Date	Classification	Page
2012-05-29	Company Confidential	1 (16)

Document No.	Issue
CNSS-12-1183	A

Product designation

VDL 6000 AIS Class A / Inland Transponder

Document title

PRODUCT SPECIFICATION

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 SCOPE

1.1 Identification

This document is the Product Specification for the VDL 6000 AIS Class A / Inland Transponder (VDL 6000-4X with firmware SW-6000-12-3.Y).
CNS Systems brand name for the product specified in this document is VDL 6000.

Figure 1-1 The VDL 6000 AIS Class A / Inland Transponder

1.2 System Overview

The Automatic Identification System (AIS) concept is based on a transponder including a VHF Transceiver, a built-in GNSS receiver and an embedded computer system to implement the unique AIS functionality.

AIS transponders are exchanging information through an advanced VHF data link network providing a reliable and secure communication channel requiring a minimum of manual involvement. Communication is performed both between ships and between ships and shore stations. Digital radio technology has been utilised in the VDL 6000 transponder in order to provide outstanding performance and flexibility. The VDL 6000 transponder includes a built-in Minimum Keyboard and Display (MKD) for presentation of received AIS target data in a list, message handling and configuration.

The operation is based on several modes and includes autonomous and continuous, assigned or polled operation.

The AIS system provides the following main functionality:

- Surveillance - improved situational awareness
- Applications for Vessel Traffic Services (VTS)
- Aids to Navigation - improved accuracy and safety by expedient update and high availability of navigational data
- Information distribution services, e.g. broadcast of ARPA targets, weather reports, safety related information and free text messaging

The VDL 6000 transponder can function either as an AIS Class A transponder or as a combined AIS Class A/Inland transponder, depending on its factory configuration (each variant can also be configured as a 'receive only' unit).

The VDL 6000 transponder interconnects with existing onboard sensor equipment such as GNSS, Gyro and optionally a Rate of Turn (ROT) gyro via the sensor interfaces. From these sensors information on position, COG, SOG, ROT, heading etc. is sent to the transponder and compiled into position report messages, which are broadcast regularly on the VHF data link. The transponder also supports broadcast and addressed transmission of text messages, and distribution of other types of information serving as a generic data link.

The transponder supports connection to other onboard equipment, such as an ECS/ECDIS system, in order to display the received data in a clear way. This requires however that the external equipment supports AIS information.

The VDL 6000 transponder provides additional interfaces for configuration and maintenance purposes, connection of a long-range communication device and a Pilot's laptop.

An overview of a typical ship installation is shown in Figure 1-2 below.

