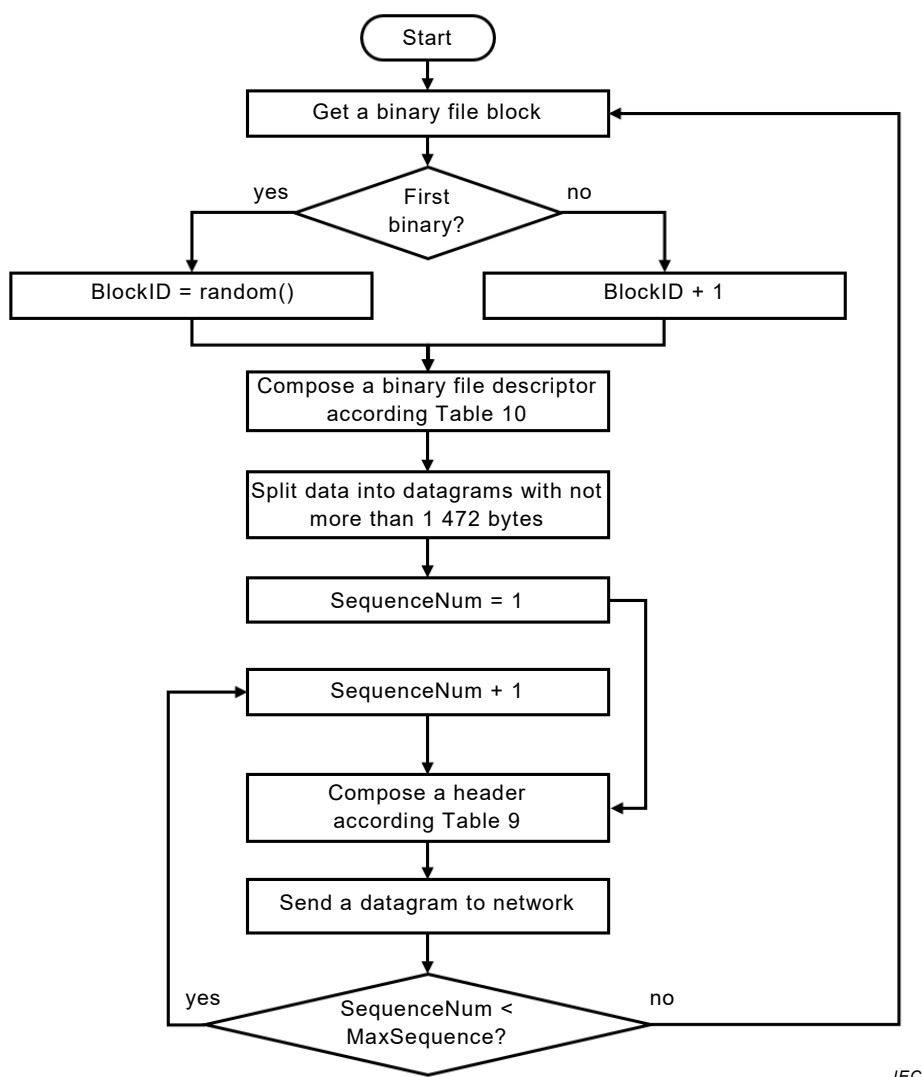
NOTE There is no error check for the data contents as this is handled by the UDP layer.

7.3.6 Sender process for binary ~~image~~ file transfer

7.3.6.1 Non re-transmittable sender process

The following steps are performed for the basic sending process (see Figure 3):

- a sender process waits until it gets ~~an image~~ a binary file block ~~including image descriptor~~;
- a block identifier is assigned for the ~~image~~ binary file block (if this is the first ~~image~~ binary file, then it is assigned randomly; otherwise, the instance identifier of the previous ~~image~~ binary file block + 1 is used). The BlockID shall be unique for each binary file transfer from the same SrcID, Device and Channel combination;
- a binary file descriptor is composed according to Table 10;
- ~~an image~~ a binary file block is split into datagrams whose size is ~~less~~ not more than 1 472 bytes and each datagram is put into the sending buffer;
- get the first datagram of the ~~image~~ binary file block;
- assign a sequence number, which is assigned ~~by zero to one~~ initially ~~and incremented by one~~;
- compose a header including token, source id, destination id and maximum sequence number according Table 9;
- send a datagram to the network;
- if all datagrams of the ~~image~~ binary file block are not transmitted, get the next datagram and go to step f);
- otherwise, then go to step a).



