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Navigations- und Funkkommunikationsgeräte und -systeme für die Seeschifffahrt –**Digitale Schnittstellen –****Teil 402: Mehrere Datensender und mehrere Datenempfänger –****Schiffssystemzusammenschaltung – Dokumentation und****Prüfanforderungen (IEC 61162-402:2005);****Deutsche Fassung EN 61162-402:2005, Text Englisch**

Maritime navigation and radiocommunication equipment and systems –

Digital interfaces –

Part 402: Multiple talkers and multiple listeners – Ship systems interconnection –

Documentation and test requirements (IEC 61162-402:2005);

German version EN 61162-402:2005, text in English

Matériels et systèmes de navigation et de radiocommunication maritimes –

Interfaces numériques –

Partie 402: Émetteurs et récepteurs multiples – Interconnexion des systèmes maritimes –

Documentation et exigences d'essai (CEI 61162-402:2005);

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Nationales Vorwort

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Für die vorliegende Norm ist das nationale Arbeitsgremium K 738 „Elektronische Navigationsinstrumente“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE zuständig.

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Navigations- und Funkkommunikationsgeräte und -systeme für die
Seeschifffahrt – Digitale Schnittstellen
Teil 402: Mehrere Datensender und mehrere Datenempfänger
Schiffssystemzusammenschaltung – Dokumentation und Prüfanforderungen
(IEC 61162-402:2005)

Maritime navigation and radiocommunication
equipment and systems – Digital interfaces
Part 402: Multiple talkers and multiple listeners
Ship systems interconnection – Documentation
and test requirements
(IEC 61162-402:2005)

Matériels et systèmes de navigation et de
radiocommunication maritimes – Interfaces
numériques
Partie 402: Émetteurs et récepteurs multiples
Interconnexion des systèmes maritimes –
Documentation et exigences d'essai
(CEI 61162-402:2005)

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CENELEC

Europäisches Komitee für Elektrotechnische Normung
European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique

Zentralsekretariat: Rue de Stassart 35, B-1050 Brüssel

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Vorwort

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Anerkennungsnotiz

Der Text der Internationalen Norm IEC 61162-402:2005 wurde von CENELEC ohne irgendeine Abänderung als Europäische Norm angenommen.

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MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DIGITAL INTERFACES –

Part 402: Multiple talkers and multiple listeners – Ship systems interconnection – Documentation and test requirements

1 Scope

1.1 General

This standard series, IEC 61162-400 and upwards, specifies a communication protocol for use in integrated ship systems. It also specifies an interface description language for use together with the protocol, a set of rules for the use of this language and a set of standard interfaces described in the language.

This part of the standard specifies a minimum set of tests to be done, test results to be achieved and documents that shall be available for all implementations of general protocol software and applications that are compliant with the IEC 61162-4 standard. Although this set of standard documents is collectively referred to as IEC 61162-4, the actual part numbers are in the 400-series (see 1.4 of IEC 61162-400).

1.2 Limitations in scope

The tests and documentation requirements do not cover electrical, physical or environmental requirements that may apply to the use of software or computers onboard ships. Such requirements may be covered by IEC 60945 or IEC 60092-504. Other standards may also be applicable.

This standard does not necessarily cover all requirements from classification societies or other authorities. It is the responsibility of the user of this standard to ensure that all appropriate regulations are addressed.

This standard contains tests to check that an application using the IEC 61162-4 protocol adheres to its advertised interface specification. These tests cannot guarantee the correct functionality of that application beyond the possibility of connecting it to the network and with a limited degree of accuracy in the messages transferred.

This standard does not cover the system in which the IEC 61162-4 communication standard is used. Additional requirements will normally apply to the total system configuration.

Fundamental requirements relating to ensuring reliable and timely transfer of data across data communication links are included in other standards associated with the integration of equipment such as IEC 60092-504 and IEC 61209. This standard does not contain tests to verify compliance with these requirements. In addition, specific equipment related standards may also contain requirements for correctness and timeliness of data transmissions. Neither does this standard contain any tests to verify such requirements. Thus, results from tests carried out in accordance with this standard cannot be used to demonstrate compliance with the requirements of any other standards for system or equipment functionality.