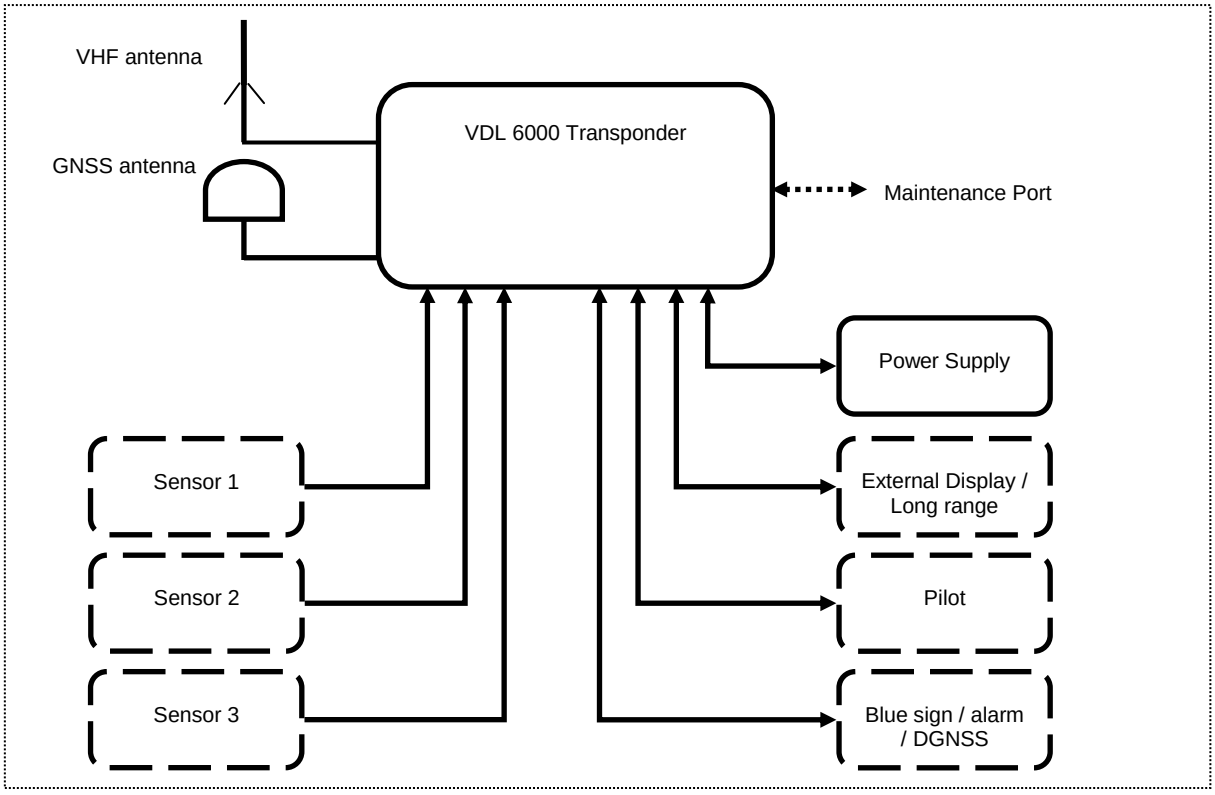

Figure 1-2 VDL 6000 installation overview

1.3 Definitions, acronyms and abbreviations

1.3.1 Definitions

The following definition is used in this document:

- **Factory configuration** – configuration performed by the manufacturer (not available to set by the user) prior to delivery of the product.

1.3.2 Acronyms and abbreviations

The following acronyms and abbreviations are used in this document.

Table 1-1 Acronyms and Abbreviations

Acronym	Description
AIS	Automatic Identification System
ARPA	Automatic Radar Plotting Aid
BIIT	Built-In Integrity Test
BSH	Bundesamt für Seeschiffahrt und Hydrographie
CCNR	Central Commission for Navigation on the Rhine
COG	Course Over Ground
DSC	Digital Selective Calling
ECDIS	Electronic Chart and Display Information System
ECS	Electronic Chart System
FVT	Fachstelle der WSV für Verkehrstechniken
IMO	International Maritime Organization
GNSS	Global Navigation Satellite System
GPS	Global Positioning System (Navstar GPS)
MTBF	Mean Time Between Failure
MKD	Minimum Keyboard and Display
ROT	Rate Of Turn
SOG	Speed Over Ground
TDMA	Time Division Multiple Access
UTC	Universal Coordinated Time
VDL	VHF Data Link
VHF	Very High Frequency
VTS	Vessel Traffic System

2 REFERENCED DOCUMENTS

[1] IMO Resolution MSC.74(69) Annex 3
Recommendation on performance standards for AIS.

[2] IMO Resolution A.694(17)
General requirements for shipborne radio equipment forming part of the global maritime distress and safety system (GMDSS) and for electronic navigational aids.

[3] ITU-R M.825-3
Characteristics of a transponder system using digital selective calling techniques for use with vessel traffic services and ship-to-ship identification.

[4] ITU-R M.1084-4
Interim solutions for improved efficiency in the use of the band 156-174 MHz by stations in the maritime mobile service.

[5] ITU-R M.1371-4
Technical characteristics for an Automatic Identification System (AIS) using time-division multiple access in the VHF maritime mobile band.

[6] IEC 61993-2 Ed.1.0
Maritime navigation and radiocommunication equipment and systems – Automatic identification systems (AIS) – Part 2: Class A shipborne equipment of the universal automatic identification system (AIS) – Operational and performance requirements, methods of test and required test results.

[7] IEC 61162-1 Ed.4.0
Maritime navigation and radiocommunication equipment and systems – Digital interfaces - Part 1: Single talker and multiple listeners.

[8] IEC 61162-2 Ed.1.0
Maritime navigation and radio communication equipment and systems – Digital interfaces - Part 2: Single talker and multiple listeners, high-speed transmission.

[9] IEC 61108-1 Ed.2.0
Maritime navigation and radio communication equipment and systems - Global navigation satellite systems (GNSS) - Part 1: Global positioning system (GPS) - Receiver equipment - Performance standards, methods of testing and required test results.

[10] IMO Resolution MSC.191(79)
Performance standards for the presentation of navigation-related information on shipborne navigational displays.

[11] IEC 62288 Ed.1.0
Maritime navigation and radio communication equipment and systems – Presentation of navigation-related information on ship borne navigational displays – General requirements, methods of testing and required test results.

