



EI-1 Electronic Inclinometer Operation and Service Manual

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Cassens & Plath GmbH

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Revision History

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1.1	15 FEB 2013	Revised for software update. Added description of the digital interface.	AW
1.2	3 MAY 2013	New features: Ethernet interface and slave display.	AW
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1.7.1	1 SEP 2015	Added description of remote dimming and DDC sentence.	AW
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1. Introduction

1.1. EI-1 Overview

Roll period and heel angle data, in combination with other ship's and environmental data, are essential for understanding the motion of the ship and its cargo, and in determining motion cues available to the crew.

Electronic inclinometers are intended to support the decision-making process of the master on board in order to avoid dangerous situations as well as Maritime Casualty Investigation by providing information about the roll period and the heel angle of the ship.

The EI-1 Electronic Inclinometer is fully compliant with the international standards for electronic inclinometer and other relevant standards.

1.2. System Composition

The standard configuration of EI-1 Electronic Inclinometer comprises a Sensor Unit and a Display Unit. Figure 1 shows the standard configuration of EI-1.

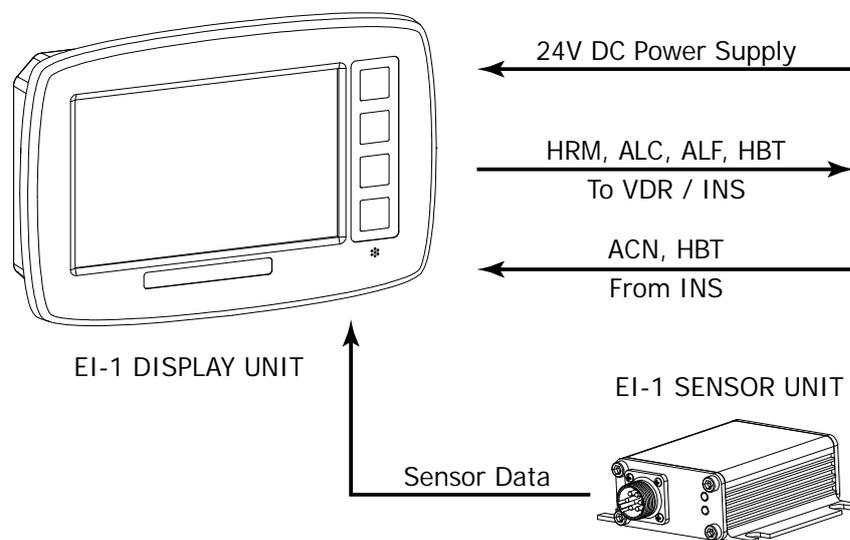


Figure 1: Standard Configuration

1.2.1. Sensor Unit

The Sensor Unit measures heel angle and pitch angle in real time. It delivers the data to the Display Unit.

Based on the state-of-the-art technology of micro-electro-mechanical systems (MEMS), the Sensor Unit embeds a high-accuracy, six-degrees-of-freedom MEMS sensor (3-axis

accelerometer and 3-axis gyroscope) as motion sensing element.

The heel angle and pitch angle data is calculated by an advanced sensor fusion and motion processing algorithm using the raw data from both the accelerometer and gyroscope. This enables reliable estimation of the ship's attitude in the presence of various linear and rotational movements, and thus ensures the accuracy of measurement under any possible situation that the ship may encounter.

1.2.2. Display Unit

The Display Unit receives instantaneous attitude and motion data from the Sensor Unit, and derives the roll period and amplitude statistics. It provides the following indications:

- Instantaneous heel angle
- Roll period
- Roll amplitude to port and starboard
- Pitch angle

Heel Angle Warning function is also provided and can be enabled or disabled by the user. The warning will be activated as soon as the heel angle exceeds the user-preset value.

1.2.3. Multiple Displays

Besides the standard configuration of one Sensor Unit and one Display Unit, the system also supports multiple displays by using additional Display Units and IEC 61162-450 digital interface, as shown in Figure 2.

