Saab TransponderTech

R4 Navigation System

Installation Manual

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Trademarks

Disclaimer

Caution

No single navigation aid should ever be relied upon as the exclusive means for navigating a vessel. The navigator is responsible for checking all aids available to confirm his position. Electronic aids are intended to assist, not replace, the navigator.

Software

This manual reflects the capabilities of R4 Navigation Display software version 5.1.4 and R4 Navigation Sensor software version 6.8-S7.

Installation Manual, Part Number and Revision

Part number 7000 109-142, revision J2.

This manual is a replacement for the earlier manual 7000 109-142 rev I.

Safety Instructions

Note the following compass safe distances:

Equipment	Standard Magnetic Compass	Steering Magnetic Compass
R4 Display	0.6 Meters	0.3 meters
R4 Navigation Sensor (GPS and DGPS)	0.6 Meters	0.4 Meters

Disposal Instructions

Broken or unwanted electrical or electronic equipment parts shall be classified and handled as ‘Electronic Waste’. Improper disposal may be harmful to the environment and human health. Please refer to your local waste authority for information on return and collection systems in your area.

Contact Details

For Information on New Products and Dealers:

Please visit our home page www.transpondertech.se

For Installation, Service and Technical Support:

Please contact your R4 Navigation System dealer

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1 INTRODUCTION

1.1 About this Manual

This manual, together with the Operator Manual, provides in-depth information to facilitate installation of the Saab TransponderTech R4 Navigation System.

The R4 Navigation System is available in two system configurations: GPS and DGPS. This manual is valid for both configurations.

1.2 System Overview

Figure 1-1 shows an overview of the R4 Navigation System. The R4 Navigation System is available in two configurations: GPS and DGPS. Both configurations feature an R4 Display. The GPS configuration also features an R4 GPS Navigation Sensor and an MGA-2 GPS antenna, while the DGPS configuration features an R4 DGPS Navigation Sensor and an MGL-4 combined GPS/Beacon antenna.

The R4 Display provides a graphical interface to the system. Via the display it is possible to create, edit and modify routes and waypoints, navigate following a route, plot the current route as well as perform other navigational functions.

The R4 GPS Navigation Sensor features a high-precision GPS receiver, capable of receiving WAAS, EGNOS and MSAS differential corrections. The R4 DGPS Navigation Sensor has all the features of the GPS Sensor, as well as a dual channel beacon receiver for reception of IALA beacon DGPS corrections. Both the GPS and the DGPS Navigation Sensor perform continuous RAIM calculations according to the IEC 61108-1 (2nd edition) standard (see Ref. [5]).

The Navigation Sensor is connected to the antenna, either an MGA-2 GPS antenna or an MGL-4 combined GPS/Beacon antenna. The MGL-4 antenna is capable of receiving both radio beacon and satellite signals.

Together the R4 Display and R4 Navigation Sensor provide three configurable serial user ports, of which two are bidirectional and one used for output only. There is also one binary Speed Log output port, one Alarm output port and one Alarm Acknowledge input port.

For more details, see sections further on in this Installation Manual.

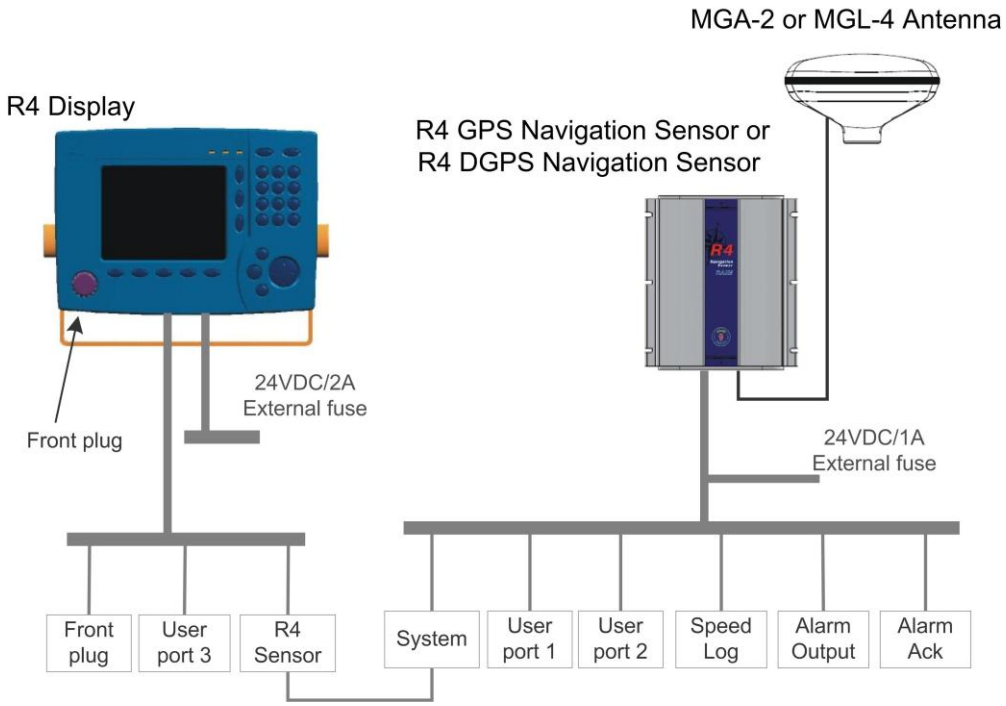

Figure 1-1: R4 Navigation System overview

2 UNPACKING THE EQUIPMENT

The R4 Navigation System is made up of parts as listed below.

Common Equipment

The following equipment is required in both GPS and DGPS configuration.

Name	Part number	Qty.
R4 Display Unit	7000 108-035	1
R4 Display Power Cable	7000 108-132	1
R4 Display Signal Cable	7000 108-133	1
R4 Navigation Sensor Power and Data Cable	7000 109-011	1
GPS antenna cabling (TNC-M / TNC-M)	Not supplied	1
Operator Manual	7000 109-143	1
Installation Manual (this document)	7000 109-142	1

GPS Configuration

The following additional equipment is required in a GPS configuration.

Name	Part number	Qty.
R4 GPS Navigation Sensor	7000 109-141	1
MGA-2 GPS Antenna (30 dB gain)	7000 000-263	1

DGPS Configuration

The following additional equipment is required in a DGPS configuration.

Name	Part number	Qty.
R4 DGPS Navigation Sensor	7000 109-140	1
MGL-4 Combined GPS/Beacon Antenna (30 dB gain)	7000 000-359	1

Accessories

The following accessories are available.

Name	Part number
R4 Display flush mount kit	7000 108-110
GPS antenna mounting tube	7000 000-117
Alarm relay unit including socket	7000 100-132
J4N junction box [note 1,2]	7000 109-121
J4N junction box installation guide [note 1]	7000 109-126

Note 1: Installation with J4N junction box is not covered by this manual. Refer to the J4N Installation Guide, 7000 109-126.

Note 2: The J4N junction box includes an alarm relay with lower power rating than alarm relay 7000 100-132.

3 INSTALLATION CABLES

The following cables are needed for installation of the R4 Navigation System.

R4 Display Signal Cable

Type: 6-Pair x 0,25 mm^2 Shielded

Length: 2 m

Connector: ConXall, Maxi-Con-18pin (male)

Marking: 7000 108-133

R4 Display Power Cable

Type: 3 x 0.5 mm^2

Length: 2 m

Connector: ConXall, Mini-Con-3pin (female)

Marking: 7000 108-132

R4 Navigation Sensor Power and Data Cable

Type: 9-Pair x 0,25 mm^2 Shielded

Length: 2 m

Connector: ConXall, Maxi-Con-18pin (male)

Marking: 7000 109-011

Sensor Antenna Cable

(Not supplied by Saab TransponderTech)

Type: See Appendix [A.6] –Sensor antenna cable selector

Length: See Appendix [A.6] – Sensor antenna cable selector

Connector: TNC (Male)

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4 MOUNTING

When mounting the R4 Navigation System it is recommended to follow the steps as described in this Installation Manual. Details of the installation procedure are found in the following sections of this Installation Manual.

Recommended installation steps:

1. Mount the R4 Display (section 4.1)
2. Mount the R4 Navigation Sensor (section 4.2)
3. Mount the antenna (section 4.3)
4. Connect the R4 Display and R4 Navigation Sensor (chapter 0)
5. Power up the system (section 6.3)
6. Perform system functional check (section 6.7)
7. Configure output sentences (section 6.8)

4.1 Mount the R4 Display

4.1.1 Location

The user interface is built upon a number of views, organized in four different modes. The different views are reached with the function keys below the screen and the ***ESC*** and ***PAGE*** keys on the right side of the front panel. The mode is changed by pressing the ***MODE*** key followed by the function key corresponding to the desired mode.

Use the function keys to step into a specific view and ***ESC*** to get back one level. ***PAGE*** provides access to additional pages of function keys in some views. An example view is shown below. In the following sections of the manual the views of the R4 Navigation System are described.

The R4 Display should be mounted close to the position from which the ship is normally operated, preferably on the bridge console close to the conning position.

When mounting the R4 Display please consider the following:

- The temperature and humidity should be moderate and stable, +15ºC to +35ºC. (Operating temperature: -15ºC to +55ºC.
- Select a location away from excessive heat sources.
- Avoid areas where there is a high flow of humid salt air.
- Avoid places with high levels of vibrations and shocks.
- Avoid mounting the R4 Display in direct sunlight.
- Ensure that there is enough airflow to avoid high ambient temperatures.
- Ensure that the cables can be connected without violating their maximum bending radius.
- The unit can affect magnetic compasses. The minimum compass safe distance is 0.6 meters to a standard magnetic compass and 0.3 meters to a steering magnetic compass.

4.1.2 Physical Size and Mechanical Drawing

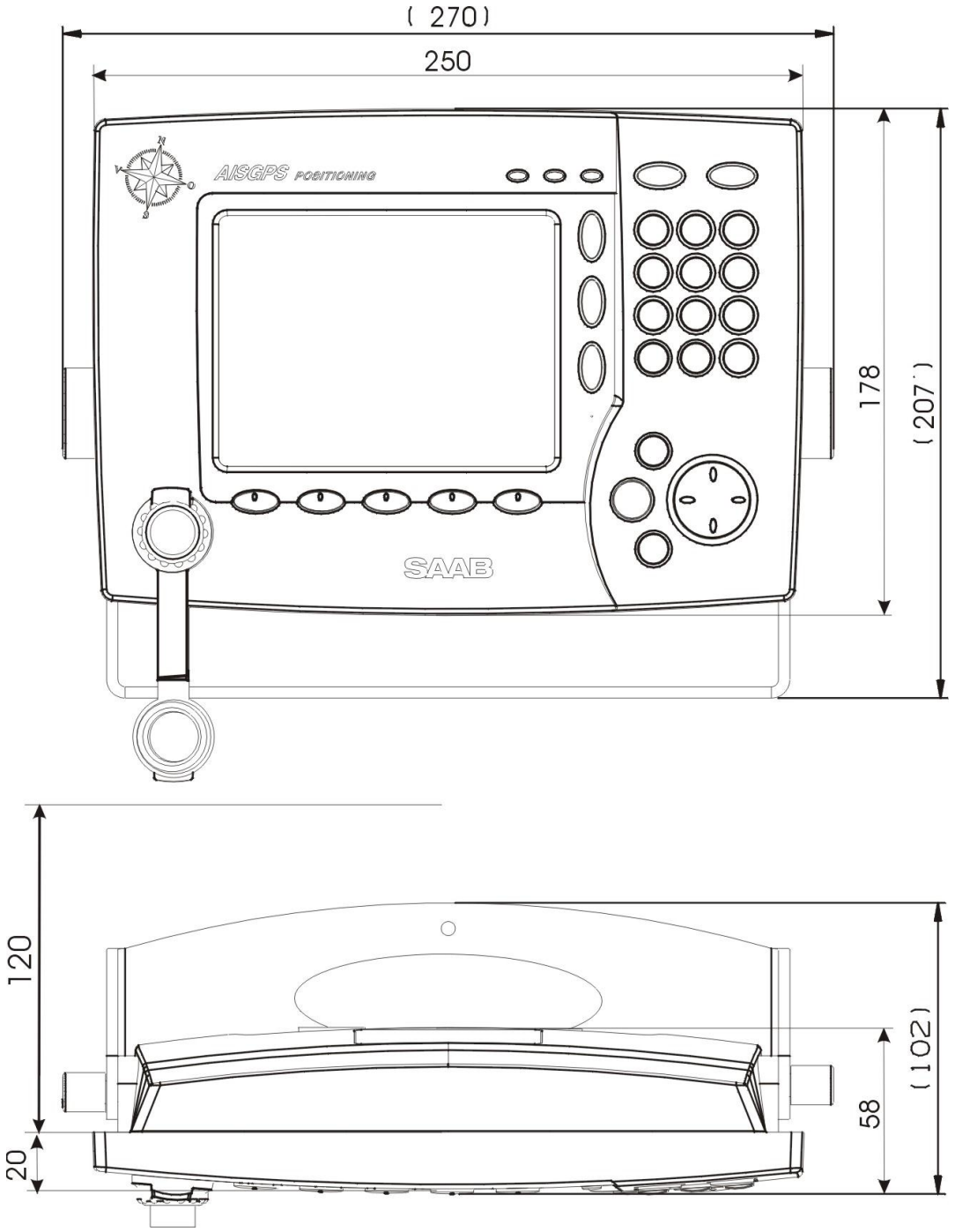

Figure 4-1: Mechanical drawing R4 Display

4.1.3 Gimbal Mounting

1. Determine where to install the R4 Display. The R4 Display can be mounted horizontally or vertically. Make sure there is enough space around the R4 Display, see Figure 4-2 below.

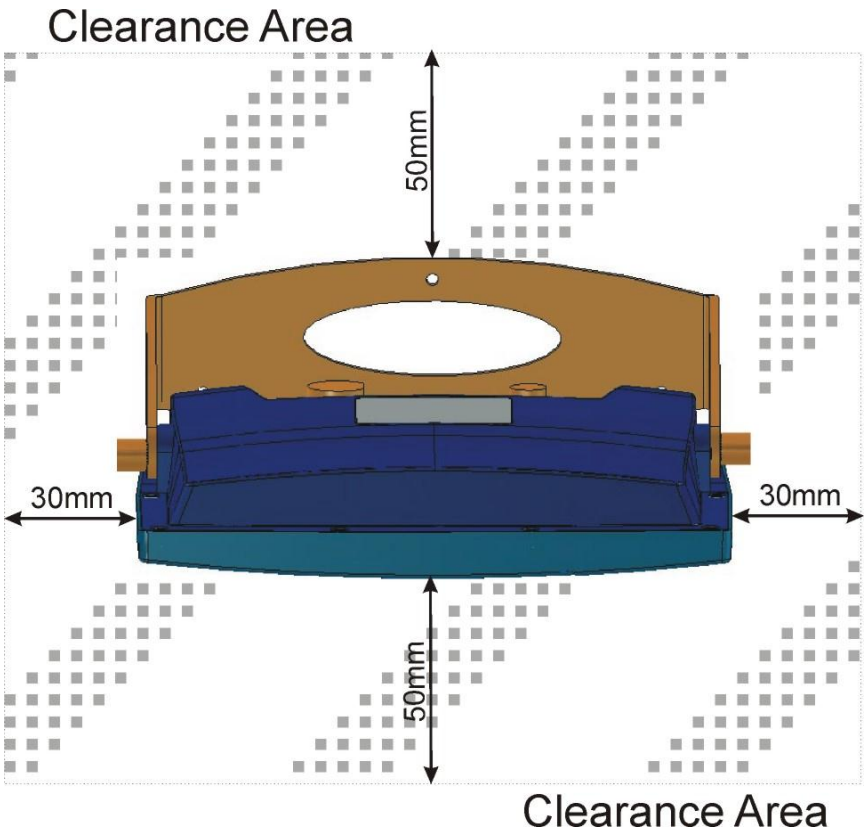

Figure 4-2: Gimbal mount clearance area

2. Fasten the gimbal mount on a flat surface with three screws, see Figure 4-3 below. The type of screws has to be chosen considering the panel material. Note that the slots on the end of the gimbal mount have to face the direction in which the R4 Display is to be mounted.