[12] IEC 60945 Ed.4.0
Maritime navigation and radio communication equipment and systems - General requirements - Methods of testing and required test results,

[13] Directive 96/98/EC
European Marine equipment directive (MED).

[14] CCNR Vessel Tracking and Tracing Standard for Inland Navigation version 1.01 (2007)

[15] CCNR Vessel Inland AIS Shipborne Equipment - According to the Vessel Tracking and Tracing Standard - Operational and Performance Requirements, Methods of Test and Required Test Results (Test Standard for Inland AIS) version 1.01 (2008)

[16] Commission Regulation EC/415/2007 concerning the technical specifications for vessel tracking and tracing systems referred to in Article 5 of Directive 2005/44/EC of the European Parliament and of the Council on harmonised river information services (RIS) on inland waterways in the Community.

[17] Directive 1995/5/EC of the European Parliament and of the Council, March 9, 1999.

[18] Eurocae ED-12B (RTCA/DO-178B)
Software Considerations in Airborne Systems and Equipment Certification.

3 REGULATORY NOTICE

The VDL 6000 transponder is type approved:

- By Bundesamt für Seeschiffahrt und Hydrographie (BSH) in Germany with a module B certificate according to the European MED directive 96/98/EC. The MED directive refers to the IMO resolution MSC.74(69) Annex 3 requirements for SOLAS ships.
- By Fachstelle der WSV für Verkehrstechniken (FVT) in Germany according to Inland AIS standards.
- By Telefication in The Netherlands with a FCC certification (FCC ID: Y83 VDL 6000-4X) in accordance with FCC requirements for radio communication equipment for the maritime service.

BSH, FVT and Telefication certificates are available here: www.cns.se

Changes or modifications not expressly approved in writing by C.N.S. Systems AB may void the user's authority to operate this equipment.

The type certification of the VDL 6000 transponder is based on a combination of the GPS receiver (inside the VDL 6000 transponder) and GPS antenna. The list of approved GPS and combined GPS/VHF antennas which have been type approved can be found below in Table 3-1.

The internal GPS of the VDL 6000 transponder is needed for UTC time synchronisation and shall only be considered as a backup positioning sensor in case the primary position sensor fails.

Table 3-1 Approved GPS and combined VHF/GPS antennas

Description	CNS Part Number
GPS Antenna (Procom GPS 4)	CNS2500-072
GPS Antenna (BJTEK Navigation, MA-700)	CNS2500-086
Combined VHF/GPS antenna including diplexer and VHF and GPS antenna adaptor cables. (AC marine GPS/VHF-1 including diplexer)	CNS2500-105
Marine GPS/VHF Antenna (BJTEK Navigation, GVA-650P)	CNS2500-116

4 SYSTEM MODES AND STATES

4.1 Factory configurable modes

The VDL 6000 transponder is factory configured in one of the following two alternative modes:

- **AIS Class A**
  Configured as an AIS Class A station, the VDL 6000 transponder supports the functionality required by an AIS Class A system for SOLAS vessels according to IMO Resolution MSC.74(69) Annex 3 [1]. The AIS Class A is defined in the standards ITU-R M.1371-4 [5] and IEC 61993-2 [6].

- **AIS Class A or Inland AIS** - selectable by the user
  Configured as AIS Class A, the VDL 6000 transponder conforms to the description of AIS Class A above.
  Configured as an Inland AIS station, the VDL 6000 transponder supports the functionality required by the Inland AIS standards [14][15] and the European Commission regulation (EC) No 415/2007 [16].

The VDL 6000 transponder can additionally be factory configured to function in **'Receive only'** mode, applicable for both alternatives above. The factory configuration 'Receive only' is not possible to set or change by the user and shall not be confused with the user configurable 'Silent mode' (see section 4.2).

4.2 Operating modes

The VDL 6000 transponder is capable of operating in the following modes in accordance with IEC 61993-2 [6] and ITU-R M.1371-4 [5]:

- **Autonomous and continuous mode** – automatic broadcast transmissions without any external control (although the mode as such may be set from a competent authority).

- **Assigned mode** – transmission intervals and/or allocation of time slots are controlled by a competent authority.

- **Polled or interrogated mode** – transmission occurs in response to an interrogation from a ship or competent authority.

The VDL 6000 transponder can be configured by the user to operate in '**Silent mode'** (the Tx functionality is set to off).

4.3 States

The VDL 6000 transponder reports its AIS status indications in accordance with IEC 61993-2 [6] and ITU-R M.1371-4 [5].