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Figure 3 – Non re-transmittable sender process

7.3.6.2 Re-transmittable sender process

The sender processing steps for re-transmittable binary ~~image~~ file transfer is as follows (see Figure 4):

- a) a sender process waits until it gets ~~an image~~ a binary file block ~~including image descriptor~~;
- b) a block identifier (BlockID) is assigned for the ~~image~~ binary file block (if this is the first ~~image~~ binary file, then it is assigned randomly; otherwise, the block identifier of the previous ~~image~~ binary file block + 1 is used). The BlockID shall be unique for each binary file transfer from the same SrcID;
- c) a binary file descriptor is composed according to Table 10;
- d) set re-transmission counter to zero(0), set query counter to zero(0), set query sequence number to 1, set final counter to zero(0);
- e) ~~an image~~ a binary file block is split into datagrams whose size is less than 1 472 bytes and each datagram is put into the sending buffer;
- f) get the first datagram of the ~~image block~~ binary file;
- g) assign a sequence number, which is ~~assigned by zero~~ set to one initially ~~and incremented by one~~;

- h) compose a header ~~including token, source id, destination id and maximum sequence number~~ according Table 9;
- i) send a datagram to the network and set an ACK timer;
- ~~i) if the sender receives an ACK message, whose sequence number is less than the maximum sequence number,~~
- ~~• get a datagram whose sequence number is sequence number in ACK message plus one,~~
 - ~~• increase re-transmission count by one,~~
 - ~~• go to Step (e);~~
- ~~j) if all datagram of the image block is not transmitted,~~
- ~~• get a next datagram,~~
 - ~~• go to Step (e);~~
- ~~k) otherwise,~~
- ~~• set a ACK timer,~~
 - ~~• wait for an ACK message;~~
- ~~l) if the sender receives an ACK message whose sequence number is equal to the maximum sequence number, then go to Step (a);~~
- ~~m) if the sender receives an ACK message whose sequence number is less than the maximum sequence number, then go to Step (h);~~
- ~~n) if ACK Timer expires and re-transmission counter is less than three, then,~~
- ~~• increase the re-transmission counter,~~
 - ~~• go to Step (j);~~
- ~~o) if ACK Timer expires and re-transmission counter is equal to three, then,~~
- ~~• clear the sending buffer,~~
 - ~~• go to Step (a);~~
- j) if the sender receives an ACK message, whose DestID is not equal to own SFI and whose SourceID is not equal to own actual DestID, go to step k);
- 1) if the sequence number of ACK message is less than the maximum sequence number and lower than the sequence number of the last transmitted datagram, increase re-transmission count by one;
 - 2) if re-transmission count is greater than the maximum number of retransmissions (see 7.3.8.7), go to step k);
 - 3) if sequence number in ACK message is identical to query sequence number, increase query counter with 1, and if query counter is more than 3, set query counter to zero (0) and go to k);
 - 4) if sequence number in ACK message is not identical to query sequence number, set query counter to 1;
 - 5) get a datagram whose sequence number is sequence number in ACK message plus one;
 - 6) set query sequence number to sequence number;
 - 7) go to step h);
- k) if all datagrams of the binary file block have not been transmitted,
- 1) get a next datagram and increase sequence number by one,
 - 2) go to step h);
- l) otherwise, wait for an ACK message;
- m) if the sender receives an ACK message whose DestID is not equal to own SFI and whose SourceID is not equal to own actual DestID , then go to step (n);

- [illegible]