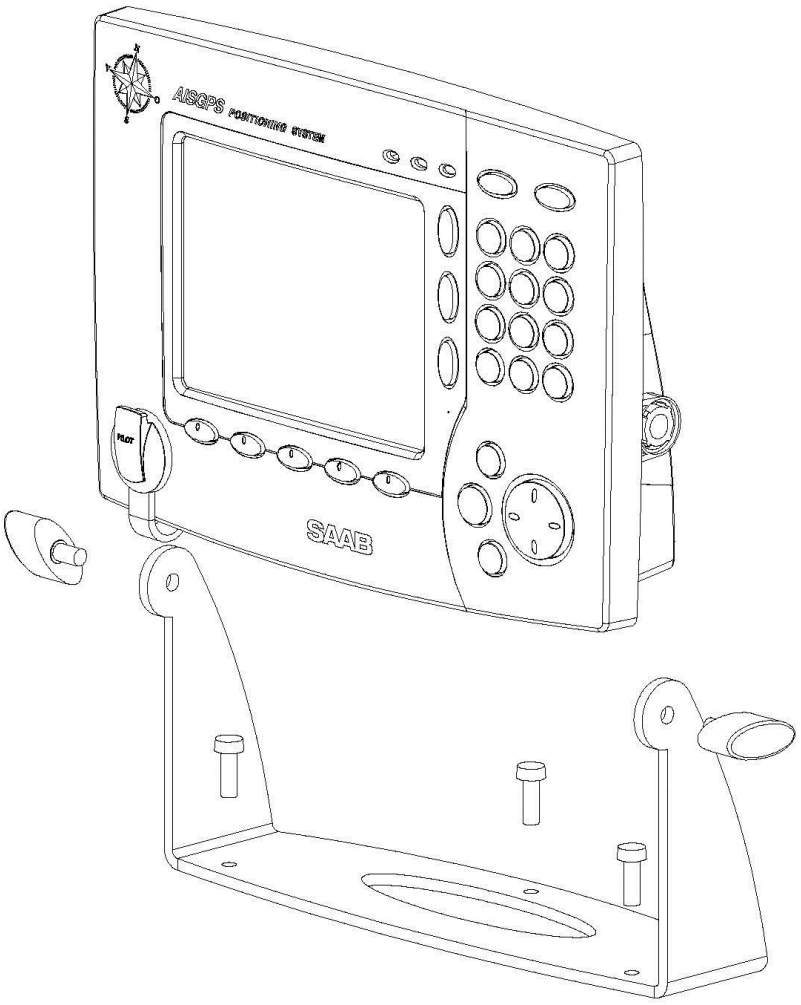

Figure 4-3: Gimbal mount

3. Slide the R4 Display into the slots on the end of the gimbal mount. Secure the R4 Display onto the gimbal mount using the locking knobs without over-tightening.

4. Attach the signal cable (18 pin plug) and the power cable (3 pin socket), as described in section 4.1.5.

5. Adjust the viewing angle after first loosening the gimbal locking knobs. Securing the R4 Display without over-tightening the gimbal locking knobs.

4.1.4 Panel Mounting

1. Determine where to install the R4 Display, see Figure 4-4 below for dimensions. Make sure that there is enough depth behind the panel, see Figure 4-5. Please note that the signal cable has a maximum bending radius of 10 centimeters.

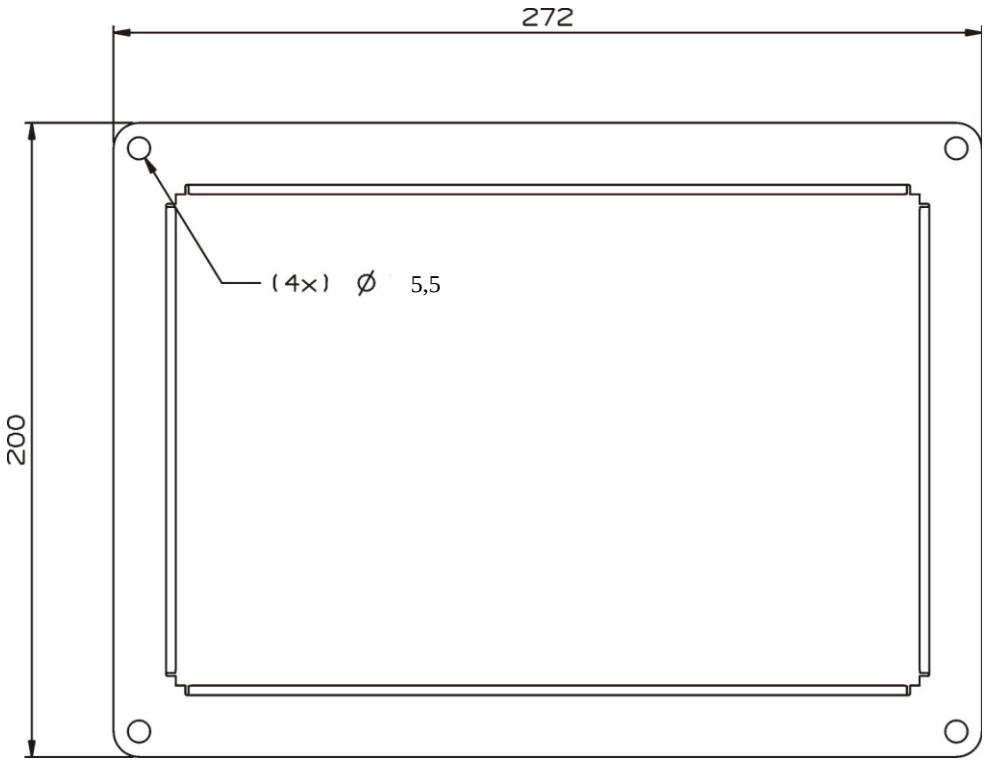

Figure 4-4: Panel mount frame dimensions

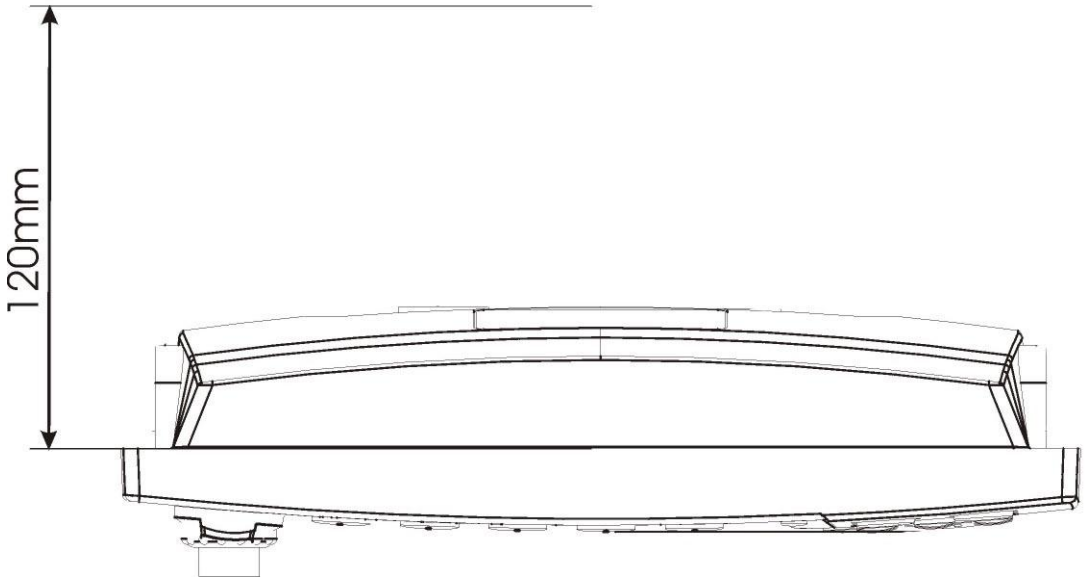

Figure 4-5: Clearance distance behind the display

2. Make one rectangular hole and four round holes in the panel, as illustrated in Figure 4-6. (If the hole template is available, place the template in the right position and drill and saw according to the template. If this method is used, exclude step 3 and 4 in this instruction.)

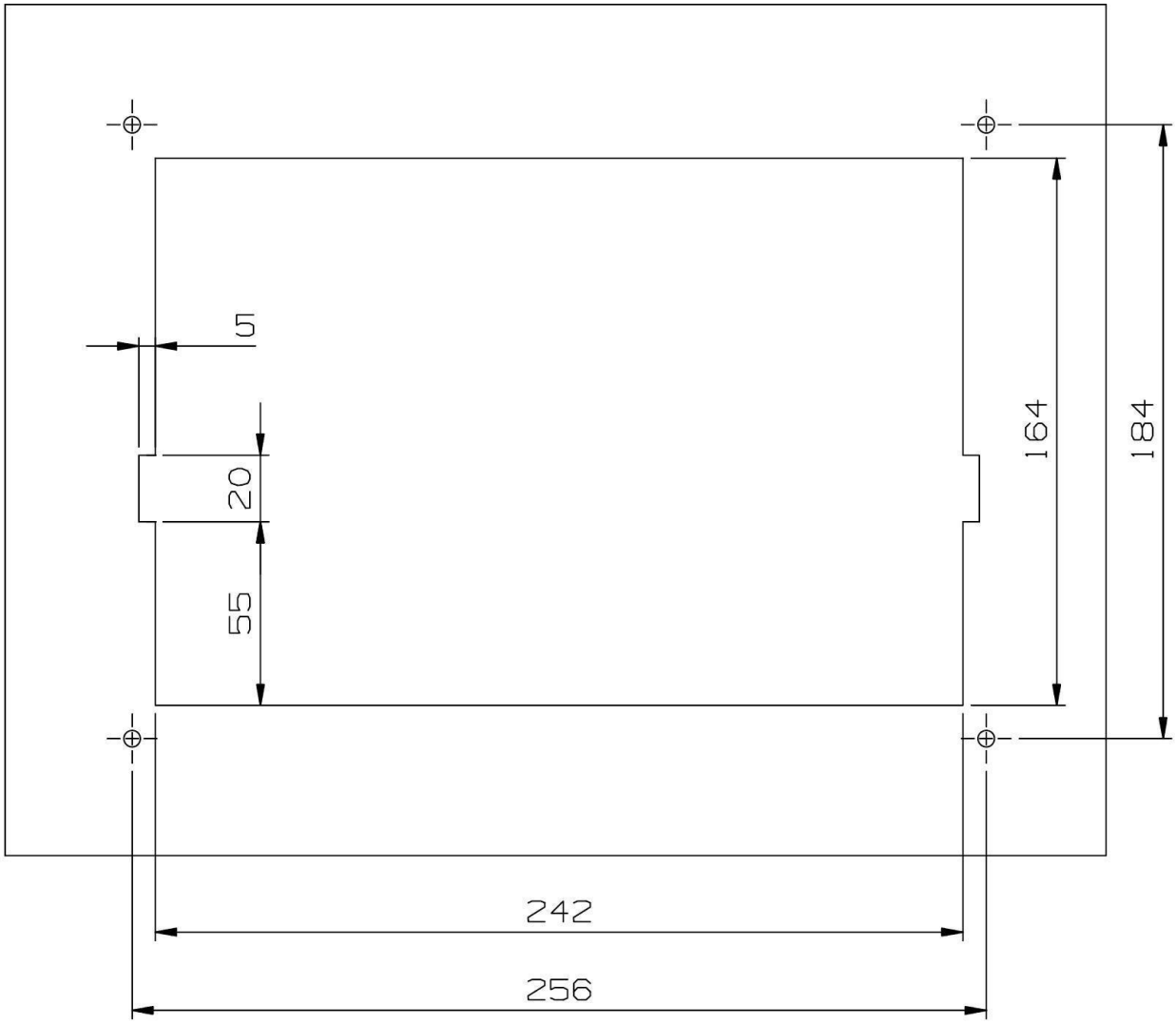

Figure 4-6: Panel mount hole dimensions

3. Attach the signal cable (18 pin plug) and the power cable (3 pin socket), as described in section 4.1.5.

4. Place the panel mount frame in the rectangular hole and mark the location of the four screw holes in the bedding.

5. Remove the panel mount frame and drill four screw holes where marked in the panel.

6. Place the seal onto the back of the R4 Display. Make sure that it aligns with the R4 Display body. Place the R4 Display in the panel mount frame. Press the R4 Display and the frame together and install the two securing screws, one on each side of the R4 Display.

7. Attach the signal cable (18 pin plug) and the power cable (3 pin socket), as described in section 4.1.5.

8. Slide the R4 Display with the panel mount frame into the rectangular hole in the panel and fasten it to the panel with four screws, as illustrated in Figure 4-7 and Figure 4-8 below.

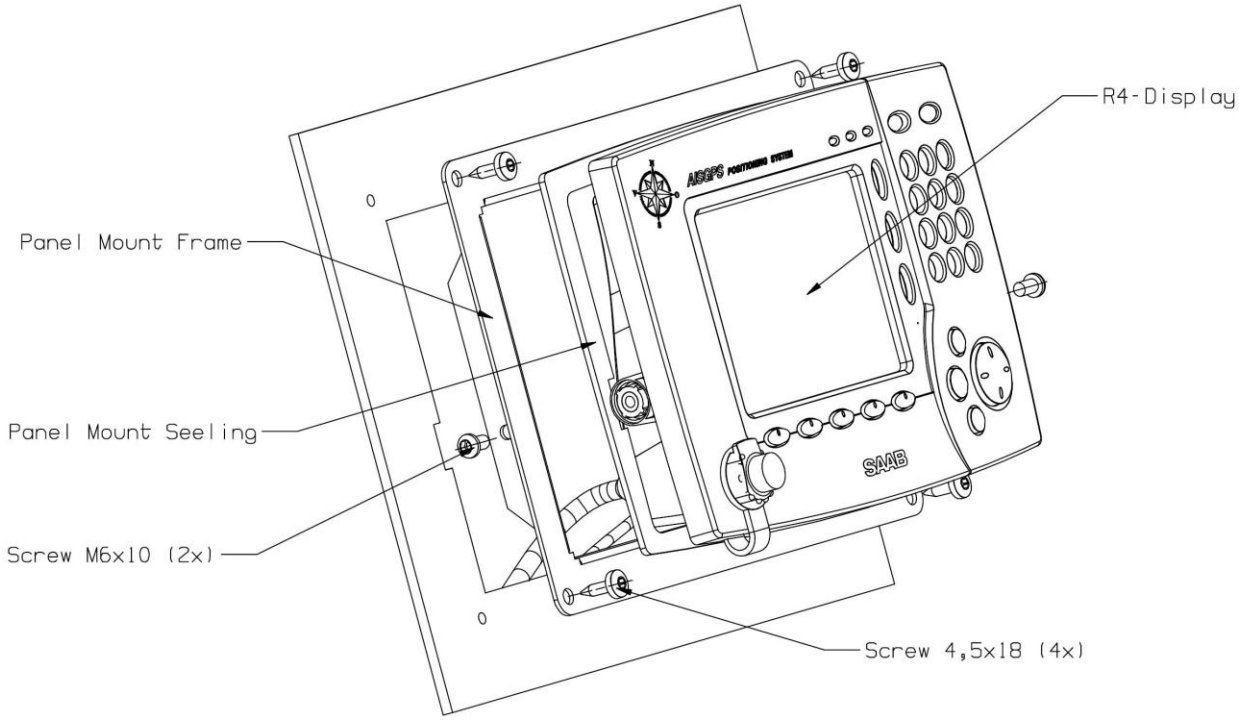

Figure 4-7: Panel mounting R4 Display

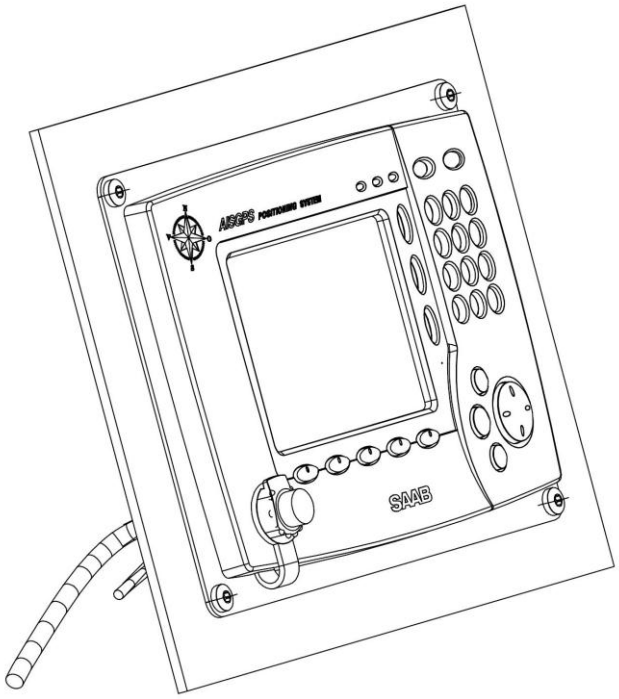

Figure 4-8: R4 Display panel mounted

4.1.5 Cabling

Use the cables included, one for power supply and one signal cable for connecting the display to the R4 Navigation Sensor, external systems and sensors. Note that the signal cable has a maximum bending radius of 10 cm.

Connect the R4 Display Power Cable, marked “7000 108-132”, and the R4 Display Signal Cable, marked “7000 108-133”, to the corresponding ConXall connectors on the back of the R4 Display. See Figure 4-9 below (illustrating a gimbal mounted R4 Display).

Wire the open end of the cables as described in section 5.2 and Appendix [A.8].