5 SYSTEM CAPABILITY

5.1 Functionality

The VDL 6000 transponder complies with applicable mobile AIS parts of the following AIS standards and regulations:

- IMO MSC.74(69) [1]
- IMO A.694(17) [2]
- ITU-R M.825-3 [3]
- ITU-R M.1084-4 [4]
- ITU-R M.1371-4 [5]
- IEC 61993-2 Ed.1.0 [6]
- IEC 61162-1 Ed.4.0 [7]
- IEC 61162-2 Ed.1.0 [8]
- IEC 61108-1 Ed.2.0 [9]
- IMO Resolution MSC.191(79) [10]
- IEC 62288 Ed.1.0 [11]

When configured for AIS Class A functionality, the VDL 6000 transponder handles all operational modes and messages applicable for AIS Class A operation as defined in the AIS standards listed above.

When configured for Inland AIS functionality, the VDL 6000 transponder handles Inland AIS operation as defined in [14], [15] and [16]; for example supporting vessel tracking and tracing in inland waterways, transmission of blue sign status messages for upstream and downstream navigation as well as traffic management by transmission of estimated time of arrival at locks, bridges and terminals.

5.2 VDL 6000 Transponder

A block diagram of the VDL 6000 transponder is shown in Figure 5-1.

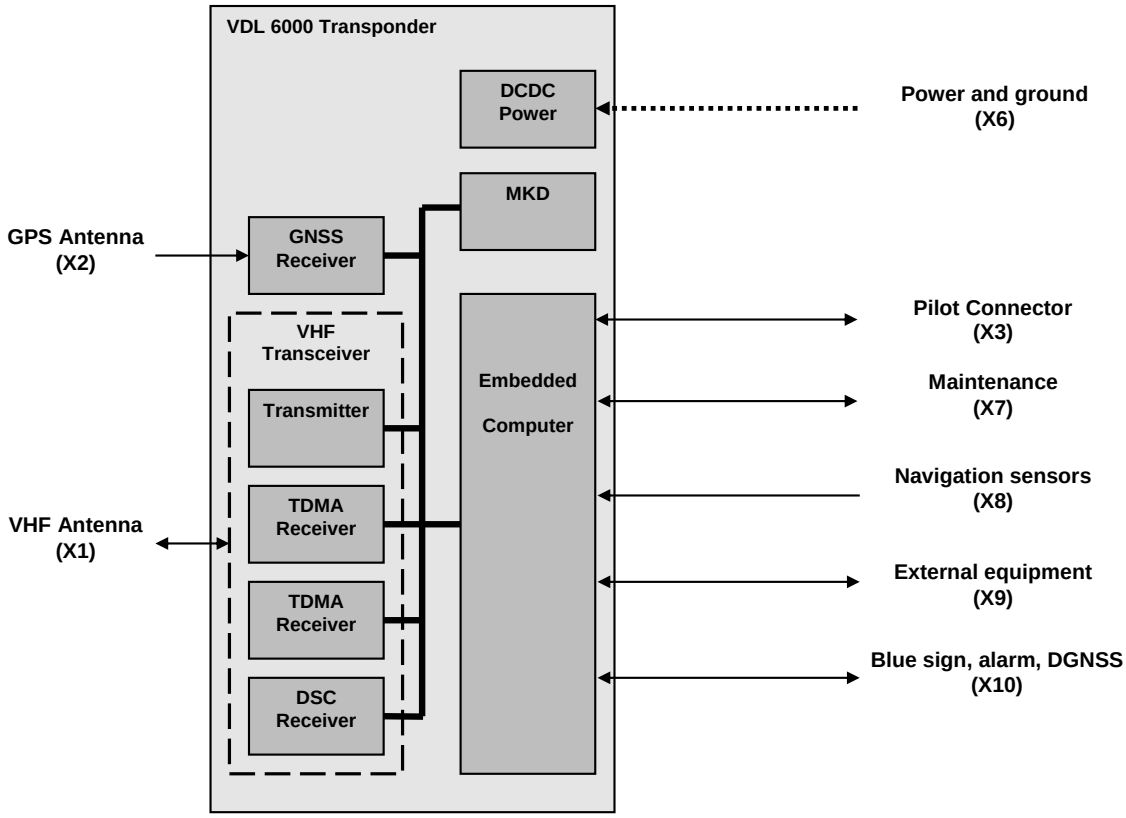

Figure 5-1 Block diagram

5.2.1 VHF Transceiver

The internal VHF transceiver in the VDL 6000 transponder handles both reception and transmission on the VHF data link and fulfils all requirements in ITU-R M.1371-4 [5] and IEC 61993-2 [6].