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7.3.7 Receiver process for binary ~~image~~ file transfer

7.3.7.1 Non re-transmittable receiver process

The receiver process steps of the non re-transmittable binary ~~image~~ file transfer, including passive receivers of a re-transmittable binary file transfer, is as follows:

- a) waits for receiving new datagram;
- b) if the BlockID of the received datagram for same source identified by the combination of SrcID, Device and Channel is not equal to that of the previous datagram,
 - if there is any data in the receiver buffer, it is delivered to the SF,
 - the receiver buffer is cleared;
- c) put a datagram into the receiver buffer;
- d) if the sequence number is the same as the maximum sequence number,
 - the all data in the received buffer is delivered to the SF,
 - the receiver buffer is cleared;
- e) go to step a).

7.3.7.2 Re-transmittable receiver process

The re-transmittable receiver process steps are performed only by the receiver whose identifier SFI is same as the DestID in the Header as follows (see Figure 5):

- a) waits for receiving a new datagram;
- b) if the token is not "RrUdP" or if DestID of received datagram is not equal to own SFI, go to step a);
- c) if the received datagram is a QUERY message, then,
 - 1) if no previous datagram is available, go to step a),
 - 2) if the sequence number of the previous datagram is not equal to maximum sequence number, go to step a),
 - 3) if all sequences flag is false (not all sequences of the previous binary block are received), go to step a),
 - 4) compose a Header with type = ACK, the BlockID and sequence number of the previous datagram,
 - 5) send an acknowledge datagram to the sender,
 - 6) go to step a);
- ~~c) if the block identifier of the received datagram is not equal to that of the previous datagram,~~
 - ~~• if there is any data in the receiver buffer, it is delivered to the SF,~~
 - ~~• the receiver buffer is cleared;~~
- ~~d) if the sequence number is not same as the sequence number of the previous datagram plus one, then,~~
 - ~~• compose a Header with the block identifier and sequence number of the previous datagram,~~
 - ~~• send a datagram to the sender,~~
 - ~~• go to Step (a);~~
- d) if the sequence number is 1,
 - 1) analyse file image descriptor and header,
 - 2) if file image descriptor or header or token is invalid, go to step a),

- 3) set re-transmission counter and query counter to zero (0), set query sequence number to 1, set all sequences flag to true,
- 4) go to step g);
- e) if no previous datagram is available, go to step g);
- f) if the BlockID of the received datagram for same source identified by the combination of SrcID, Device and Channel is not equal to that of the previous datagram,
 - 1) if there is any data in the receiver buffer, it is delivered to the SF,
 - 2) the receiver buffer is cleared;
- g) if the sequence number is not 1 and not the same as the sequence number of the previous datagram plus one,
 - 1) increase re-transmission count by one,
 - 2) if re-transmission count is greater than the maximum number of retransmissions (see 7.3.8.7), set all sequences flag to false and go to step (a),
 - 3) if previous sequence number is identical to query sequence number increase query counter with 1,
 - 4) if query counter is more than 3 set query counter to zero (0),
 - 5) set all sequences flag to false and go to step (a),
 - 6) if previous sequence number is not identical to query sequence number, set query counter to 1,
 - 7) set query sequence number to previous sequence number,
 - 8) compose a Header with type = ACK, the block identifier and sequence number of the previous datagram,
 - 9) send an acknowledge datagram to the sender,
 - 10) go to step (a);
- h) put a datagram into the receiver buffer;
- i) if the sequence number is same as the maximum sequence number,
 - 1) all the data in the receive buffer is delivered to the SF,
 - 2) the receiver buffer is cleared,
 - 3) the re-transmission count is set to zero (0);
- j) if all sequences flag are true,
 - 1) compose a Header with type = ACK, the block identifier and maximum sequence number,
 - 2) send an acknowledge datagram to the sender;
- k) go to step a).