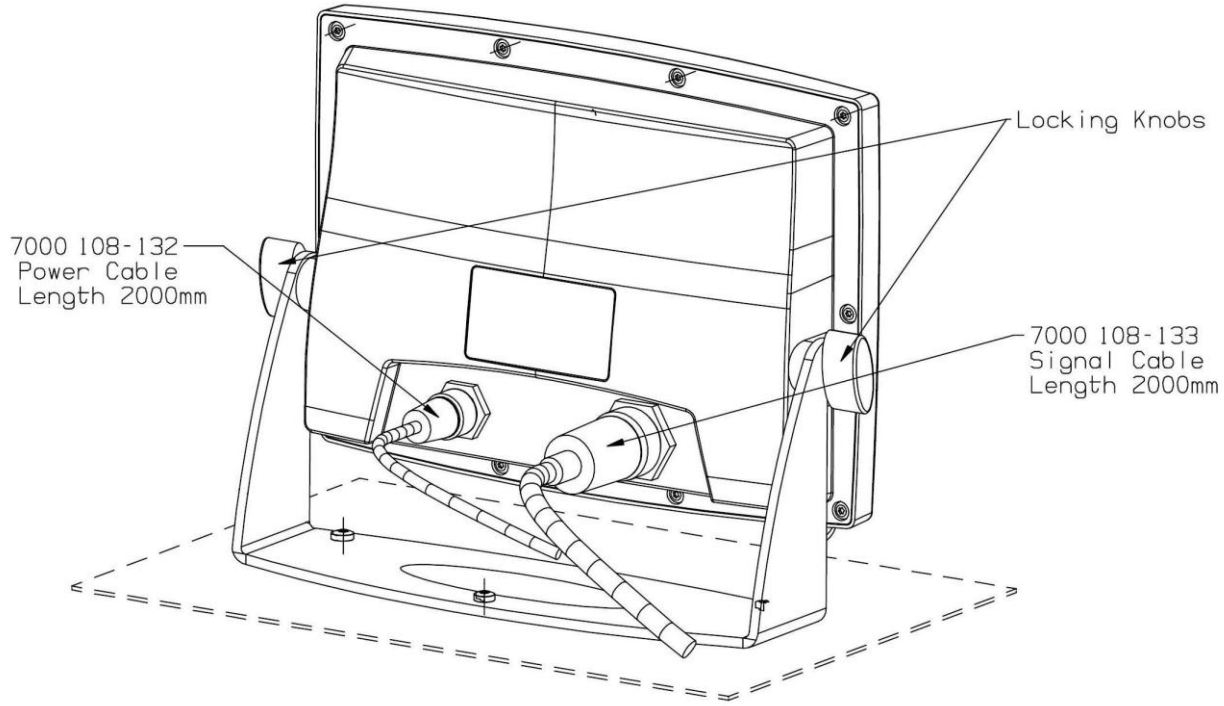

Figure 4-9: Connecting the power cable and the signal cable to the R4 Display

Note: The Signal cable for connecting to the R4 Display and the Power and Data cable for connecting to the R4 Navigation Sensor both use 18 pin connectors. Make sure they are not interchanged! The R4 Display Signal cable is marked with “7000 108-133” and can also be identified by the fact that only 13 pins are mounted in the male connector.

4.1.6 Power Supply

The R4 Display can be connected to an emergency power source. If connected to an emergency battery, a re-calculation must be made for the battery capacity. For power consumption, see section 8.1.

The R4 Display is designed to operate on 24 VDC. The nominal power used is 8.5 W. The R4 Display shall be externally fused (slow blow fuse) with a 2 A fuse.

Install according to section 5.2 and Appendix [A.8].

4.2 Mount R4 Navigation Sensor

4.2.1 Location

When mounting the R4 Navigation Sensor please consider the following:

- Mount the unit so that the LEDs can be observed if needed for troubleshooting purposes.
- The temperature and humidity should be moderate and stable, +15ºC to +35ºC. (Operating temperature: -30ºC to +70ºC.)
- Select a location away from excessive heat sources.
- Avoid areas where there is a high flow of humid salt air.
- Avoid places with high levels of vibrations and shocks.
- Ensure that there is enough airflow to avoid high ambient temperatures.
- Ensure that the different cables can be connected without violating their maximum bending radius.
- The unit can affect magnetic compasses. The minimum compass safe distance is 0.6 meters to a standard magnetic compass and 0.4 meters to a steering magnetic compass.

4.2.2 Clearance Area

Leave a clearance around the R4 Navigation Sensor to facilitate service and installation. See recommended clearance area in Figure 4-10 below.

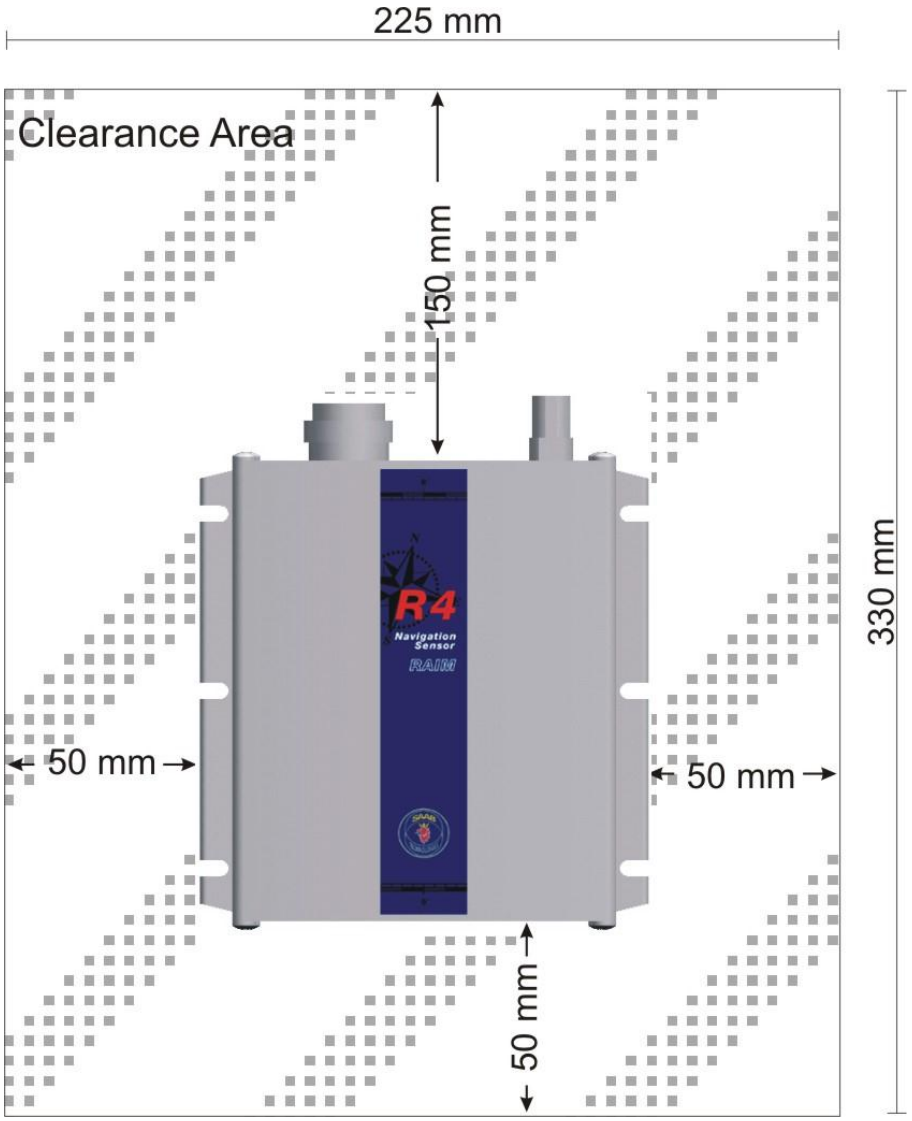

Figure 4-10: Clearance area for R4 Navigation Sensor

4.2.3 Physical Size and Mechanical Drawing

See figure below.

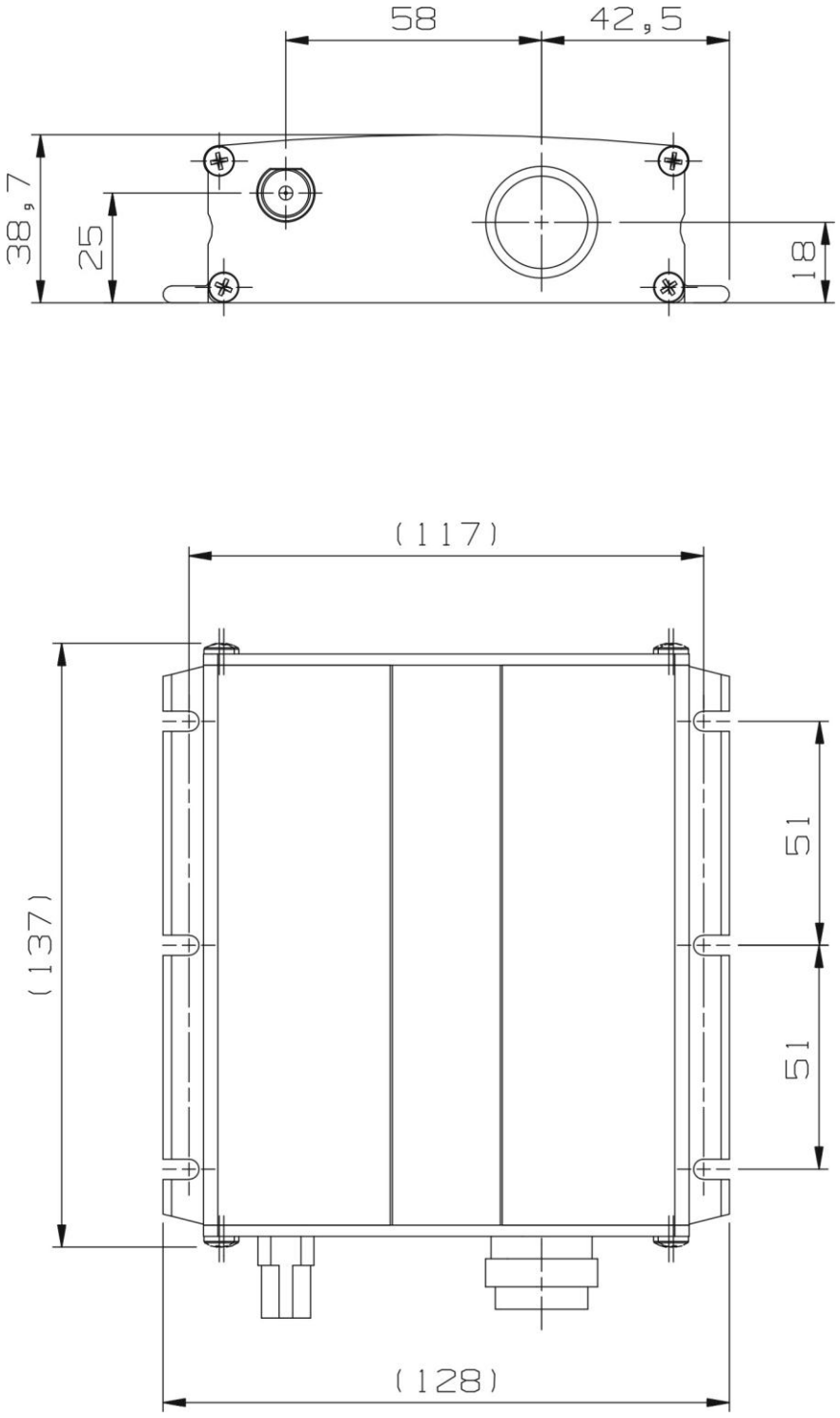

Figure 4-11: R4 Navigation Sensor mechanical drawing

4.2.4 Cabling

Use the included R4 Power and Data cable, marked “7000 109-011”, to connect the R4 Navigation Sensor to the power source, R4 Display and any external systems or sensors. Note that the cable has a maximum bending radius of 15 cm. Connect the cable’s 18 pin male ConXall connector to the female 18 pin connector on the back of the R4 Navigation Sensor. Wire the open end of the cable as described in section 5.1 and Appendix [A.8].

Connect the antenna to the R4 Navigation Sensor, following the instructions in section 4.3.

Note: The power and data cable for connecting to the R4 Navigation Sensor and the signal cable for connecting to the R4 Display both use 18 pin connectors. Make sure they are not interchanged! The R4 Sensor power and data cable is marked with “7000 109-011” and can also be identified by the fact that all 18 pins are mounted in the male connector.

Note: The R4 Navigation Sensor provides 5 VDC across its antenna port. The antenna shield as well as the R4 Navigation Sensor power and data cable shield and Signal GND lines are connected to the negative terminal of the 24V DC power supply. Connecting to the ship’s structure or incompatible devices may result in damage to equipment.

Note: The Chassis of the R4 Navigation Sensor is not connected to any internal ground and may thus be connected to the ship’s structure if desired.

4.2.5 Power Supply

The R4 Navigation Sensor can be connected to an emergency power source. If connected to an emergency battery, a re-calculation must be made for the battery capacity. For power consumption, see section 8.2.

The R4 Navigation Sensor is designed to operate on 24 VDC. The nominal power used is 2.7 W. The R4 Navigation Sensor shall be externally fused (slow blow fuse) with a 1 A fuse.

Install according to section 5.1 and Appendix [A.8].

4.3 Mount the GPS or DGPS Navigation Antenna

The R4 Navigation Sensor should be connected to the included antenna, which in the GPS configuration is a MGA-2 GPS antenna and in the DGPS configuration is a MGL-4 combined GPS/Beacon antenna.

Attention should be paid to the location and installation of the different antennas on the ship in order to obtain the best possible signal reception. Installation of the Navigation Sensor's antenna is a crucial part of the system installation. How and where you install your antenna and cable will greatly affect its sensing efficiency.

4.3.1 Antenna Location

Mount the MGA-2 or MGL-4 antenna at a location with a clear, unobstructed view of the sky. For best beacon reception performance, mount the MGL-4 antenna so that the center of the black gasket is at least 8 cm (3 in) above any metal surface.

Local noise generated by your vessel or surroundings may affect your navigation system performance. To minimize this impact, you should locate the antenna outside the path of any radar beam, away from any transmitting antennas, and away from any other sources of interference such as motors, solenoids and other electronics. Do not, however, mount the antenna in the top of a mast or tower, as this may degrade the COG and SOG readings.

The MGA-2 and MGL-4 uses a 1-14-UNS thread for mounting. Mount the antenna on a standard US 1" 14 thread pipe or other standard antenna mount (not included).

Note: Antennas threaded onto a mount should be tightened only by hand. Do **not** tighten the antenna by turning on the antenna cover, instead hold the mounting shaft located at the bottom of the antenna and tighten by hand. Do not thread the shaft deeper than ¾. Do not use tools to install the antenna on the shaft as this may cause damage. Damage caused by over tightening is not covered by warranty.

Note: Once the system has been correctly mounted and connected, it is possible to monitor the R4 Navigation Sensor receiving performance via the graphical interface of the R4 Display. This information can be used to locate the optimum placement of the antenna. This is further described in section 6.7.

4.3.2 Cabling

The maximum allowable cable loss is 18 dB for the MGA-2 and MGL-4 antennas. The maximum cable length depends on the attenuation the cable and the chosen antenna. As an aid to cable selection, refer to Appendix [A.6].

Double shielded coaxial cable is recommended. The coaxial cable should be routed directly between the antenna and the R4 Navigation Sensor in order to reduce electromagnetic interference effects. The cable should not be installed close to high-power lines, such as radar or radio-transmitter lines or any AIS VHF antenna cable. A

separation of one meter or more is recommended to avoid interference due to RF-coupling. Crossing of antenna cables should be done at 90 degrees to minimize magnetic field coupling.

4.3.3 Cable Mounting

Coaxial cables should be installed in separate signal cable channels/tubes and at least 10 cm away from power supply cables. Crossing of cables should be done at right angles (90°).

Coaxial cables should not be exposed to sharp bends, which may lead to a change of the characteristic impedance of the cable. The minimum bending radius should be 5 times the cable's diameter.

All outdoor installed connectors should be weatherproofed, e.g. with shrink tubing, watertight seal tape or butyl rubber tape and plastic tape sealing, to protect against water penetration into the antenna cable.

Secure the cable properly, near the cable ends.

Connect the antenna to the R4 Navigation Sensor before you apply power to it.

4.3.4 Grounding

The MGA-2 and MGL-4 antennas do not require any antenna ground connection.

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5 WIRING CABLE CONNECTIONS

A detailed installation wiring diagram for the R4 Navigation System is available in Appendix [A.8]. This diagram includes cable connections for the R4 Navigation Sensor, R4 Display, power supply and RS422 ports. The diagram also illustrates how to correctly connect shield of external equipment. **Please refer to this diagram when doing the installation.**

The following chapters give a detailed description of the cables for the R4 Display and the R4 Navigation Sensor.