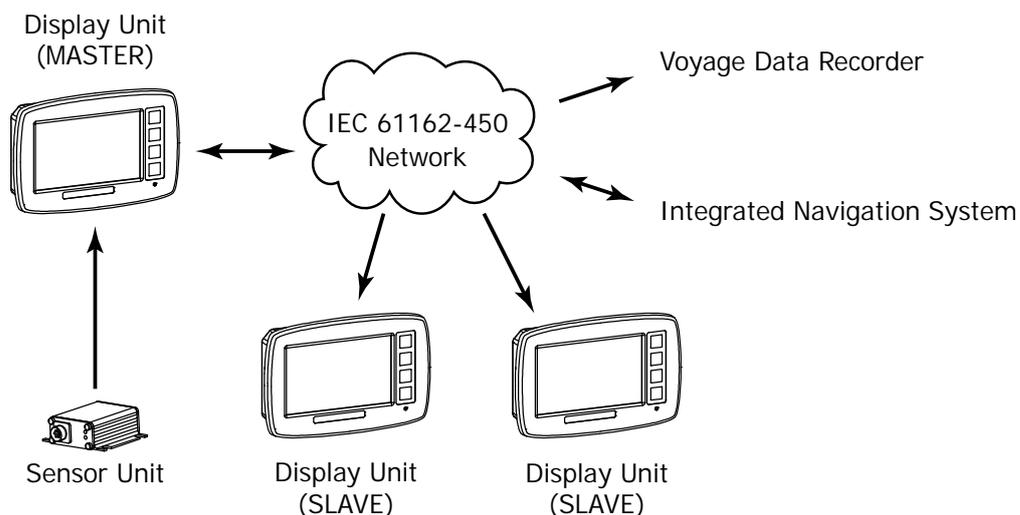


Figure 2: Multiple Display

2. Operating Instructions

2.1. Operation Panel

Figure 3 shows the operation panel on the Display Unit of EI-1.

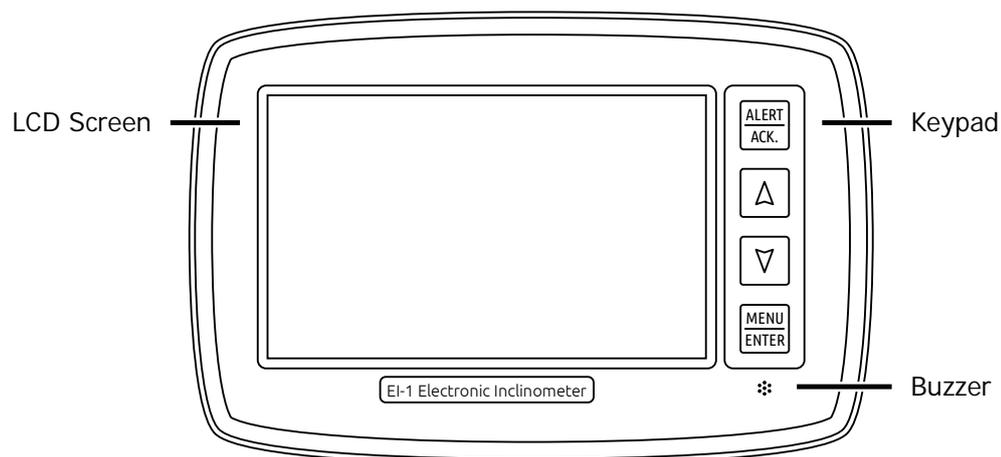


Figure 3: Operation Panel

The Display Unit is equipped with a color LCD screen (800×480 pixels) to display the graphical user interface. Four keys (**MENU/ENTER** , **▲** , **▼** and **ALERT/ACK.**) are provided for the user to operate the Display Unit. Buzzers are also available at the lower right corner of the operation panel and on the back side of the display unit.

The keys on the operation panel are illuminated and this makes the inclinometer very convenient to operate even at night. The brightness of the screen and the key illumination can be adjusted by the user in order to ensure the readability under all ambient light conditions and not to impair night vision.

2.2. Power On and Off

The EI-1 Electronic Inclinometer has a power switch on the back side of the Display Unit, and **ALERT/ACK.** key on the front panel acts as the power on/off button.

To power on:

- Make sure the switch on the back side of the Display Unit is switched to “ON” position. If not, turn it on.
- Press the **ALERT/ACK.** key (here it acts as power-on button).

Then the **▲** , **▼** and **MENU/ENTER** keys are illuminated. After approximately 30 seconds, the system boot is finished and the software GUI is shown.