1.3 Limitations in test coverage

The test plan only specifies general tests of the protocols and a limited set of other general properties (black box tests). The test procedures will not generally cover tests of operating systems, communication libraries or other software components that are used to implement the standard. Neither does this standard specify any tests related to the way the system is implemented (white or glass box testing).

1.4 Limitations in degree of detail

The test procedures are general in nature and do not generally specify detailed test programs and procedures. The procedures specify a minimum set of functional aspects that need to be tested, with, in some cases, a minimum required set of excitations and corresponding required responses. The testers must develop the detailed procedures and test tools themselves.

2 Normative references

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

IEC 60092-504, *Electrical Installations in ships – Special features – Control and instrumentation*

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

IEC 61162-4, (shorthand for all parts in the IEC 61162-400 series), *Maritime navigation and radio-communication equipment and systems – Digital interfaces – Part 4xx: Multiple talkers and multiple listeners – Ship systems interconnection*

IEC 61162-400, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 400: Multiple talkers and multiple listeners – Ship systems interconnection – Introduction and general principles*

IEC 61162-401, *Multiple talkers and multiple listeners – Ship systems interconnection – Application profile*

IEC 61162-410, *Multiple talkers and multiple listeners – Ship systems interconnection – Transport profile requirements and basic transport profile*

IEC 61162-420, *Multiple talkers and multiple listeners – Ship systems interconnection – Companion standard requirements and basic companion standards*

IEC 61209, *Maritime navigation and radiocommunication equipment and systems – Integrated Bridge Systems (IBS) – Operational and performance requirements, methods of testing and required test results*

IEC 61508-3, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements.*

IEC 61508-4, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 4: Definitions and abbreviations*

ISO 9001: 2000, *Quality management systems – Requirements.*

ISO/IEC 90003: 2004, *Software engineering – Guidelines for the application of ISO 9001: 2000 to computer software.*

3 Definitions

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

3.1

black-box testing

testing that ignores the internal workings and internal structure of a component and focuses on the responses generated as a result of controlled stimuli and execution conditions. Typically used to evaluate the compliance of a component with specified functional requirements. See also *white-box testing*

3.2

defect

latent faults in a component ("bug" in software), that either represent or can cause an error and by that a failure

3.3

error

that part of the system state that is liable to lead to a failure (IEC 61508-4) IEC 61508-4 does not classify a software defect as an error, but as a fault. In this standard, the term defect will be used to mean also software defects. The term fault will not be used.

3.4

fault

see error and defect

3.5

failure

occurs when a delivered service deviates from the intended service. It is the effect of an *error* on the service (IEC 61508-4)

3.6

memory leak

situation where a program is not able to reclaim dynamically allocated memory that should be released as a result of the removal of an internal object. It typically occurs during sequences of connect and disconnect

3.7

safety integrity level

discrete level (one out of a possible four) where safety integrity level 4 has the highest level of safety integrity and safety integrity level 1 has the lowest. Safety integrity is the probability of a safety-related system satisfactorily performing the required safety functions under all the stated conditions within a stated period of time (see IEC 61508-4).

3.8

white-box testing

testing that uses knowledge of the internal structure and internal workings of a component to exercise, for example selected internal execution paths or sub-component interactions in the component. See also *black-box testing*.

4 Overview and basic principles

4.1 Introduction

This part of IEC 61162 covers test and documentation requirements. Proper testing, based on a test plan, and the availability of documentation are factors that are important in ensuring the correctness of a protocol or application software module. This document specifies general requirements to testing and documentation for both protocol and application modules. This document only specifies the tests that have to be made and the required test results. It does not specify the tools or mechanisms that are used to perform the test. This is the responsibility of the tester.