5.1 R4 Navigation Sensor Cable Description

Figure 5-1 describes the power and data cable of the R4 Navigation Sensor. The R4 Navigation Sensor cable is connected by an 18-pin ConXall connector and supplies several different interfaces, described below. The cable is also used to apply power to the sensor.

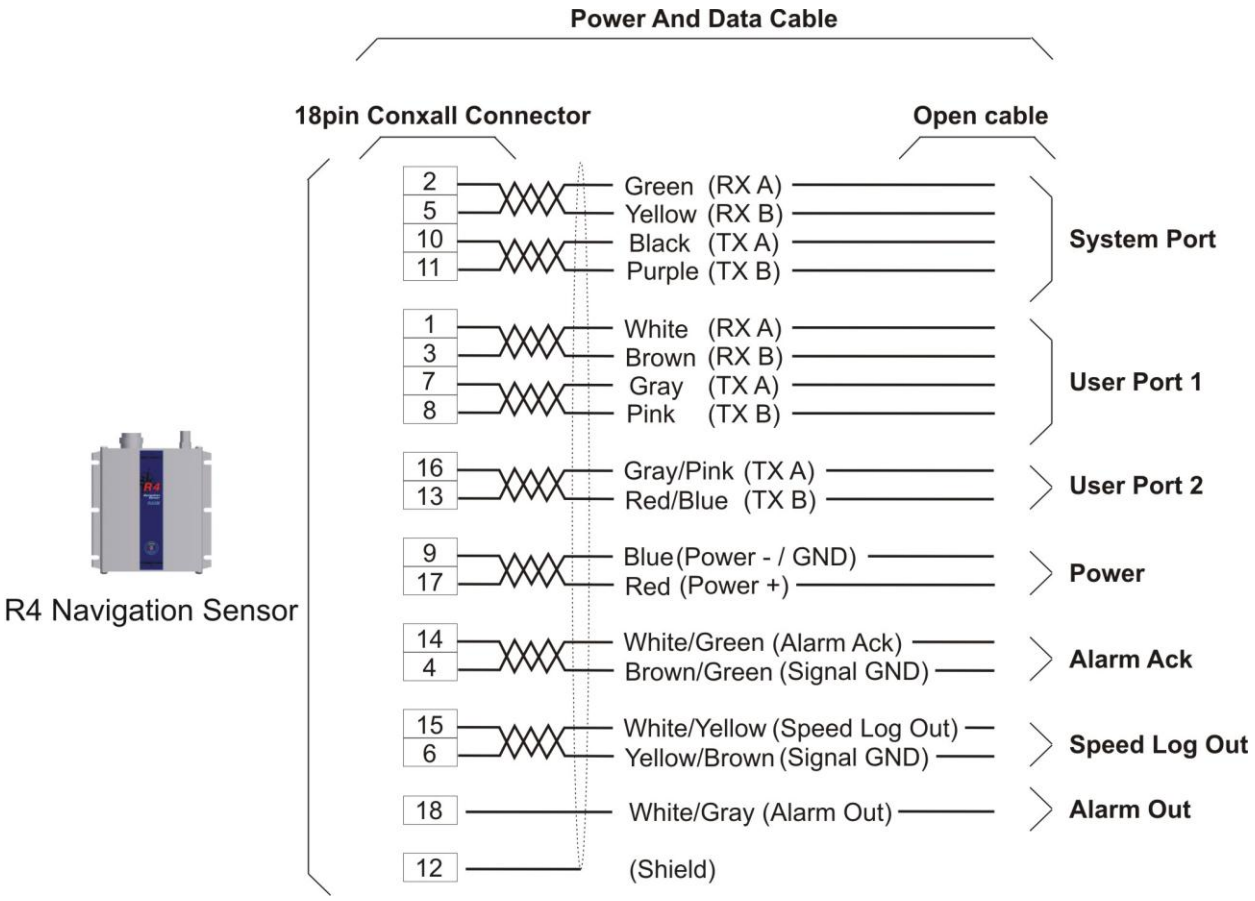


Figure 5-1: R4 Navigation Sensor Power and Data cable

Important:

The shield of the Navigation Sensor power and data cable (7000 109-011) is referenced to the negative 24V DC supply. For this reason, **the free end of the cable shield must not be connected to the ship's structure**. For the same reason, don't connect the Navigation Sensor alarm acknowledge signal ground, the speed log pulse signal ground or the cable shield for the GPS antenna to the ship's structure.

5.1.1 System Port

The System port interface is used to connect to the R4 Display, via the Display's R4 Sensor port. The TX lines of the port shall be connected to the RX lines of the R4 Sensor port on the Display, and the RX lines of the System port shall be connected to the TX lines of the R4 Sensor port.

5.1.2 User Port 1

The port is bidirectional and can be used to connect to external equipment such as an ECDIS system, or to external sensors such as compass or depth sensors. It is recommended to use this port when connecting to ECDIS systems.

To receive data on the port, its RX lines shall be connected to the TX lines of the external equipment.

For an external equipment to receive data from the R4 Navigation System via the port, the TX lines of the port shall be connected to the RX lines of the external equipment.

It is up to the user to configure the types of messages that shall be sent and received on the port, as well as the baud rate used for communication.

This port may also be configured for input of external differential corrections in RTCM SC-104 format. In this case, the port can not be used for output of data. Refer to the Operator Manual, section "GPS Config" in the reference chapter on how to configure the port for differential corrections.

5.1.3 User Port 2

The port can only be used to output data from the R4 Navigation System to external equipment. The TX lines of the port shall be connected to the RX lines of the external equipment.

It is up to the user to configure the types of messages that shall be sent on the port, as well as the baud rate used for communication.

5.1.4 Power Wires

Connect the Power + and the Power - / GND wires to a 24 VDC power supply.

5.1.5 Alarm Out Binary Port

The Alarm Out binary port is used to indicate navigational alarms to external alarm signaling and alarm monitoring systems. The Alarm Out wire should be connected via an alarm relay unit to negative ship supply. The port is normally active supplying 23 VDC. When an alarm is activated, the port will go low and supply 0 VDC. The port will remain low until the alarm is deactivated. Once the alarm is deactivated the port will go high, supplying 23 VDC again.

The port has a driving capacity of 50 mA and must thus have a minimum load resistance of 460 Ω.

5.1.6 Alarm Acknowledge Binary Port

The Alarm Acknowledge binary port is used to acknowledge all active alarms. The “Alarm Ack” wire should be connected to Signal GND via a normally open momentary switch, capable of handling a 1 mA current. Except for the switch, no extra circuits are needed.

The switch should be closed to activate the Alarm Acknowledge signal and acknowledge the active alarms.

Note: Signal GND is internally connected to the negative 24V DC supply of the R4 Navigation Sensor.

5.1.7 Speed Log Out Port

The Speed Log Out port provides a 50 ms long 5 V pulse with an interval corresponding to the ship’s present speed. To use the port, the Speed Log Out wire should be connected via a pulse counting circuit to Signal ground. The port has a driving capacity of 10 mA .

The number of pulses that can be generated per nautical mile can range between 100 and 400, configured as described in the “I/O Config” section in the Operator Manual. The default setting is that Speed Log output is disabled.

The speed pulse interval has a resolution of 50 ms, providing a resolution of 0.5 knots up to 10-20 knots depending on pulse rate and a working range up to 30 knots.

Note: Signal GND is internally connected to the negative 24V DC supply of the R4 Navigation Sensor.

5.2 R4 Display Cables Description

Figure 5-2 describes the signal and the power cables of the R4 Display, and which internal wires of the signal cable that corresponds to each interface. Note that TX on the R4 Display shall be connected to RX on interfacing equipment and RX on the R4 Display shall be connected to TX on interfacing equipment.

The individual ports are further described in the following sections.

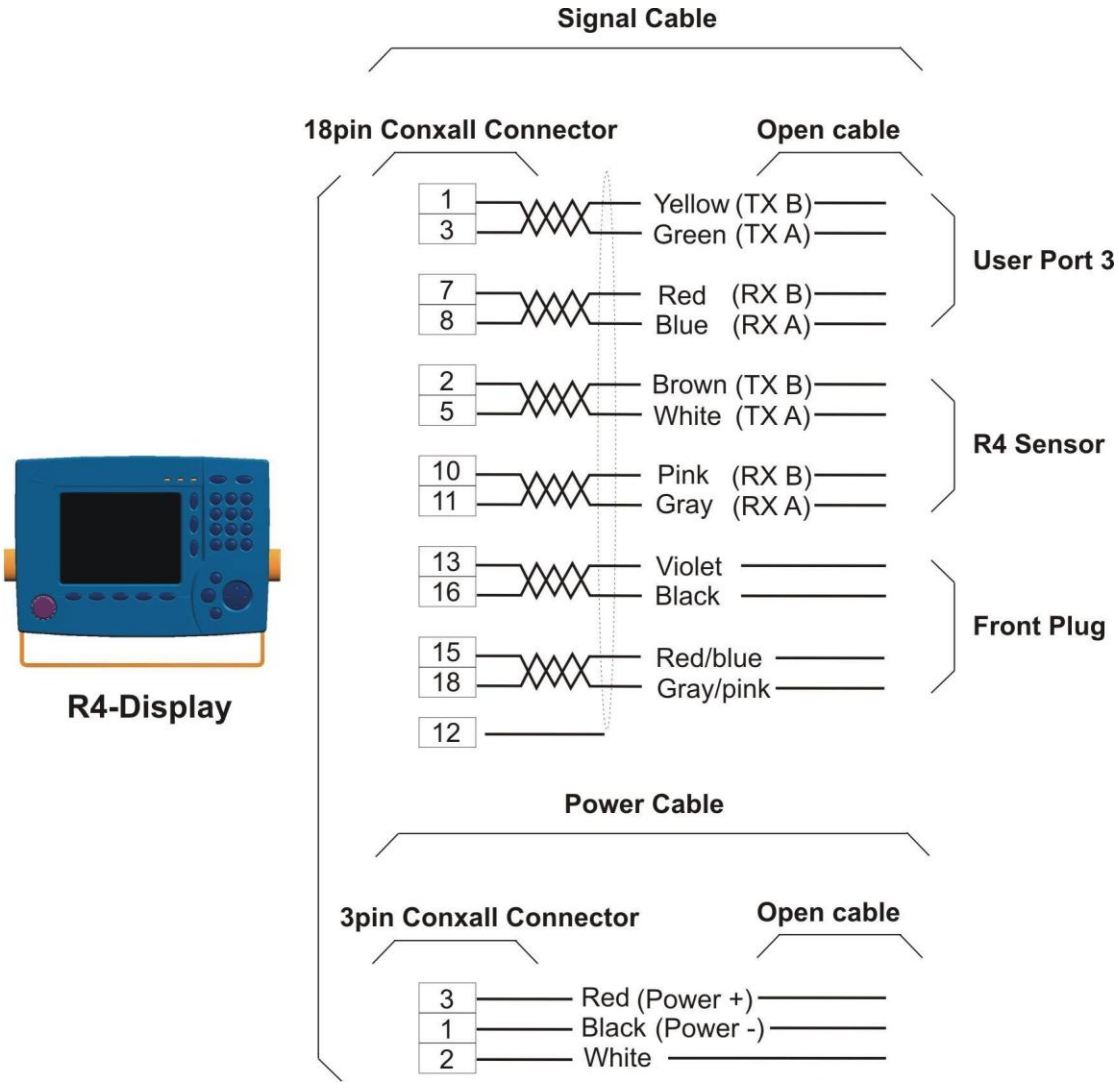


Figure 5-2: R4 Display Signal cable and Power cable description

5.2.1 Power Wires

Connect the Power + and the Power - wires to a 24 VDC power supply.

5.2.2 R4 Sensor Port

The R4 Sensor port is used to connect to the R4 Navigation Sensor unit. The TX lines of the port shall be connected to the RX lines of the System port on the R4 Navigation Sensor. The RX lines of the R4 Sensor port shall be connected to the TX lines of the System port.

5.2.3 User Port 3

The port is bidirectional and can be used to connect to external equipment and sensors, such as a compass or depth sensor. The port only supports a limited set of sentences.

To receive data on the port, its RX lines shall be connected to the TX lines of the external equipment.

For an external equipment to receive data from the R4 system via the port, the TX lines of the port shall be connected to the RX lines of the external equipment.

It is up to the user to configure the types of messages that shall be sent and received on the port, as well as the baud rate used for communication.

This port may also be connected to the User Port 3 of an external R4 navigation system in order to synchronize database and settings in a dual redundant system installation. The TX lines of one system shall be connected to the RX lines of the other system and vice versa. Refer to the Operator Manual, section “Redund Config” in the reference chapter for more information.

5.2.4 Front Plug Port (not used)

In a R4 Navigation System this port is not used. It is up to the installer to use this port for own purposes if desired.

The characteristics of the port are described in Appendix [A.5].

5.3 Dual Display Mode

The R4 Navigation System supports a dual display mode where two R4 Navigation Displays can be interconnected and used together with a single R4 Navigation Sensor. One of the displays (the primary display or dual display master) will have the full functionality of the R4 Navigation System whereas the other display (the secondary display or dual display slave) will be somewhat limited in terms of mainly configuration related tasks. Normal operational functions and databases for waypoints and routes will be shared by both displays.

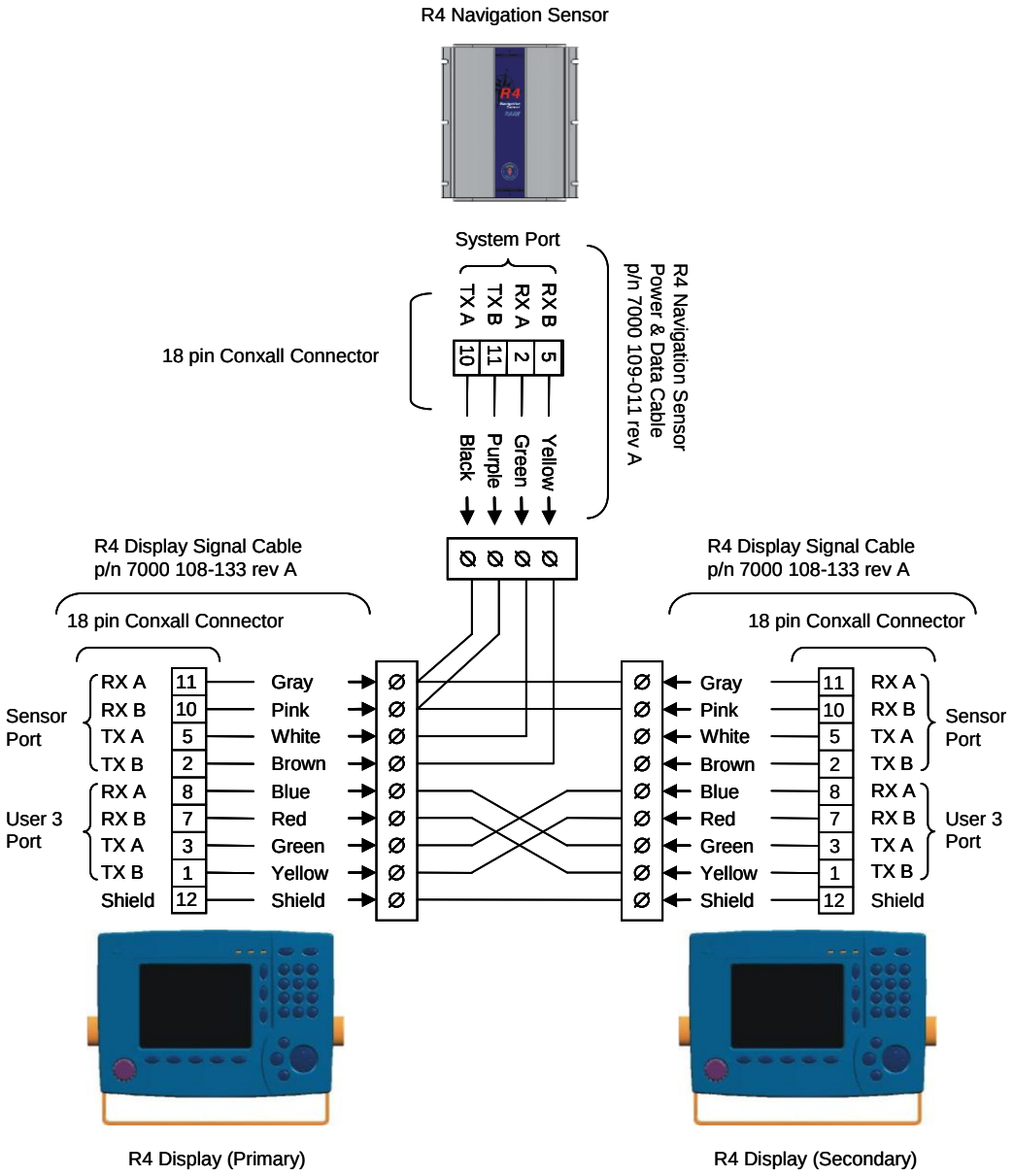
5.3.1 Dual Display Installation

The primary display is to be installed as in a basic R4 Navigation System. The secondary display shall be added to the basic system as follows:

- The Rx lines of the secondary R4 Navigation Display sensor port shall be connected to the Tx lines of the R4 Navigation Sensor system port (in parallel with the Rx lines of the primary display sensor port). The Tx lines of the secondary display sensor port shall not be connected
- The User 3 ports of the primary and secondary displays shall be interconnected (Rx to Tx and vice versa)
- Power may be supplied to the secondary display in parallel with the power supply to the primary display. One common or two individual 2A fuses may be used for the display power supply

The signal connections between the dual displays and the R4 Navigation sensor are illustrated in the figure below. Note that this is not a complete installation diagram. For details about power connections and other connections to the R4 Navigation Sensor refer to previous sections in this manual.