The transceiver is equipped with one transmitter, which is alternately used for transmissions on independent frequencies.

The transceiver is equipped with three receivers for simultaneous operation on independent frequencies, two receivers are used for AIS TDMA operation and one receiver is dedicated for DSC reception.

5.2.2 Embedded Computer

The VDL 6000 transponder has an embedded computer that executes the AIS functionality software.

5.2.3 GNSS Receiver

The VDL 6000 transponder is equipped with an internal GNSS receiver, 50-channel GPS L1 type, which is used for time synchronization and backup sensor for position information. The GNSS receiver is configured to have an update rate of 1Hz. Under normal operating conditions the transponder maintains time synchronization such that the start of each frame is synchronized with the start of any Universal Coordinated Time (UTC) minute.

If the primary time source, i.e. the internal GNSS receiver, is malfunctioning, information received from other AIS stations will be used for indirect synchronization in accordance with IEC 61993-2 [6].

Data from the internal GNSS receiver, such as position (COG and SOG), is also used for back-up purposes in case of a failure of the external positioning sensor.

It is possible to receive differential corrections from external equipment such as a beacon receiver to enhance position accuracy in back-up mode (RTCM SC-104, type 1 and type 9).

5.2.4 DCDC power

The VDL 6000 transponder is intended for connection to a 12 or 24 V DC power source with negative return. The input power is filtered and transformed to the necessary internal voltage levels needed.

5.2.5 Minimum Keyboard and Display (MKD)

The VDL 6000 transponder includes a built-in MKD available on the front panel of the transponder. It fulfils applicable parts defined in IEC 61993-2 [6], IMO MSC.191(79) [10] and IEC 62288 [11].

The MKD is equipped with a text display containing eight lines with 21 characters each and a 16 button keyboard, see Figure 5-2 below.

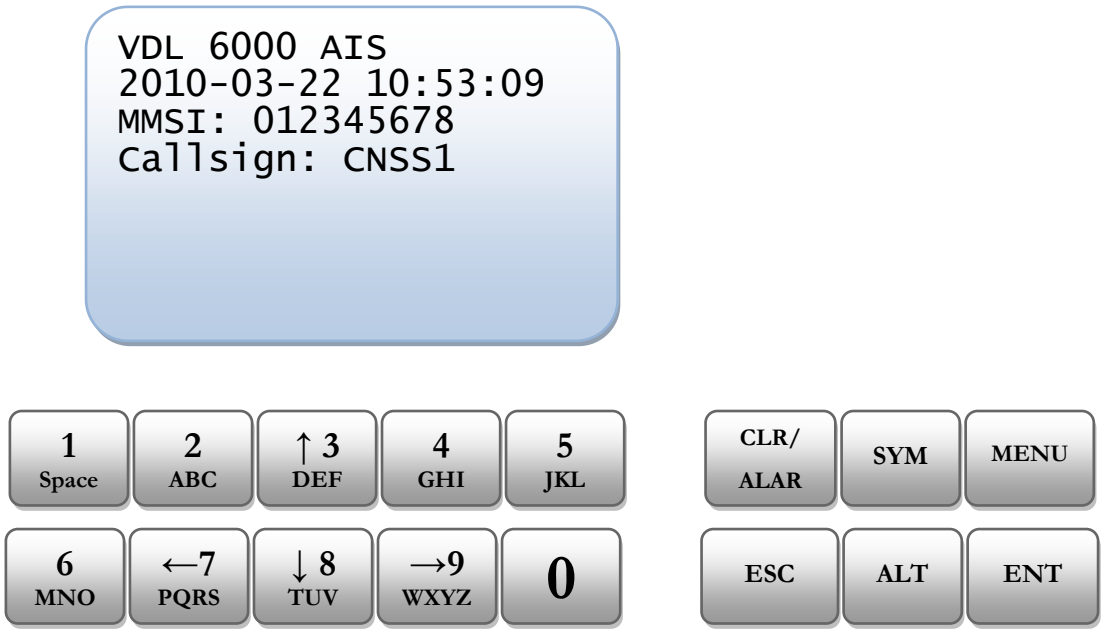

Figure 5-2 MKD display and buttons

The MKD is used for the following main tasks:

- Initialisation and configuration of the system
- Presentation of data for received AIS targets
- Reception and transmission of text messages

The display is transflexive; it is not depending on backlight in daylight. Buttons have illumination that always is off in daylight, controlled by a light sensor. The brightness of the backlight can be configured.