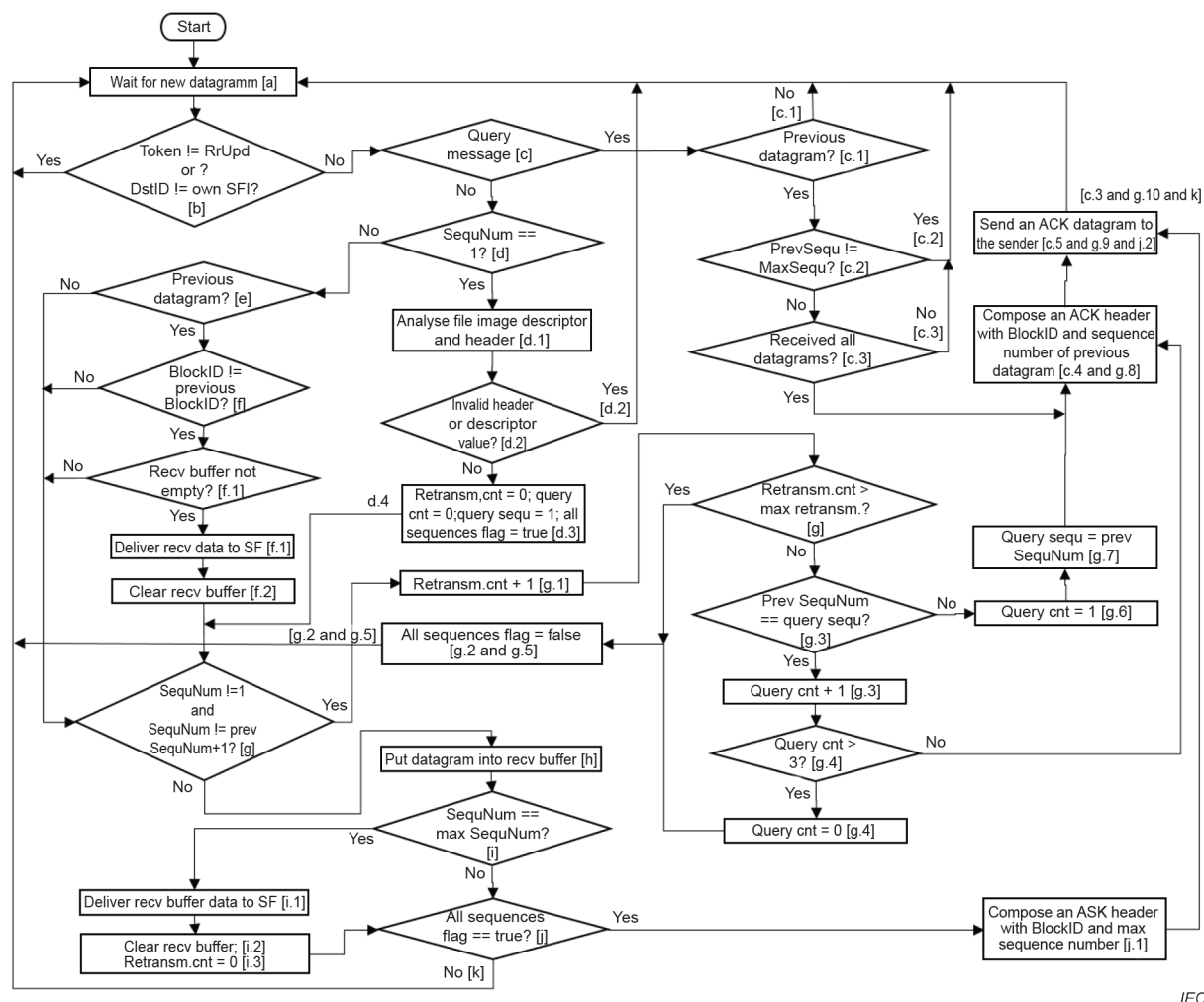


Figure 5 – Re-transmittable receive process

7.3.8 Other requirements

7.3.8.1 Re-transmittable messages that cannot be processed

Both receiver and sender shall silently ignore messages that are related to the retransmit process that they cannot process themselves.