Refer to the Operator Manual, section “Redund Config” in the reference chapter for more information about configuration and operation of the dual display mode.



Details of signal connections between primary display, secondary display and R4 Navigation Sensor in a dual display installation

Figure 5-3: Dual Display Installation

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6 SYSTEM CONFIGURATION AND SETTINGS

This section describes how to start up the system, verify its functionality and, if needed, adjust the R4 Navigation System to its usage environment.

All parameters are set via the R4 Display. To set parameters, follow the steps as described in the following sections.

6.1 R4 Display Keys

The R4 Display has a number of keys that are used to navigate in the menus and enter values. The locations of the keys are illustrated in Figure 6-1.

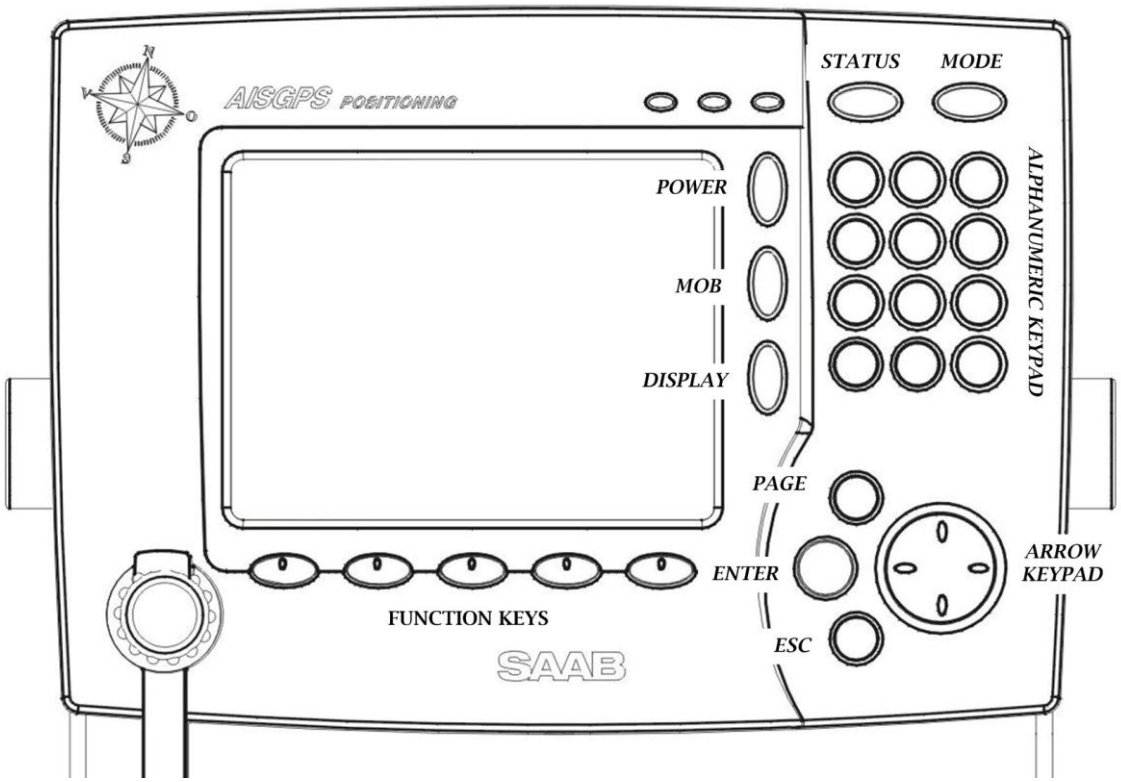


Figure 6-1: R4 Display key names and location

The keys are described below:

POWER Used for turning the R4 display on and off. To turn the power off, press and hold the key for about 3 seconds.

MOB Used to mark the spot of an event or where a person has fallen overboard. To activate the Man Over Board (MOB) function, hold the key for at least 5 seconds. If held shorter, the event mark functionality is activated.

DISPLAY Provides controls for fast configuration of backlight, contrast, LED and button illumination.

STATUS Not used in the R4 Navigation System.

MODE Used for changing mode of operation, which can be set to any of *Navigate*, *Plan Voyage*, *Alarms & Msgs* and *Config*.

ALPHANUMERIC KEYS These keys are used for entering text and numbers. To write a number in a numeric field press the key once. To write a character in a text field press once for the first character associated with the key, twice for the second character and so on.

PAGE Provides access to additional pages of function keys in certain views. A small arrow in the bottom right corner of the display indicates that more pages are available.

ENTER Used to start editing a field and for confirming data entry. Also used to view or edit a highlighted route, leg or waypoint.

ESC Returns display to previous page, or restores a data field's previous value.

∧ ∨ (Up and down on ***ARROW KEYPAD***) Moves the field and list highlight up and down, and the cursor position when editing a field.

< > (Left and right on ***ARROW KEYPAD***) Moves the field highlight left and right, and the cursor position when editing a field.

FUNCTION KEYS These keys have different functions depending on the current view. The function is displayed above each key on the screen. In some views, additional pages of function keys may be accessed with the ***PAGE*** key.

6.2 Status LEDs

6.2.1 R4 Navigation Sensor Status LEDs

The R4 Navigation Sensor has four LEDs that indicate its status. The red LED marked “PWR” indicates when lit that power is applied to the Sensor.

The yellow “GPS” LED indicates when continuously lit that the Sensor has obtained a solid GPS lock.

The yellow “CORR” LED indicates when continuously lit that the Sensor has achieved a solid SBAS or radio beacon lock with marginal data error rate. If the error rate is significant, this LED will blink showing that the lock is marginal.

The green “DGPS” LED indicates when lit that the Sensor has attained and is reporting a differentially corrected position. It may initially blink for a short while until the pseudorange residuals of the navigation solution have settled below a threshold value.

6.2.2 R4 Display Status LEDs

The three status LEDs of the R4 Display are used to indicate the current RAIM state. The RAIM state can be one of *safe* (green LED)*, caution* (yellow LED) and *unsafe* (red LED). The different RAIM states are described in the Operator Manual, section “RAIM Accuracy Limit” in the Getting Started chapter.

6.3 System Power Up

The system is turned on by applying power to the R4 Navigation Sensor and the R4 Display. The R4 Navigation Sensor does not have a switch for turning it on, but instead starts directly once power is applied. The R4 Display is turned on by pressing the ***POWER*** key. The LEDs on the R4 Display should light up momentarily indicating that it is starting.

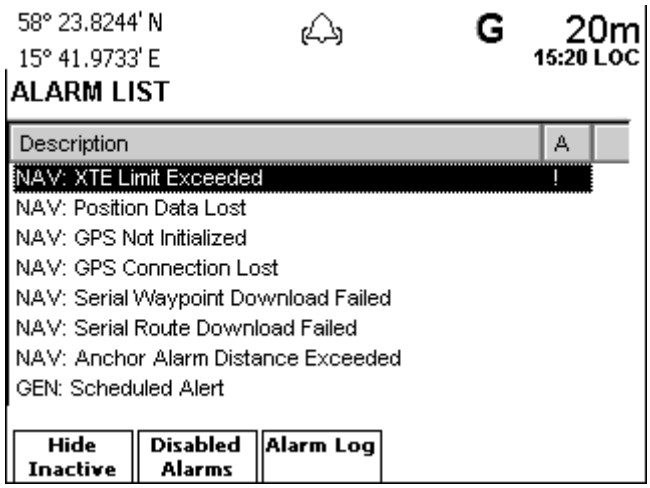
When the system is started, there may be some alarms displayed depending on which sensors that have been connected to the system. If any alarms are displayed, take notice of the alarms displayed and then acknowledge them by pressing the ***ENTER*** key until the alarms are not displayed any more.

The R4 Navigation Sensor should—when correctly installed—provide a position quickly, within approximately 60 seconds. SBAS lock requires approximately 30 seconds to acquire, and radio beacon lock 60 seconds. It can however take up to 5 minutes for a full ionospheric map to be received from SBAS, and optimum accuracy obtained. The status of the Navigation Sensor is indicated by its LEDs, as was described in section 6.2 above.

To continue the system configuration, see the following sections.

6.4 Viewing Active Alarms

In addition to being indicated by pop-up dialogs, the currently active alarms can be seen in the *Alarm List* view in the *Alarms & Msgs* mode. The view is accessed by pressing the ***MODE*** key followed by the function keys **ALARMS & MSGS** and **ALARM LIST**. The view is illustrated below.



On entrance, the view only displays the enabled alarms. To view the status of alarms that have been disabled (if any), press function key **Show Disabled**.

Active alarms are indicated with an exclamation mark (!).

6.5 GPS Connection Lost Troubleshooting

The R4 Display continuously monitors the serial connection to the R4 Navigation Sensor. If the connection is lost or never established, the R4 Display will activate the alarm “GPS Connection Lost” and show the 

status icon. In this state, the Display can not communicate with the Navigation Sensor. Perform the following steps to troubleshoot the condition:

1. Verify that the correct cables have been connected to the R4 Display and to the R4 Navigation Sensor. Note that both cables use 18-pin Conxall male connectors. The cable marked “7000 108-133” (with 13 pins mounted in the connector) should be connected to the R4 Display. The cable marked “7000 109-011” (with 18 pins mounted in the connector) should be connected to the R4 Navigation Sensor.

2. Verify that power is correctly applied to the R4 Navigation Sensor, indicated by the red LED marked “PWR” being lit on the Sensor. If not, check the wiring of the positive and negative power wires.

3. Verify the wiring of the interconnection between the R4 Display and R4 Navigation Sensor. Ensure that the TX lines of the R4 Sensor port on the R4 Display are connected to the RX lines of the System port on the R4 Navigation Sensor, and vice versa. Ensure that TX-A is connected to RX-A, TX-B to RX-B and so on, as illustrated in Table 6-1.

Table 6-1. Connections between R4 Display and R4 Navigation Sensor

The "R4 Sensor" port on the R4 Display		The "System" port on the R4 Navigation Sensor
TX-A	⇔	RX-A
TX-B	⇔	RX-B
RX-A	⇔	TX-A
RX-B	⇔	TX-B

See the wiring diagram in appendix A.8.

4. Verify the communication rate of the R4 Sensor port on the R4 Display. It should be set to 57600 bps. The communication rate can be seen in the *Port Rate Config* view, as described in section "Port Rate Config" in the Reference chapter of the Operator's Manual.

5. The *View Raw Data* view can be used to monitor the traffic on the R4 Sensor port, which gives information on if any data are received from the R4 Navigation Sensor. The *View Raw Data* view is described in section "Port Rate Config" in the Reference chapter of the Operator Manual. If the *View Raw Data* screen displays garbage characters, it is possible that the A and B wires of the interconnection between the R4 Display and R4 Navigation Sensor have been interchanged. See step 3 above. If this does not help, contact your R4 Navigation System dealer.

6.6 Position Data Lost Troubleshooting

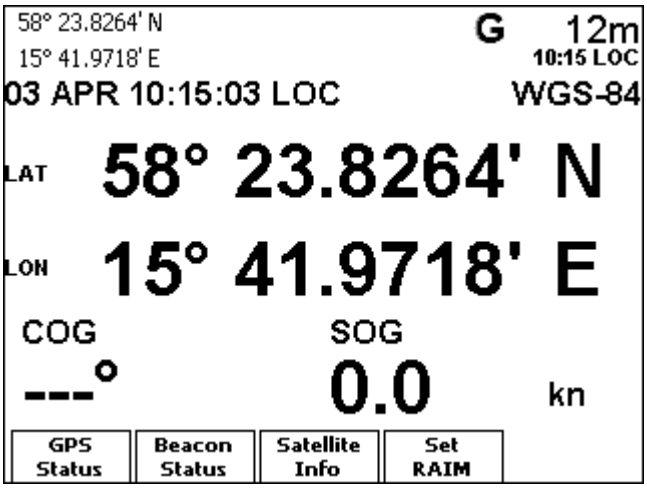
The alarm "Position Data Lost" indicates that no valid positioning information is received from the R4 Navigation Sensor. If the alarm "GPS Connection Lost" also is active, then the communication with the Navigation Sensor is not functioning and should be resolved first, as described in section 6.4 above.

When only the "Position Data Lost" alarm is active, this indicates that the R4 Navigation Sensor is not receiving a good enough GPS satellite signal to produce a position. The  status icon will be shown. Check the connection of the antenna cable to the Navigation Sensor and to the MGA-2 or MGL-4 antenna. Also check the installation and placement of the antenna, and ensure that it conforms to that specified in section 4.2. The *Satellite Info* view, described in step 3 of section 6.7, can give further details on received position data.

6.7 System Functional Check

When the R4 Navigation System has been installed according to the procedures described in the previous sections and no "GPS Connection Lost" or "Position Data Lost" alarms are displayed, it is recommended to make a first functional check of the system. This can be done following the procedure described below.

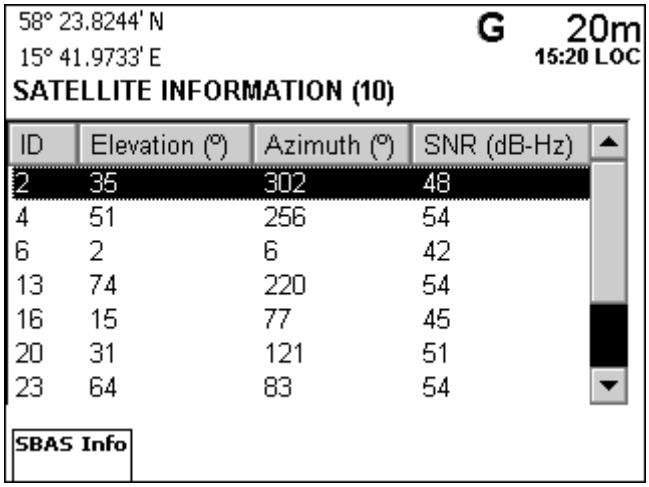
1. Press ***MODE*** key and then press function key **NAVIGATE** followed by **Position**. The *Position* view should be displayed, as illustrated below:



2. Verify that latitude and longitude are displayed, and that an icon in the status bar indicates that valid position information is received. This is indicated by one of the icons **G** (valid uncorrected position), **B** (position corrected using radio beacon differential corrections), **D** (position corrected using external corrections) or **D** SBAS (position corrected using SBAS differential corrections).

To verify the quality of received GPS and radio beacon signals, the following steps can be performed. The signal strength is measured as a signal to noise (SNR) ratio. (The SNR is the strength of the signal above the noise floor.) The higher the SNR, the better your receiver is receiving the signal. The optimum antenna location will be a position where your average SNR is highest. You should turn on all equipment that you intend to use during normal operation when locating the best position for the antenna.

3. To verify the signal strength of received GPS signals, press the function key **Satellite Info** when in the *Position* view. The following view should be displayed.

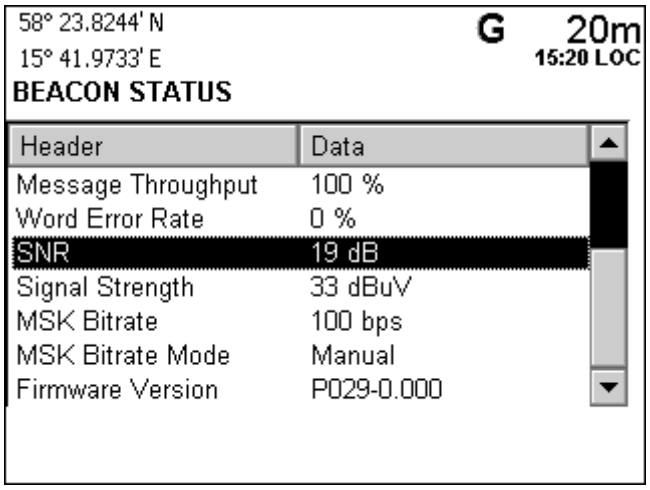


The *Elevation* field presents each satellite's height in degrees above the horizon. The *Azimuth* field presents the satellite's angular horizontal position, counted clockwise from the north. The R4 Navigation Sensor is more precise when it receives satellites widely spread across the sky, at various elevations.