Documentation requirements are more specific and define the minimum requirements for documentation that follows protocol or application modules. The user should take care to supplement the minimum requirements with whatever extra documentation that it is felt to be necessary to use the module in question. Of particular importance is software documentation in the case where there is the possibility to modify the module.

Annexes summarise the test requirements in a form that can be used as a test log.

4.2 Purpose of this standard

This standard shall help to ensure that important aspects of an implementation of IEC 61162-4 basic software does what it is supposed to do and that it does not contain any hidden defects. This standard can also be used to ensure that an application using the IEC 61162-4 standard actually implements the interface to the network that it advertises through its specification or companion standard document.

This standard shall also define a minimum set of documents that shall follow the application or be available from the developer of the application or communication software. These documents will partly specify interface and functionality attributes as well as act as part proof of the implementation's adherence to the IEC 61162-4 specification.

With these two goals in mind, this standard covers part of the verification and validation process that is necessary to produce safe integrated ship systems. The main emphasis is, however, on verification.

4.3 Use in the different stages of a development process

The stages of a development process are dependent on the process being used and how that process is implemented. However, the stages on a high level can be characterised as belonging to the specification, design, implementation and integration phases. The following clauses will, [with the basis] in these phases, specify where this standard can be applied and which other standards can be used.

This standard does not address the software development- and lifecycle as such. However, this standard requires that any software produced to comply with IEC 61162-4, as a minimum is developed to the ISO 9001 standard and implements the relevant part of this standard as specified in ISO/IEC 90003, for the software product, or to equivalent standards.

4.3.1 Specification

The specification of an IEC 61162-4 module is contained in IEC 61162-400, IEC 61162-401 and IEC 61162-410. The interface between applications and the IEC 61162-4 network shall be specified through companion standard documents as prescribed in IEC 61162-420.

4.3.2 Design

IEC 61162-400, IEC 61162-401 and IEC 61162-410 contain parts of the design specification in the form of ER-diagrams, message sequence charts, state diagrams and basic modularisation. Additional design documents are, however, necessary for the coding of an IEC 61162-4 implementation. This standard does not prescribe particular methods or tests for the preparation of design documents.

The IEC 61508-3 standard may be appropriate for certain types of system that need a high safety integrity level. The standard will, in any case, contain guidelines that can be used in the design phase.

4.3.3 Implementation

No part of this standard prescribes any particular principle that shall be used during implementation of IEC 61162-4 compliant devices.

IEC 61508-3 may be appropriate for certain types of system that need a high safety integrity level. The standard will in any case contain guidelines that can be used in the implementation phase.

4.3.4 Integration

This part of IEC 61162 describes a set of functional tests that shall be performed on a finished IEC 61162-4 module or application. Some of these tests are appropriate as pre-integration tests and can also be helpful in pinpointing particular problems in the implementation. Notes in the standard will give information to that effect, where appropriate.

IEC 61508-3 may be appropriate for certain types of systems that need a high safety integrity level. This standard will in any case contain guidelines that can be used in the integration phase.

IEC 61209 also contains requirements that are appropriate for certain types of systems, in particular integrated bridge systems.

4.3.5 Verification

This standard covers functional tests (black-box tests) that shall be used to verify that a module, or an implementation thereof, using the IEC 61162-4 protocol, satisfies certain functional requirements that are inherent in the test section of this part of the standard. This standard is mainly intended for the use in the verification phase.

4.4 Structure of this standard

This clause specifies general requirements of the development process. Clause 5 identifies the critical functionality in the IEC 61162-4 protocol and relevant test scenarios. Clause 6 defines test tools and test scenarios. Clause 7 contains test plans for general protocol modules. Clause 8 contains test plans for application modules. Clause 9 contains documentation requirements. Annexes contain summary tables that can be used as basis for the creation of test and documentation logs and check lists.

5 Critical functionality in the protocol

This clause analyses the typical IEC 61162-4 functionality and system architecture and defines the most important test scenarios. The purpose of this clause is to describe the rationale behind the selection of test cases and also to be a basis for the creation of more extensive and voluntary tests when these are desired by the implementers or users.