7.3.8.2 Multiple binary-image file blocks

A receiver that receives a binary-image file block more than once shall ignore all but one of the transmissions.

NOTE It is allowed both to ignore the first (overwrite buffer) or the last (ignore).

7.3.8.3 Retransmissions size

If a sender retransmits one or more binary-image file blocks, each of the blocks shall have the same size and same header information.

7.3.8.4 Maximum outgoing rate

The data volume for each binary-image file source shall not exceed 2 MBytes per second.

NOTE This provision is included to guarantee spare network capacity for other transmissions in between the blocks of a large binary ~~image~~ file. When the ~~image~~ binary file is transmitted as multicast, it will flood the network and can inhibit transmissions of other data.

7.3.8.5 End of transmission for non re-transmittable and re-transmittable binary file transfer

The receiver shall assume that a transmission has ended unsuccessfully when it gets a binary ~~image~~ file block from the same source identified by the combination of SrcID, Device and Channel (see Table 9 and Table 10) with a new BlockID. Then the receiver stops the current receiving process and becomes ready for the new ~~image~~ binary file block ~~receiving being received~~. The transmission shall also be considered finished when the last block is signalled by the SequenceNum from the sender. When a re-transmittable receiver identified by the DestID gets the last block after successful reception of all previous blocks, then it sends an ACK message to the sender to indicate successful transfer and so as to start new ~~image~~ binary file block transmission. The receiver of non-re-transmittable binary file transfer and a receiver of re-transmittable binary file transfer not identified by DestID shall not send ACK message to the sender.

~~The sender shall assume that a transmission has ended unsuccessfully when it requires more than three re-transmissions of the binary image blocks including control messages.~~ The re-transmittable sender assumes that the transmission is successfully finished only if it receives an ACK message with the SequenceNum which is equal to the MaxSequence; otherwise, a transmission has ended unsuccessfully. When a transmission is ended, a sender starts a new transmission if necessary.

7.3.8.6 Gaps between ACK messages for re-transmittable binary file transfer

In general, a receiver shall, immediately after loss detection, transmit an ACK message to the sender if a binary ~~image~~ file block has been lost ~~either~~ by having a gap in sequence numbers ~~or by finding errors in the block~~. Since there is a time delay between the reception of the ACK message and re-transmission of lost data at the sender, a receiver waits for the sender's response. For this purpose, a receiver should wait at least 200 ms before it sends another ACK message for the following datagrams. However, when a receiver receives all messages correctly, it shall send an ACK message immediately to the sender.

NOTE ACK message is used both for positive and negative acknowledge. See 7.3.3.5 for the description of the ACK message.

7.3.8.7 Maximum retransmissions for re-transmittable binary file transfer

~~The maximum number of re-transmissions is limited for three times. If an image block requires more than three times re-transmission, the sender stops the transmission and starts a new image block transmission.~~

The sender shall not retransmit the same datagram identified by sequence number of a binary file more than three times. After three retransmissions, the sender shall ignore any additional retransmission requests for this datagram identified by sequence number and continue transmitting the next datagram identified by sequence number. The receiver shall not query the same datagram identified by sequence number of a binary file more than three times.

The maximum number of re-transmission requests for a binary file shall be limited to 10 % of the maximum sequence number for the binary file but shall be not lower than three times. If the sender of a binary file receives more re-transmission queries than the maximum number, it shall ignore all further retransmission queries and continue to transmit the binary file until the last datagram identified by sequence number. In the case the receiver did not successfully receive all datagrams identified by sequence numbers of binary file, the receiver shall not acknowledge the last received datagram identified by sequence number with sequence number equal to maximum sequence number. The receiver shall not query datagrams in the same binary file more than the maximum number of retransmissions.

In addition to data message re-transmission, control (**Query**) messages can be re-transmitted in case the control message is lost. The re-transmission counter increases whenever the control message is transmitted.