The *SNR* column shows the SNR for each received satellites signal. A good antenna installation should receive three or more satellites with SNR values above 50. If few satellite signals are received, and / or the received signals have low SNR ratings, this could indicate that the GPS reception is poor and that the position of the antenna needs to be adjusted. See section 4.3.1 for antenna placement guidelines.

4. If installing a DGPS configuration with a R4 DGPS Navigation Sensor, it is also possible to monitor the received radio beacon signal strength. Follow the steps below.

   Go back to the *Position* view by pressing ***ESC*** and then press function key **Beacon Status**. Use ∨ to scroll down to the second page of information so the SNR value can be inspected. The following view should be displayed.



The observed radio beacon SNR value should be interpreted as follows:

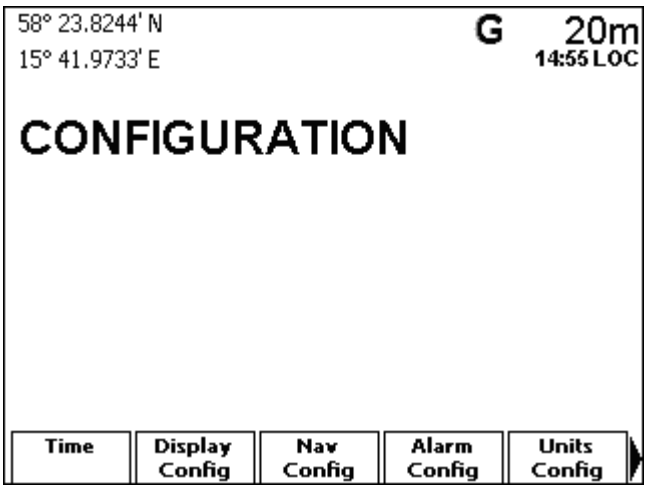
SNR	Description	Data Throughput
>25	Excellent	100% data throughput
20 to 25	Very Good	100% data throughput
15 to 20	Good	Good data throughput up to 100%
10 to 15	Stable	Moderate to good data throughput
7 to 10	Intermittent	Low data throughput
<7	No Lock	No data throughput

If the received signal has a low SNR rating, this could indicate that the radio beacon reception is poor and that the position of the Combined GPS/Beacon antenna needs to be adjusted. See section 4.3.1 for antenna placement guidelines.

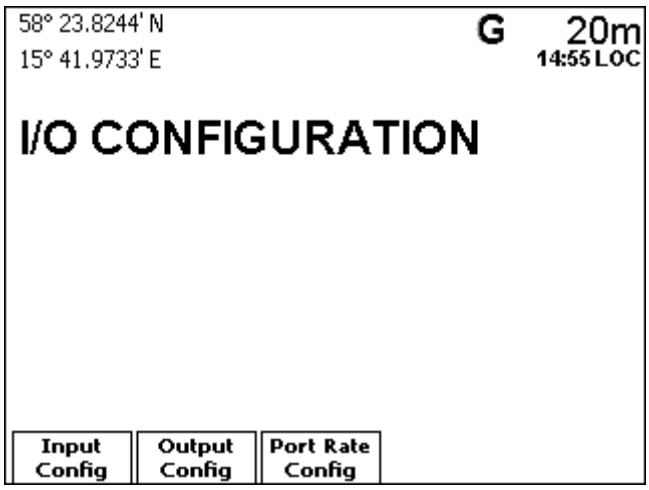
6.8 Specifying Port Communication Rates

To connect external systems and sensors to the R4 Navigation System, the communication rates of the serial ports might have to be adjusted. The speed log output rate can also be adjusted – per speed log output is disabled. To adjust these settings, follow the steps below.

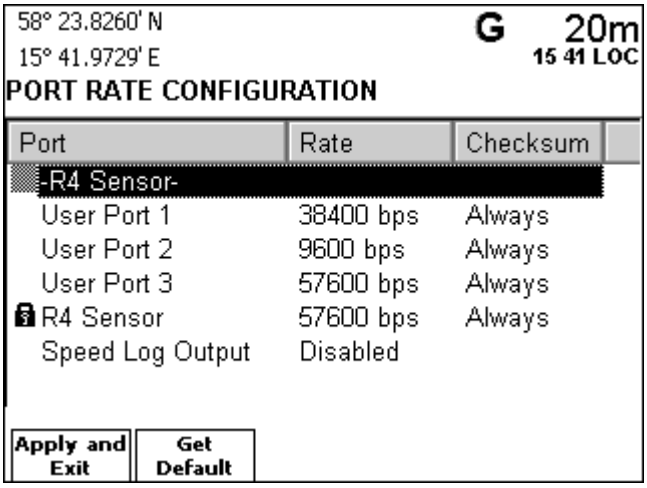
1. Enter *Config* mode by pressing the ***MODE*** key followed by function key **CONFIG**.



2. Press the ***PAGE*** key, and then function key **I/O Config.** The *I/O Configuration* view is shown.



3. Press function key ***Port Rate Config***. The Port Rate Configuration view is shown, as illustrated below.



4. Select the port to modify communication rate for using ∧ ∨, and press ***ENTER***.

5. Use ∧ ∨ to select the desired communication rate, and press ***ENTER*** when done.

6. Press function key **Apply and Exit** to store the made changes.

6.9 Configuring Output Sentences

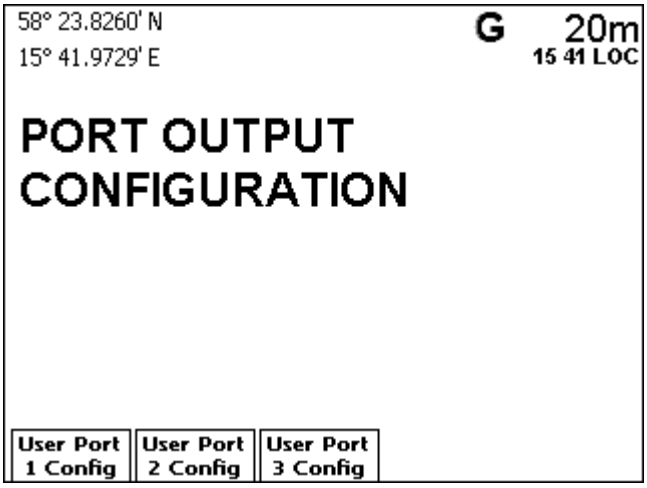
The sentences that are sent on each of the user ports are configurable on sentence level. The sentences that can be output from the R4 Navigation System are listed in section 7.4. Each sentence configured for output will increase the load on the port. Only turn on the sentences that you intend to use.

To configure output sentences, follow the steps described below. Step 1 and 2 are identical to the first two steps described in section 6.8.

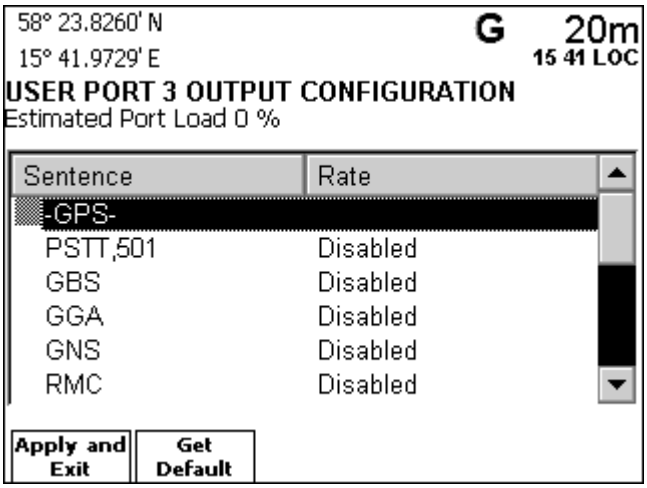
1. Enter *Config* mode by pressing the ***MODE*** key followed by function key **CONFIG**.

2. Press the ***PAGE*** key, and then function key **I/O Config.** The *I/O Configuration* view is shown.

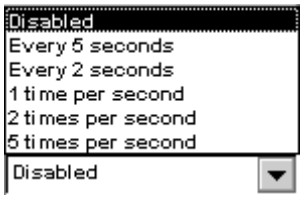
3. Press function key **Output Config** to display the *Port Output Configuration* view, as illustrated below.



4. Press the function key corresponding to the port to configure output sentences for. The view for configuring output sentences is displayed, as illustrated below.



5. Select the sentence to modify the sentence send rate for using ∧ ∨, and press ***ENTER*.** A drop-down box is displayed, with the send rates valid for the selected sentence. See illustration to the right. Use ∧ ∨ to select the entry in the drop-down box that best represents your desired rate, and then press ***ENTER*.**



6. Repeat the procedure for each sentence that you wish to modify. Press the **Apply and Exit** function key when done.

7. Press ***ESC*** to leave the *Port Output Configuration* view, and ***ESC*** again to leave the *I/O Configuration* view.

6.10 Adjusting System Settings

The R4 Navigation System is fully operational once correctly mounted, connected and configured, as have been described in this document. However, it may be desired to adjust some system characteristics to the operating environment and the preferences of the users of the system. System settings that can be adjusted includes—among others—used waypoint pass criterion, measurement units, cross-track error limit and enabled and disabled alarms. For information on adjustable parameters please refer to the Operator Manual, section “Adjusting Settings” in the Reference chapter.

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7 SERIAL COMMUNICATION INTERFACES

This section describes the electrical characteristics of the serial interfaces in the R4 Navigation System, as well as the supported IEC 61162 input and output sentences.

7.1 Electrical Characteristics R4 Display

7.1.1 Output Drive Capacity

Each talker output can have a maximum of 10 listeners drawing 2.0 mA.

7.1.2 Input Load

Each listener draws less than 2 mA @ 2 V input voltage.

7.1.3 Termination

If needed, 1 kΩ line termination resistors can be placed in the terminal block on the input ports.

7.1.4 Schematics

Each of the RS422 serial interfaces on the R4 Display fulfils the requirements as specified in Ref. [2]. In addition, they support baud rates up to 115200. For details of input and output schematics, see Figure 7-1 and Figure 7-2 respectively.

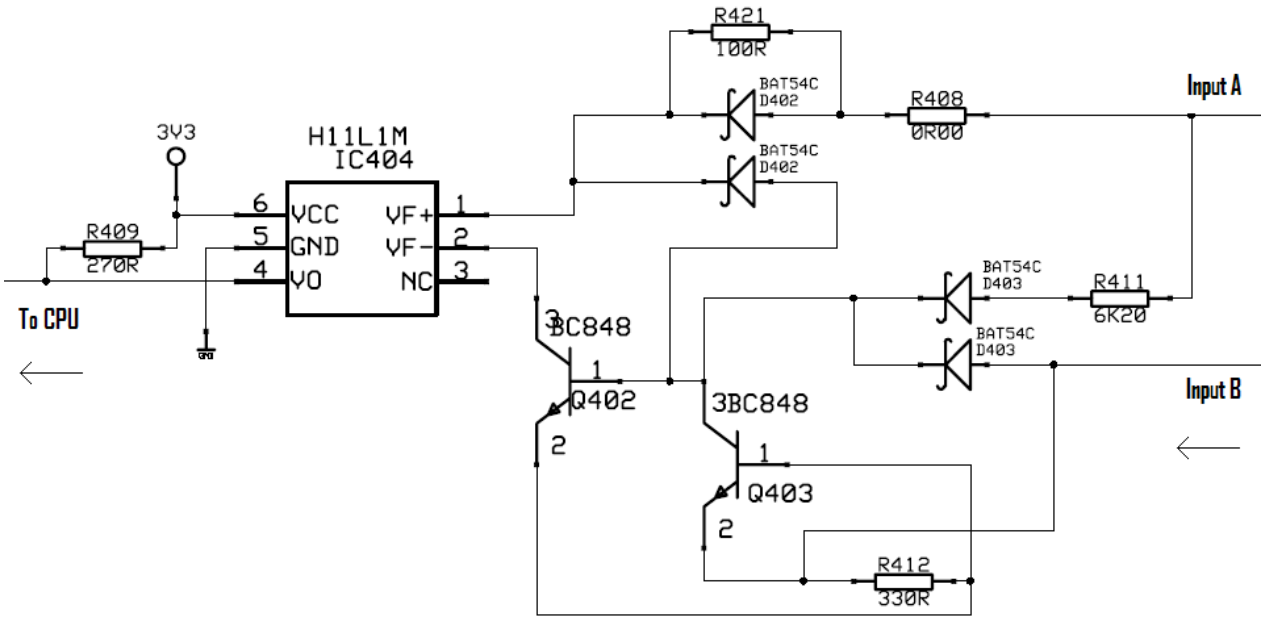


Figure 7-1: R4 Display serial interface input schematics

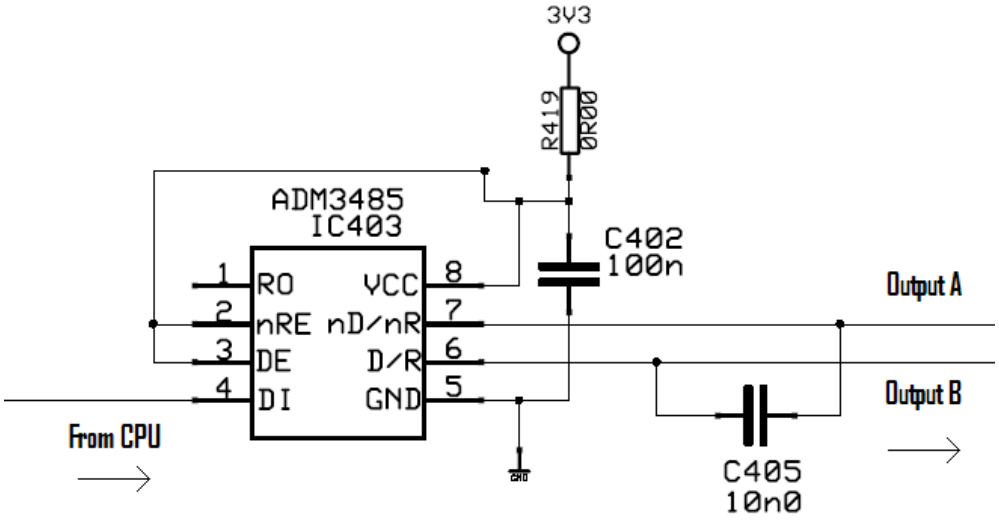


Figure 7-2: R4 Display serial interface output schematics

7.2 Electrical Characteristics R4 Navigation Sensor

7.2.1 Output Drive Capacity

Each talker output can have a maximum of 20 listeners drawing 2.0 mA.

7.2.2 Input Load

Each listener draws less than 2 mA @ 2 V input voltage.

7.2.3 Termination

If needed, 1 kΩ line termination resistors can be placed in the terminal block on the input ports.

7.2.4 Schematics

Each of the RS422 serial interfaces on the R4 Navigation Sensor fulfils the requirements as specified in Ref. [2]. In addition, User Port 1 supports a communication rate up to 38400 bps and User Port 2 up to 19200 bps. For details of input and output schematics, see Figure 7-3 and Figure 7-4 respectively.

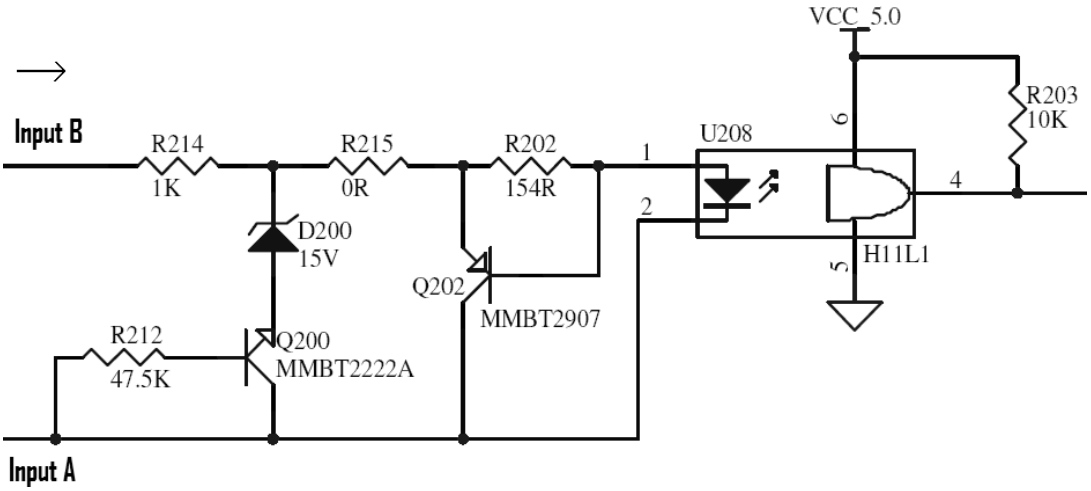


Figure 7-3: R4 Navigation Sensor serial interface input schematics

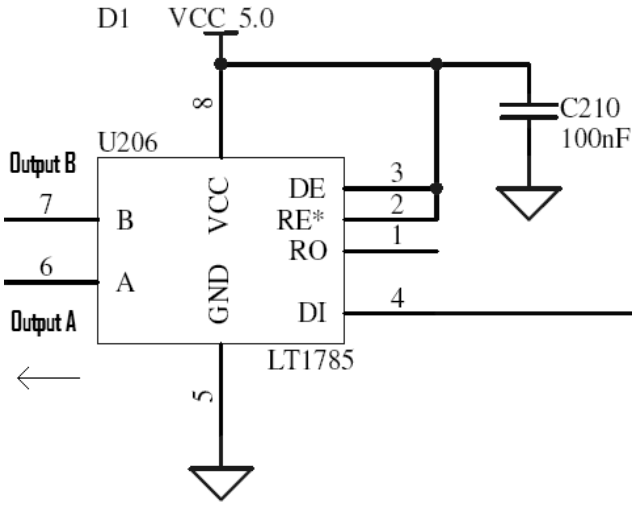


Figure 7-4: R4 Navigation Sensor serial interface output schematics

7.3 Input Sentences

The serial interfaces of the R4 Navigation System supports receiving and interpreting the input sentences described in Table 7-1 below. The user can configure which messages to receive and interpret and which port to receive them on. This is described in section “Input Config” in the Reference chapter of the Operator Manual, Ref. [1].