5.1 Function groups

An implementation of the IEC 61162-4 protocol standard will typically have to handle a set of different functions where an error in any or each can cause failure. The most important functions are listed in the following clauses.

5.1.1 MAU management

A MAU and an LNA must be able to co-operate to establish a MAU-LNA session and provide, for example MAU name services and MAU watchdog functions. The typical stages in MAU management are:

- a) Accept a connection attempt from a MAU and register that MAU as existing in the system. This includes checks for duplicate MAU names and the two connection sequences that need to be considered: 1) LNA starts before MAU. 2) MAU starts before LNA.
- b) Make the new MAU name and status available in the network. Respond to messages about other MAUs by providing additional information, for example about duplicate names.
- c) Provide the optional watchdog function and, if necessary, let the LNA kill the MAU when the watchdog fails.
- d) From the LNA, handle the death of a MAU correctly, i.e. clean up internal state and report death to the system.
- e) From the MAU, handle the death of the LNA correctly, i.e. clean up internal state and start reconnection attempts if appropriate. This also applies to the closing down of the MAU-LNA link from the LNA.
- f) Handle the reconnect of a previously dead MAU or LNA correctly.

5.1.2 Interface and session management

MAUs connect to each other through interfaces. The system must be able to handle the establishment and disruption of such connections as prescribed in the A-profile. The system must also be able to handle session management, i.e. identification of parties in an exchange of messages and flow control. The cases that need to be considered are enumerated below:

- a) A server MAU exports an interface for use by clients. Note that there is a time difference between the establishment of the server MAU session and the export of the interface and that this must be handled by the LNA when remote clients attempt to connect.
- b) A client MAU connects to the interface.

Note that steps a) and b) may be executed in the opposite order.

- c) The server LNA shall check the connect message and, if appropriate, send a connection request to the server MAU. Checks shall be made that the client is allowed to connect and that the client's request is a true sub-set of the servers advertised interface.
- d) If the connection attempt is accepted by both server components, i.e. the LNA and MAU, an acknowledgement shall be sent to the client MAU. The client can start to send transaction requests.
- e) The server LNA and MAU shall be able to handle multiple clients in the same manner and be able to keep the different sessions apart with regard to transaction source identity and routing of transactions.
- f) The client MAU or its LNA may die or the client MAU may close its side of the connection. The server MAU shall be notified of the closing and the LNA clean up internal state, including discarding any pending transactions.
- g) The server MAU or its LNA may die or the server MAU may close its side of the connection. The client shall be notified and the LNA clean up its internal state.

Note that f) may occur before g) or the two may occur at the same time.

- h) The client and the server shall be able to reconnect at any time and the connection shall be re-established as for the first connection. The client shall, if appropriate, be automatically reconnected by the LNA.

Connection management must handle an arbitrary large number of clients and server MAUs in all possible configurations; also when both client and server are located at the same LNA.

5.1.3 Transaction management

Data is exchanged as transactions between a client and server MAU. The system must be able to execute these transactions correctly and on time. Transactions are performed in a number of distinct steps:

- a) The client MAU creates a request.
- b) The client MAU protocol library (MAPI) adds address information and converts the outgoing message to network format (data marshalling).
- c) The client LNA multiplexes outgoing messages to correct destination LNA.
- d) The server LNA de-multiplexes incoming messages to correct MAU.
- e) The server MAU's MAPI converts the message to internal format, marshals the data and extracts address information.
- f) An application routine in the server MAU processes the message and generates an acknowledgement. Multiple acknowledgements may also be generated for subscription messages.
- g) Address information is added to the acknowledgement by the MAPI and the message is converted to network format.
- h) The server LNA identifies the target MAU and multiplexes the message onto the correct LNA link. For some message types (subscription), the LNA must duplicate the message to a number of subscribers.
- i) The client LNA receives the message and targets it at the client MAU.