7.3.8.8 Timer management for re-transmittable binary file transfer

The re-transmission timer is managed at the sender. A sender sets the re-transmission timer when either a whole ~~image~~ **binary file** block is transmitted and waits for an ACK message, or a control message (QUERY) message is transmitted. When the re-transmission timer expires, the sender (re-) transmits a QUERY message and sets the timer again unless the re-transmission counter reaches three.

7.3.8.9 UDP port and IP addresses for non re-transmittable and re-transmittable binary file transfer

Multicast addresses and ports for the service type are given in Table 5. As a default, addresses for ~~simple non re-transmittable~~ and re-transmittable ~~image~~ **binary file** transfer service shall be 239.192.0.21 and 239.192.0.26 respectively. As a default, the port for ~~simple non re-transmittable~~ and re-transmittable **binary file** transfer shall be 60021 and 60026 respectively.

The receiver shall reply with ACK to the sender using the incoming datagram's AckDestPort and multicast address corresponding to this port number.

NOTE—The radar should support configuration of the VDR port number and IP address.

7.3.9 Error logging

Equipment shall maintain a count of the events of invalid binary ~~image~~ **file** structures processed and make the count available. As a minimum, the following events shall be logged:

- the number of ~~image~~ **binary file** blocks where errors occur;
- missing datagrams;
- unrecognized header.

7.4 General IEC 61162-3 PGN message transmissions

(see 8.12)

7.4.1 Message structure

The message structure for transporting IEC 61162-3 PGN messages into IEC 61162-450 networks is illustrated in Table 13.

Table 13 – Structure for PGN message

Header (see Table 9)
PGN message descriptor
IEC 61162-3 message fragment
IEC 61162-3 message fragment (zero or more)

The maximum message size of the PGN is 1 785 bytes. The PGN message shall be transmitted using one or two IEC 61162-450 datagrams. When there is a missing datagram, then the PGN message will be ignored as an error since the re-transmission of the lost datagram is not required.

7.4.2 Message format

The message format for transporting IEC 61162-3 PGN messages into IEC 61162-450 networks is illustrated in Table 14. The PGN message descriptor length for PGN messages is 32 bytes.

Table 14 – PGN message descriptor

Field Name	Size	Description
Source NAME (SNAME)	8 bytes of characters	Name of source. NAME shall be compliant with IEC 61162-3.
Source Device Identifier (SDID) ^a	2 byte of numeric number	Address of source device which is compliant with IEC 61162-3.
Destination NAME (DNAME)	8 bytes of characters	Name of destination. NAME shall be compliant with IEC 61162-3.
Destination Device Identifier (DDID) ^a	2 byte of numeric number	Address of destination device which is compliant with IEC 61162-3.
PGN number	4 byte of numeric number	PGN number of IEC 61162-3.
Priority	1 byte of numeric number	Priority of IEC 61162-3. Bit 0-2 are used and Bit 3 to Bit 7 are reserved.
Reserved (REVD)	7 bytes	Reserved bytes.
^a Two bytes are specified to allow for future expansion.		

7.4.3 Address translation requirements

7.4.3.1 PGN group identification

A PGN group is defined as a logical group of devices that can share the information and message. Each PNGF shall be assigned a PGN group to communicate with devices in the group. The device address in a PGN group shall be unique in the network.

A PNGF may be registered with more than one PGN group if some of devices are required to communicate with devices in different PGN groups.

Means shall be provided to configure PGN groups at each PNGF.

7.4.3.2 Device identification

The PNGF shall represent all IEC 61162-3 equipment which are uniquely identified in the network.

A virtual device in an IEC 61162-3 network is identified by the source address. Each virtual device shall be identified by SFI of PNGF where it is connected, its PGN group number, its IEC 61162-3 source address and NAME. When there is no address available, then the address cannot be mapped until a new address is available. When a new address is not available, this event shall be recorded as specified in 4.3.3.

7.4.3.3 Address resolution

When a PNGF receives a query (i.e. Address Claim Message) about the device address with NAME and it has the information about the device, it shall respond with the address without forwarding the message to the IEC 61162-3 network.