The `PSTT,510` sentence is always interpreted if received.

Table 7-1. Interpreted IEC 61162-1 and proprietary input sentences

Sentence	Name
ACK	Acknowledge Alarm (Note 1)
DBT	Depth below transducer
DPT	Depth
HDG	Heading, deviation and variation
HDT	Heading, true
VHW	Water speed and heading
RTE	Routes
Rnn	Routes (for old NMEA compliance)
WPL	Waypoint location
PSTT,510	Set RAIM accuracy level (proprietary message)

Note 1: The ACK message alarm identifier must be identical to the identifier field in the ALR output message relating to the alarm to be acknowledged.

7.4 Output Sentences

The serial interfaces of the R4 Navigation System supports transmission of the sentences described in Table 7-2 and Table 7-3 below. All sentences can be transmitted on User Port 1 and 2, while User Port 3 supports a limited set of sentences.

The user can configure which sentences to output on each serial interface and the output rate, as described in section “Output Config” in the Reference chapter of the Operator Manual, Ref. [1].

Sentences marked with a transmission rate of “0.2 – 5 Hz” can be transmitted 0.2, 0.5, 1, 2 and 5 times per second. Sentences marked with a transmission rate of “0.033 – 0.2 Hz” can be transmitted every 5, 15 or 30 second. Sentences marked with “1 Hz” can be transmitted once per second only. Messages marked with “-“ are not supported on that port. Transmission of each sentence can also be disabled.

Table 7-2. Supported GPS output sentences

Sentence	Description	Port 1 & 2	Port 3
GGA	GPS fix data	0.2 – 5 Hz	1 Hz
GLL	Geographic position, latitude/longitude	0.2 – 5 Hz	-
GLL2 (NMEA 1.5)	Geographic position, latitude/longitude (Position with only 2 decimals)	1 Hz	1 Hz
GLL2 (NMEA 2.3)	Geographic position, latitude/longitude (Position with only 2 decimals)	1 Hz	1 Hz
GNS	GNSS fix data	0.2 – 5 Hz	1 Hz
RMC	Recommended minimum specific GNSS data	0.2 – 5 Hz	1 Hz
VTG	Course over ground and ground speed	0.2 – 5 Hz	1 Hz
ZDA	UTC time and date	0.2 – 5 Hz	1 Hz
DTM	Datum reference	0,033 – 0.2 Hz	0,033 – 0.2 Hz
GBS	GNSS satellite fault detection	1 Hz	1 Hz
GRS	GNSS range residuals	1 Hz	-
GSA	GNSS DOP and active satellites	1 Hz	-
GST	GNSS pseudorange error statistics	1 Hz	-
GSV	GNSS satellites in view	1 Hz	-
PSTT,501	RAIM Status (proprietary message)	1 Hz	1 Hz

Table 7-3. Supported navigation output sentences

Sentence	Description	Port 1 & 2	Port 3
ALR	Alarm state	Note 1	Note 1
AAM	Waypoint arrival alarm	1 Hz	-
APB	Heading/track controller (Autopilot) sentence B	1 Hz	-
BOD	Bearing, origin to destination	1 Hz	-
BWC	Bearing and distance to waypoint (great circle)	1 Hz	-
BWR	Bearing and distance to waypoint, rhumb line	1 Hz	-
BWC/BWR Auto	BWC or BWR messages output depending on the navigation algorithm used for current leg in working route. (see Note 3)	1Hz	-
HSC	Heading steering command	1 Hz	-
RMB	Recommended minimum navigation information	1 Hz	-
XTE	Cross-track error, measured	1 Hz	-
WPL/RTE Working	Working routes and associated waypoint locations (see Note 4)	1 Hz	1 Hz
WPL/RNN Working (see Note 2)	Working routes and associated waypoint locations	1 Hz	1 Hz
WPL/RTE Upload	Complete routes and associated waypoint locations, and individual waypoints (see Note 5)	1 Hz	1 Hz

Note 1: The ALR message provides current state of all external alarms with 3Hz every 30 seconds, and for individual alarms with a single message when an alarm state has changed.

Note 2: Supported for NMEA backwards compliance. Use of `WPL/RTE` is recommended.

Note 3: BWC or BWR messages (as determined by the selected default navigation algorithm) with null data will be transmitted when no working route is selected. Duplicate messages may be transmitted if BWC/BWR Auto is selected together with BWC and/or BWR.

Note 4: The previous waypoint and up to next four waypoints of the working route will be transmitted. When sailing towards the first waypoint in the working route, the first transmitted waypoint will be the current position when the working route is selected (t0).

Note 5: Route or waypoint(s) to be uploaded are manually selected and transmitted once.

8 TECHNICAL SPECIFICATIONS

8.1 R4 Display

PHYSICAL

Dimensions:	Height: 207 mm Width: 270 mm Depth: 102 mm
Weight:	1.1 kg

POWER

Input Voltage:	24 V DC (22 to 31V DC)
Current need:	Nom 0.35 A (8.4 W) @ 24 VDC input

ENVIRONMENTAL

Temperature:	-15°C to +55°C (Operational) -55°C to +85°C (Storage)
Vibrations:	IEC 60945 ed. 4.
EMC:	IEC 60945 ed. 4
Compass Safe Distance:	53 cm (for standard magnetic compass) and 28 cm (for steering magnetic compass)

8.2 R4 Navigation Sensor

Specifications are valid for both the *R4 GPS Navigation Sensor* and the *R4 DGPS Navigation Sensor* unless otherwise specified.

PHYSICAL

Dimensions:	Height: 39 mm Width: 128 mm Depth: 137 mm
Weight:	0.5 kg
Antenna connector:	TNC-Female

POWER

Input power voltage:	24 V DC (10 to 32V DC)
Nominal power:	2.0 W (GPS version) 2.7 W (DGPS version)
Nominal current:	0.08 A @ 24 VDC input (GPS version) 0.11 A @ 24 VDC input (DGPS version)
Antenna feeding:	+5 VDC
Antenna input impedance:	50 Ω

ENVIRONMENTAL

Temperature:	-30°C to +70°C (Operational) -40°C to +80°C (Storage)
Vibrations:	IEC 60945 ed. 4.
EMC:	IEC 60945 ed. 4
Compass Safe Distance:	60 cm (for standard magnetic compass) and 40 cm (for steering magnetic compass)

INTERNAL GPS RECEIVER

Type:	L1, C/A code, 12 channel, parallel tracking (2 channels dedicated for SBAS tracking)
Update rate:	5 Hz max
Position accuracy:	< 2 m, Horizontal, 2 sigma (95%), DGPS < 5 m, Horizontal, 2 sigma (95%), GPS

INTERNAL BEACON RECEIVER (DPGS version only)

Channels:	2 independent channels
Frequency range:	283.5 to 325.0 kHz
Channel spacing:	500 Hz
MSK bit rate:	50, 100 and 200 bps
Input sensitivity:	2.5 µV/m for 6 dB SNR @ 200 bps MSK Rate

9 APPENDICES

APPENDIX A.1 – REFERENCE DOCUMENTS

Ref. [1]	7000 109-143	Operator Manual – R4 Navigation System
Ref. [2]	IEC 61162-1	Maritime navigation and radio communication equipment and systems – Digital interfaces – Part 1: Single talker and multiple listeners.
Ref. [3]	RTCM SC-104	RTCM Recommended Standards for Differential GNSS Service.
Ref. [4]	IEC 61162-2	Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 2: Single talker and multiple listeners, high-speed transmission
Ref. [5]	IEC 61108-1	Maritime navigation and radiocommunication 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

APPENDIX A.2– INTERPRETATION OF IEC 61162-1 SENTENCES

Output Sentences, GPS

All output sentences use GP as talker identifier.

DTM - Datum Reference

$--DTM,ccc,a,x.x,a,x.x,a,x.x,ccc

Field	Format	Name	Comment
1	--DTM	Sentence Id	
2	ccc	Local datum	Always W84
3	a	Local datum subdivision code	Null field
4	x.x	Lat offset, min	Always zero
5	a		
6	x.x	Lon offset, min	Always zero
7	a		
8	x.x	Altitude offset	Always zero
8	ccc	Reference datum	Always W84

GBS - GNSS Satellite Fault Detection

$--GBS,hhmmss.ss,x.x,x.x,x.x,xx,x.x,x.x,x.x

Field	Format	Name	Comment
1	--GBS	Sentence Id	
2	hhmmss.ss	UTC time of GGA or GNS	
3	x.x	Expected error in latitude	
4	x.x	Expected error in longitude	
5	x.x	Expected error in altitude	
6	xx	ID number of most likely failed satellite	
7	x.x	Probability of missed detection for most likely failed satellite	
8	x.x	Estimate of bias	
9	x.x	Standard deviation of bias estimate	

GGA - Global Positioning System Fix Data

$--GGA,hhmmss.ss,llll.ll,a,yyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx

Field	Format	Name	Comment
1	--GGA	Sentence Id	
2	hhmmss.ss	UTC of position	
3	llll.ll	Latitude	
4	A		
5	yyyy.yy	Longitude	
6	a		
7	x	GPS quality indicator	
8	xx	Satellites in use	
9	x.x	Horizontal dilution of precision	
10	x.x	Antenna altitude	
11	M	Units of antenna altitude, meter	
12	x.x	Geodial separation	
13	M	Units of geodial sep.	
14	x.x	Age of differential GPS data	
15	xxxx	Differential reference station ID	

GLL – Geographic position, latitude/longitude

$--GLL,llll.ll,a,yyyy.yy,a,hhmmss.ss,A,a

Field	Format	Name	Comment
1	--GLL	Sentence Id	
2	llll.ll	Latitude	
3	a		
4	yyyy.yy	Longitude	
5	a		
6	hhmmss.ss	UTC of position	
7	A	Status	
8	a	Mode indicator	

GNS – GNSS fix data

$--GNS,hhmmss.ss,llll.ll,a,yyyy.yy,a,c--c,xx,x.x,x.x,x.x,x.x,x.x

Field	Format	Name	Comment
1	--GLL	Sentence Id	
2	hhmmss.ss	UTC of position	
3	llll.ll	Latitude	
4	a		
5	yyyy.yy	Longitude	
6	a		
7	c--c	Mode indicator	
8	xx	Total number of satellites	
9	x.x	HDOP	
10	x.x	Antenna altitude, meter	
11	x.x	Geodial separation	
12	x.x	Age of differential corrections	
13	x.x	Differential reference station ID	

GRS – GNSS range residuals

$--GRS,hhmmss.ss,x,x.x,x.x,…

Field	Format	Name	Comment
1	--GRS	Sentence Id	
2	hhmmss.ss	UTC time of associated GGA or GNS fix	
3	X	Mode	
4	x.x	Range residuals (1)	
5	x.x	Range residuals (2)	
…	…	…	
15	x.x	Range residuals (12)	

GSA – GNSS DOP and active satellites

$--GSA,a,x,x.x,x.x,…,x.x,x.x,x.x,x.x

Field	Format	Name	Comment
1	--GSA	Sentence Id	
2	A	Mode	
3	X	Mode	
4	x.x	Satellite ID (1)	
5	x.x	Satellite ID (2)	
…	…	…	
15	x.x	Satellite ID (12)	
16	x.x	PDOP	
17	x.x	HDOP	
18	x.x	VDOP	

GST – GNSS pseudorange error statistics

$--GST,hhmmss.ss,x.x,x.x,x.x,x.x,x.x,x.x,x.x

Field	Format	Name	Comment
1	--GST	Sentence Id	
2	hhmmss.ss	UTC time of associated GGA or GNS fix	
3	x.x	RMS value	
4	x.x	Standard deviation of semi-major axis	
5	x.x	Standard deviation of semi-minor axis	
6	x.x	Orientation of semi-major axis	
7	x.x	Standard deviation of latitude error	
8	x.x	Standard deviation of longitude error	
9	x.x	Standard deviation of altitude error	

GSV – GNSS satellites in view

$--GSV,x,x,xx,xx,xx,xxx,xx,...

Field	Format	Name	Comment
1	--GSV	Sentence Id	
2	x	Total number of messages	
3	x	Message number	
4	x	Total number of satellites in view	
5	xx	Satellite ID number (Satellite 1)	
6	xx	Elevation, degrees (Satellite 1)	
7	xxx	Azimuth, degrees true (Satellite 1)	
8	xx	SNR (Satellite 1)	
…	…	…	Fields for all satellites are used

RMC – Recommended minimum specific GNSS data

$--RMC,hhmmss.ss,A,llll.ll,a,yyyy.yy,a,x.x,x.x,xxxxxx,x.x,a,a

Field	Format	Name	Comment
1	--RMC	Sentence Id	
2	hhmmss.ss	UTC of position	
3	A	Status	
4	llll.ll	Latitude	
5	a		
6	yyyy.yy	Longitude	
7	a		
8	x.x	Speed over ground, knots	
9	x.x	Course over ground, degrees true	
10	xxxxxx	Date	
11	x.x	Magnetic variation	
12	a		
13	a	Mode indicator	

VTG – Course over ground and ground speed

$--VTG,x.x,T,x.x,M,x.x,N,x.x,K,a

Field	Format	Name	Comment
1	--VTG	Sentence Id	
2	x.x	Course over ground, degrees true	
3	T		
4	x.x	Course over ground, degrees magnetic	
5	M		
6	x.x	Speed over ground, knots	
7	N		
8	x.x	Speed over ground, km/h	
9	K		
10	a	Mode indicator	

ZDA – Time and date

$--ZDA,hhmmss.ss,xx,xx,xxxx,xx,xx

Field	Format	Name	Comment
1	--ZDA	Sentence Id	
2	hhmmss.ss	UTC	
3	xx	Day (UTC)	
4	xx	Month (UTC)	
5	xxxx	Year (UTC)	
6	xx	Local zone hours	Used if configured
7	xx	Local zone minutes	**Used if configured**

Output Sentences, Navigation

All output sentences use GP as talker identifier.