The display includes a night mode function that can be turned on or off. When turned on, all text will be light on a dark background. This function can be combined with the backlight, which can be used to set the amount of light emitted in night mode.

5.3 VHF / GPS Antenna and cabling

In addition to the transponder, the following equipment is required for a complete ship installation and can optionally be provided as a part of the delivered system:

- VHF Antenna and cable
- GPS Antenna and cable

A combined VHF/GPS antenna and cable can also be used.

6 SYSTEM EXTERNAL INTERFACES

The VDL 6000 includes the external interfaces listed in Table 6-1.

Table 6-1 External interfaces

Interface		Mechanical	Electrical	Logical	Comment
X1	VHF antenna	N female	Impedance 50 Ω	-	Transmission and reception
X2	GNSS antenna	TNC female	Impedance 50 Ω	-	
X3	Pilot	Receptacle, shell size 11, 9 pin	RS422	IEC 61162-1 [7]	Used by a pilot for connection to the Personal Pilot Unit
X6	Power and ground	3-way pluggable screw terminal	12 or 24 V DC, negative return	-	
X7	Maintenance	Dsub9 female	RS232		Only for use by specially trained personnel
X8	Navigation sensors	Screw terminal	RS422	IEC 61162-1 [7]	
X9	External equipment	Screw terminal	RS422	IEC 61162-1 [7]	Long range, external display
X10	Blue sign, alarm, DGNSS	Screw terminal	max 32 VDC	On/off	Blue sign, digital input
		Screw terminal	max 40 VDC 2A	Open/closed	Alarm, digital output
		Screw terminal	RS232	RTCM SC-104 Type 1 or 9	DGNSS input

The external interfaces are located on the rear side of the VDL 6000. An overview of the rear panel is found in Figure 6-1.

Figure 6-1 VDL 6000 rear panel overview

7 SAFETY ASPECTS

The VDL 6000 transponder is designed in accordance with the safety aspects defined by the relevant parts of IEC 60945 [12].

8 SYSTEM ENVIRONMENT

The VDL 6000 transponder fulfils environmental requirements for protected installation in accordance with IEC 60945 [12].

9 COMPUTER RESOURCES

The VDL 6000 transponder software is developed according to a development process based on applicable parts of [18]. The programming language is C.

10 SYSTEM QUALITY FACTORS

10.1 System flexibility

The architecture of the software is such that added functionality easily can be introduced without major software redesign.

10.2 Software upgrade

It is possible to upgrade the software in the VDL 6000 transponder via the maintenance interface using a PC with a software upgrade package.

10.3 Internal GNSS navigation data

The navigation data provided by the internal GNSS receiver will be used as sensor input if the normally utilised external source is unavailable.

10.4 Fault monitoring

The VDL 6000 transponder has a Built-in Integrity Test (BIIT) capable of detecting failures in the system in accordance with IEC 61993-2 [6].

10.5 Corrective maintenance

The VDL 6000 transponder does not require any corrective maintenance.

11 DELIVERY PACKAGE

The delivery package includes the VDL 6000 transponder, connectors (for interfaces X6, X8, X9 and X10) and manuals for installation, maintenance and operation.

12 TECHNICAL CHARACTERISTICS

Table 12-1 Technical characteristics

Parameter	Characteristic value
Power input	12 or 24 V DC, negative return
Power consumption	Min 2.5 W, nominal 9.5 W, max 47 W
Number of transmitters	1
Number of receivers	3 (2 AIS TDMA, 1 DSC)
Frequency range	156 – 163 MHz
Channel spacing	25 kHz
Frequency stability	+/- 0.0002% = +/- 2 ppm
Tx to Rx turnaround time	< 1 ms
Channel selection time	< 26 ms
Carrier power (adjustable)	1 W or 12.5 W, 50 Ohm load
Receiver sensitivity, 20% MER	< -107 dBm AIS 25kHz
Modulation scheme	GMSK (AIS TDMA) / FSK (DSC)
Baud rate	9 600 bps (AIS TDMA) / 1200 bps (DSC)
GNSS receiver	GPS L1, 50 parallel channel, 1Hz update rate
Physical dimensions (W x H x L)	164 x 103.5 x 233 mm (132 x 100.5 x 233, without brackets)
Weight	2.3 kg
Cooling	Not required
Approvals	BSH, FVT, FCC, CE