ALR – Alarm State

$--ALR,hhmmss.ss,xxx,A,A,c--c

Field	Format	Name	Comment
1	--ALR	Sentence Id	
2	hhmmss.ss	UTC time of last condition change	
3	xxx	Alarm identifier number	
4	A	Alarm condition	A = Threshold exceeded, V = not exceeded
5	A	Acknowledge state	A = Acknowledged, V = Unacknowledged
6	c--c	Alarm description text	

AAM – Waypoint arrival alarm

$--AAM,A,A,x.x,N,c--c

Field	Format	Name	Comment
1	--AAM	Sentence Id	
2	A	Status	
3	A	Status	
4	x.x	Arrival circle radius	
5	N	Units of radius, nautical miles	
6	c--c	Waypoint ID	

APB – Heading/Track Controller (Autopilot) Sentence B

$--APB,A,A,x.x,a,N,A,A,x.x,a,c--c,x.x,a,x.x,a,a

Field	Format	Name	Comment
1	--APB	Sentence Id	
2	A	Status	
3	A	Status	
4	x.x	Magnitude of XTE	
5	a	Direction to Steer	
6	N	XTE units	
7	A	Status	
8	A	Status	
9	x.x	Bearing origin to destination	
10	a		
11	c--c	Destionation waypoint ID	
12	x.x	Bearing, present position to destination	
13	a		
14	x.x	Heading to steer to destination	
15	a		
16	a	Mode indicator	

BOD – Bearing, origin to destination

$--BOD,x.x,T,x.x,M,c--c,c--c

Field	Format	Name	Comment
1	--BOD	Sentence Id	
2	x.x	Bearing, degrees true	
3	T		
4	x.x	Bearing, degrees magnetic	
5	M		
6	c--c	Destination waypoint ID	
7	c--c	Origin waypoint ID	

BWC – Bearing and distance to waypoint

BWR – Bearing and distance to waypoint, rhumb line

$--BWC,hhmmss.ss,llll.ll,a,yyyy.yy,a,x.x,T,x.x,M,x.x,N,c--c,a

$--BWR,hhmmss.ss,llll.ll,a,yyyy.yy,a,x.x,T,x.x,M,x.x,N,c--c,a

Field	Format	Name	Comment
1	--BWC --BWR	Sentence Id	
2	hhmmss.ss	UTC of observation	
3	llll.ll	Waypoint latitude	
4	a		
5	yyyy.yy	Waypoint longitude	
6	a		
7	x.x	Bearing, degrees true	
8	T		
9	x.x	Bearing, degrees magnetic	
10	M		
11	x.x	Distance, nautical miles	
12	N		
13	c--c	Waypoint ID	
14	a	Mode indicator	

HSC – Heading steering command

$--HSC,x.x,T,x.x,M

Field	Format	Name	Comment
1	--HSC	Sentence Id	
2	x.x	Commanded heading, degrees true	
3	a		
4	x.x	Commanded heading, degrees magnetic	
5	a		

RMB – Recommended minimum navigation information

$--RMB,A,x.x,a,c--c,c--c,llll.ll,a,yyyy.yy,a,x.x,x.x,x.x,A,a

Field	Format	Name	Comment
1	--RMB	Sentence Id	
2	A	Status	
3	x.x	Cross track error, nautical miles	
4	a	Direction to steer L/R	
5	c--c	Origin waypoint ID	
6	c--c	Destination waypoint ID	
7	llll.ll	Destination waypoint latitude	
8	a		
9	yyyy.yy	Destination waypoint longitude	
10	a		
11	x.x	Range to destination, nautical miles	
12	x.x	Bearing to destination, degrees true	
13	x.x	Destination closing velocity	
14	A	Arrival status	
15	a	Mode indicator	

RTE – Routes

$--RTE,x.x,x.x,a,c--c,c--c,...,c--c

Field	Format	Name	Comment
1	--RTE	Sentence Id	
2	x.x	Total number of messages being transmitted	
3	x.x	Message number	
4	a	Message mode	
5	c--c	Route identifier	
6	c--c	Waypoint identifier (first)	
…	…	…	
n	c--c	Waypoint identifier (last)	

WPL – Waypoint location

$--WPL,llll.ll,a,yyyy.yy,a,c--c

Field	Format	Name	Comment
1	--VPL	Sentence Id	
2	llll.ll	Waypoint latitude, N/S	
3	a		
4	yyyy.yy	Waypoint longitude, E/W	
5	a		
6	c--c	Waypoint identifier	

XTE – Heading steering command

$--XTE,A,A,x.x,a,N,a

Field	Format	Name	Comment
1	--XTE	Sentence Id	
2	A	Status	
3	A	Status	
4	x.x	Magnitude of cross-track error	
5	a	Direction to steer, L/R	
6	N	Units, nautical miles	
7	a	Mode indicator	

Input Sentences

Per default, any talked identifier is accepted.

ACK – Acknowledge alarm

$--ACK,xxx

Field	Format	Name	Comment
1	--ACK	Sentence Id	Used
2	xxx	Alarm identifier number	Corresponds to ALR message for alarm to acknowledge

DBT – Depth below transducer

The displayed depth will be adjusted according to depth input configuration parameters. The used depth (in the correct unit) is calculated from field 2.

$--DPT,x.x,f,x.x,M,x.x,F

Field	Format	Name	Comment
1	--DPT	Sentence Id	Used
2	x.x	Water depth, feet	Used
3	f		
4	x.x	Water depth, meter	Not used
5	M		
6	x.x	Water depth, fathoms	Not used
7	F		

DPT – Depth

The displayed depth will be adjusted according to depth input configuration parameters.

$--DPT,x.x,x.x,x.x

Field	Format	Name	Comment
1	--DPT	Sentence Id	Used
2	x.x	Water depth relative to transducer, meter	Used
3	x.x	Offset from transducer, meter	Used if configured
4	x.x	Max range scale in use	Not used

HDG – Heading, Deviation And Variation

$--HDG,x.x,x.x,a,x.x,a

Field	Format	Name	Comment
1	--HDG	Sentence Id	Used
2	x.x	Magnetic sensor heading, degrees	Used
3	x.x	Magnetic deviation, degrees E/W	Used
4	a		
5	x.x	Magnetic variation, degrees E/W	Used
6	a		

HDT - Heading, True

$--HDT,x.x,T

Field	Format	Name	Comment
1	--HDG	Sentence Id	Used
2	x.x	Heading, degrees true	Used
3	T		

RTE – Routes

$--RTE,x.x,x.x,a,c--c,c--c,...,c--c

Field	Format	Name	Comment
1	--RTE	Sentence Id	Used
2	x.x	Total number of messages being transmitted	Used
3	x.x	Message number	Used
4	a	Message mode	Used
5	c--c	Route identifier	Used
6	c--c	Waypoint identifier (first)	Used
…	…	…	…
n	c--c	Waypoint identifier (last)	Used

WPL – Waypoint location

$--WPL,llll.ll,a,yyyy.yy,a,c--c

Field	Format	Name	Comment
1	--WPL	Sentence Id	Used
2	llll.ll	Waypoint latitude, N/S	Used
3	a		
4	yyyy.yy	Waypoint longitude, E/W	Used
5	a		
6	c--c	Waypoint identifier	Used

VHW – Water speed and heading

$--VHW,x.x,T,x.x,M,x.x,N,x.x,K

Field	Format	Name	Comment
1	--VHW	Sentence Id	Used
2	x.x	Heading, degrees true	Used
3	T		
4	x.x	Heading, degrees magnetic	Used
5	M		
6	x.x	Speed, knots	Used
7	N		
8	x.x	Speed, km/h	Not used
9	K		

APPENDIX A.3 – OTHER NMEA SENTENCES

Output Sentences

All output sentences use GP as talker identifier.

GLL2 (NMEA 1.5) – Geographic position, latitude/longitude

Position with 2 decimals only.

$--GLL,llll.ll,a,yyyy.yy,a,hhmmss.ss,A

Field	Format	Name	Comment
1	--GLL	Sentence Id	
2	llll.ll	Latitude	2 decimals only
3	a		
4	yyyy.yy	Longitude	2 decimals only
5	a		
6	hhmmss.ss	UTC of position	
7	A	Status	

GLL2 (NMEA 2.3) – Geographic position, latitude/longitude

Position with 2 decimals only.

$--GLL,llll.ll,a,yyyy.yy,a,hhmmss.ss,A,a

Field	Format	Name	Comment
1	--GLL	Sentence Id	
2	llll.ll	Latitude	2 decimals only
3	a		
4	yyyy.yy	Longitude	2 decimals only
5	a		
6	hhmmss.ss	UTC of position	
7	A	Status	
8	a	Mode indicator	

Rnn – Routes (old NMEA versions)

Can only be used for output of working (active) route. It is recommended to use the RTE sentence instead if this sentence.

$--Rnn,cccc,cccc,…,cccc

Field	Format	Name	Comment
1	--Rnn	Sentence id and route identifier	'nn' is always 00
2	cccc	Waypoint identifier (first)	
..	…	…	
15	cccc	Waypoint identifier (last)	

Input Sentences

Rnn – Routes (old NMEA versions)

Can only be used for input of working (active) route. It is recommended to use the RTE sentence instead if this sentence. Per default, any talker ID is accepted.

$--Rnn,cccc,cccc,…,cccc

Field	Format	Name	Comment
1	--Rnn	Sentence id and route identifier	'nn' is interpreted as route identifier (00 – 99).
2	cccc	Waypoint identifier (first)	Used
..	…	…	…
15	cccc	Waypoint identifier (last)	Used

APPENDIX A.4 – PROPRIETARY SENTENCES (PSTT)

In addition to standardized IEC sentences (described in IEC 61162-1) the R4 Navigation System supports the following proprietary sentences on its user ports.

Proprietary Output Sentence

The following proprietary sentence can be output from the R4 Navigation System.

$PSTT,501 – RAIM Status

This sentence provides information on the current RAIM status, as well as the settings used when calculating RAIM. It is output once every second.

$PSTT,501,hhmmss.ss,x,x.x,x.x,x.x

Field	Format	Name	Type	Comment
1	501	Sentence Id	Unsigned char	501 always
2	hhmmss.ss	Time	Char[9]	Hours, minutes, seconds and milliseconds in decimal notation. (Field left empty if time not available)
3	x	RAIM Flag	Integer	0 = Good (Green) 1 = Caution (Yellow) 2 = Unsafe (Red)
4	x.x	RAIM Radius	Float	RAIM Radius in meters.
5	x.x	Prob. HPR	Float	Max allowed probability (in %) for that the position is outside the RAIM Radius. Fixed 5.0000.
6	x.x	Prob. False	Float	Max allowed probability (in %) for that the RAIM calculation is wrong. Fixed 5.0000.

Proprietary Input Sentence

The following proprietary sentence can be input to the R4 Navigation System.

$PSTT,510 – Set RAIM Accuracy Level

This sentence is received from an external device, typically an ECDIS system, to change the RAIM accuracy level in the R4 Navigation System. The setting received overrides any RAIM settings present in the active route. When the active route has been ended, the override status is removed. Routes sailed after this can modify the RAIM accuracy level.

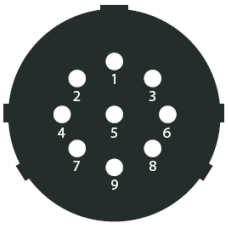
$PSTT,510,x

Field	Format	Name	Type	Comment
1	510	Sentence Id	Unsigned char	510 always
2	x	Navigation Accuracy	Integer	Navigation accuracy to set, in meters. Valid values are 1 to 999. If empty, the sentence removes any RAIM override condition

APPENDIX A.5 – FRONT PLUG PORT CHARACTERISTICS

The Front Plug port is available on the front of the R4 Display. In a R4 Navigation System the port is not used. It is up to the user to use this port for own purposes if desired. In a R4 AIS Transponder System, this port is used to connect to the Pilot port on a R4 Transponder.

The connections of the front plug port are directly forwarded to the 9-pin connector plug available on the front of the R4 Display. The pin numbering of the front plug is described in the figure below.



Front plug pin numbering

The connections between the signal cable and the front plug are listed in following table.

Internal Signal to Front plug connections in the R4 Display

Front plug	Signal plug	Color in signal cable
PIN 9	PIN 12	Shield
PIN 1	PIN 13	Violet
PIN 5	PIN 15	Red/blue
PIN 4	PIN 16	Black
PIN 6	PIN 18	Gray/pink

APPENDIX A.6 – SENSOR ANTENNA CABLE SELECTOR

The table below gives recommendation on cables that can be used for the navigation (MGA-2 or MGL-4) antenna connection. Due to the high frequency of GPS signals it's important that the attenuation in the cable is low for the specific frequency (1.5 GHz).

Specification of recommended cables

Type	Attenuation @ 1.5 GHz (dB/m)	∅ (mm)	Weight (kg/100m)
RG 58	0.9	5	3.7
RG 400	0.6	4.95	6.3
RG 223	0.6	5.40	5.5
RG 214	0.35	10.8	18.5
RG 225	0.3	10.9	23.3

For optimum performance of the R4 Navigation Sensor, 12 dB should remain after subtraction of cable loss from the antenna pre-amplifier gain. Thus, a maximum of 18 dB signal loss is allowed in the antenna cable, when using the 30 dB gain MGA-2 GPS antenna or MGL-4 Combined GPS/Beacon antenna. Given this criteria, the following recommended cable maximum lengths have then been calculated.

Recommended maximum cable length using standard antenna

Cable type	Max length with MGA-2 or MGL-4
RG 58	20 m
RG 400	30 m
RG 223	30 m
RG 214	51 m
RG 225	60 m

Maximum cable length is calculated as:

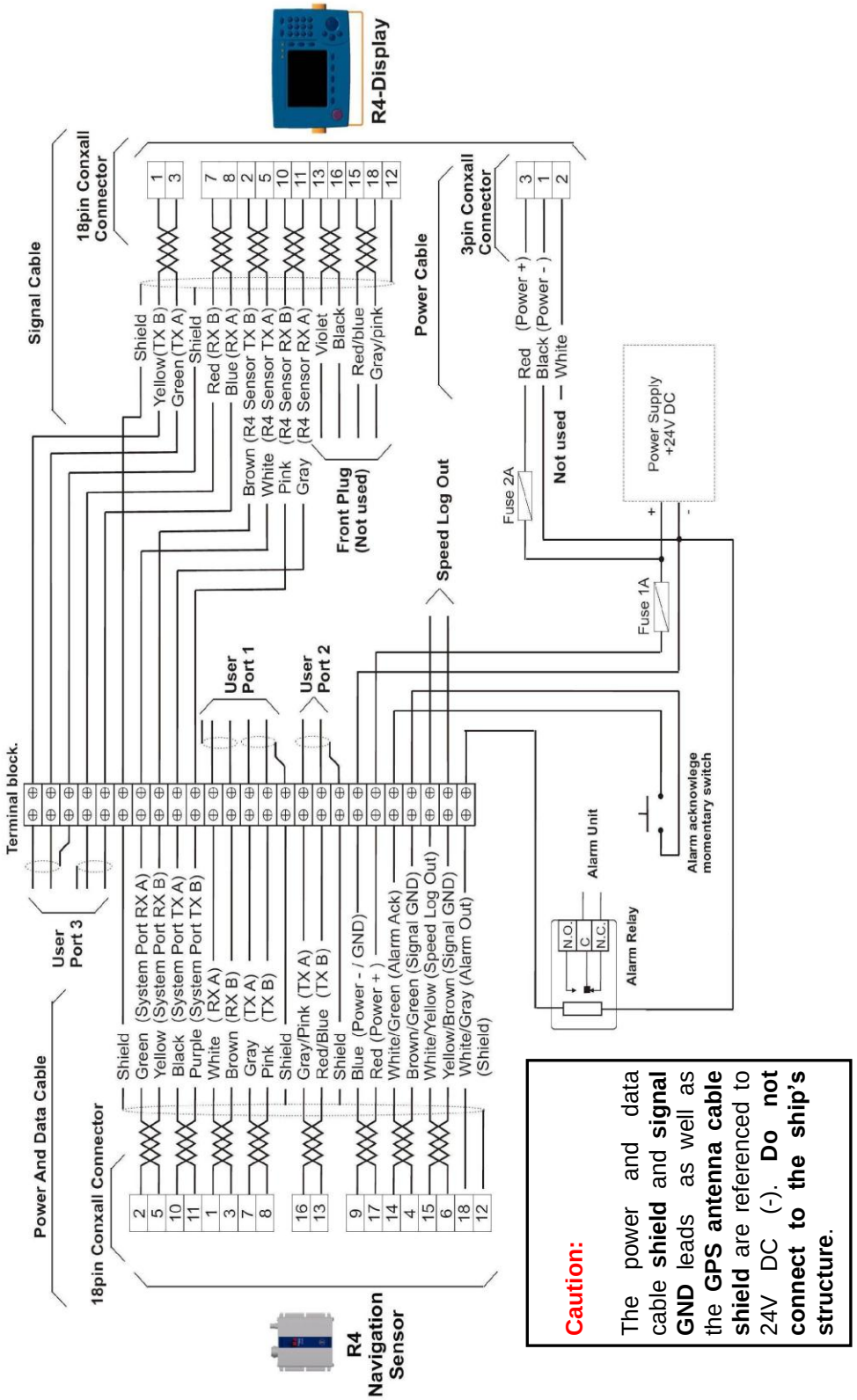
Maximum cable length = allowed total loss / cable attenuation per meter

APPENDIX A.7 – GLOSSARY

BIIT	Built In Integrity Test
COG	Course Over Ground
dB	Decibel
DC	Direct Current
DGNSS	Differential Global Navigational Satellite System
DGPS	Differential GPS
ECDIS	Electronic Chart Display and Information System
EGNOS	European Geostationary Navigation Overlay Service
GNSS	Global Navigation Satellite System – A common label for satellite navigation systems (such as GPS and GLONASS).
GPS	Global Positioning System
HF	High Frequency
IALA	International Association of Lighthouse Authorities
IEC	International Electro-technical Commission
IMO	International Maritime Organization
LED	Light Emitting Diode
MSAS	MTSAT Satellite Augmentation System (Japan)
N/A	Not Applicable
NMEA	National Marine Electronics Association
RTCM	Radio Technical Commission for Maritime Services.
Rx	Receive
SBAS	Satellite Based Augmentation System
SNR	Signal to Noise Ratio
SOG	Speed Over Ground
Tx	Transmit
UTC	Universal Time Coordinated
WAAS	Wide Area Augmentation System (United States)

APPENDIX A.8 – INSTALLATION WIRING DIAGRAM

The following figure illustrates how to wire the R4 Display and R4 Navigation Sensor to each other and to the power source.



Caution:

The power and data cable **shield** and **signal GND** leads as well as the **GPS antenna cable shield** are referenced to 24V DC (-). **Do not connect to the ship's structure.**