To power off:

- Hold the **ALERT/ACK.** key for approximately 15 seconds (here it acts as power-off button).

Then the inclinometer will be turned off.

Normally, the switch on the back side of the Display Unit can be always kept at "ON" position. During maintenance, it should be turned off.

**NOTICE**

The international regulations require that the heel angle data shall be measured and recorded. This electronic inclinometer shall be kept running whenever the vessel is underway.

It is also highly recommended to keep it running all the time, even when the vessel is docking or berthing.

2.3. Screen Display

Figure 4 shows the main screen of EI-1 graphical user interface.

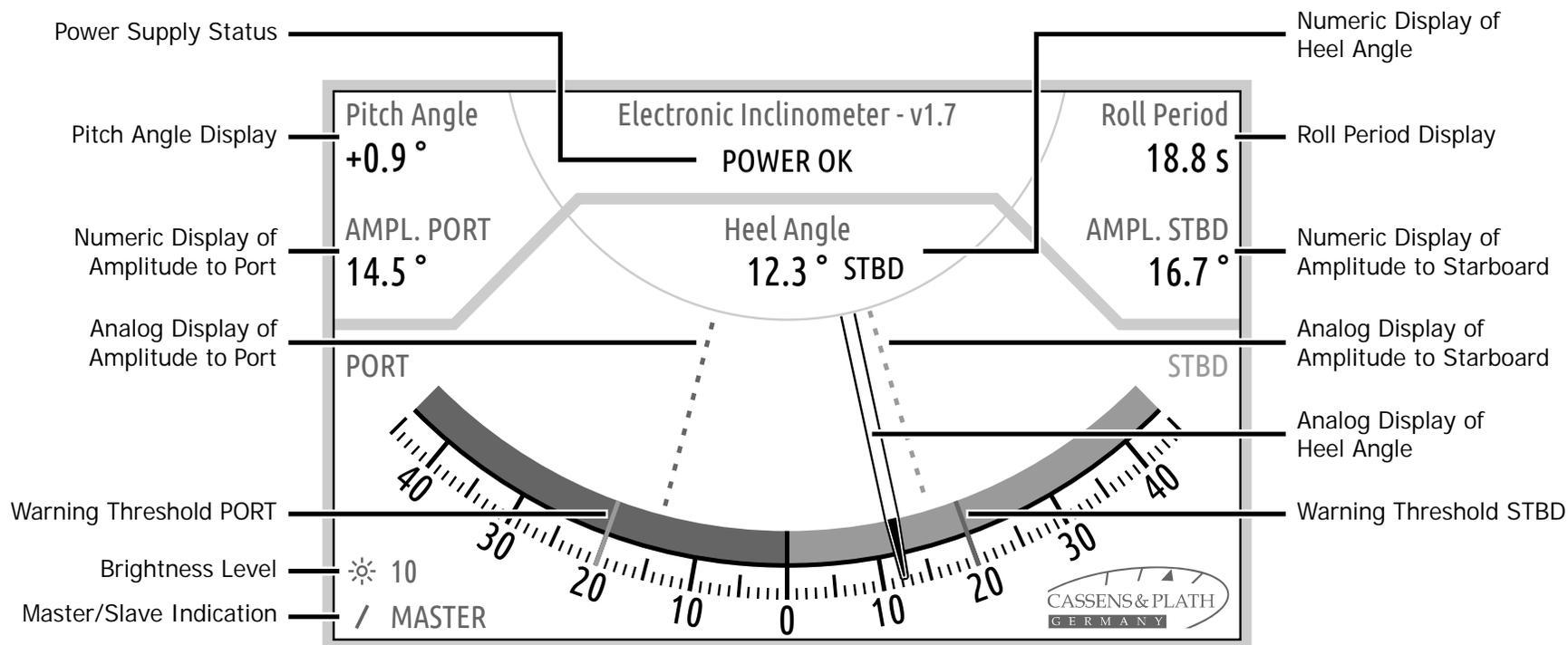


Figure 4: Main Screen

The following readings are available on the main screen.

2.3.1. Heel Angle

Instantaneous heel angle is displayed in two different forms:

- Numeric display

Heel angle is indicated by the numeric display at the center of the screen and is refreshed every 0.1 second. The digital indication has a range from 90 degrees port to 90 degrees starboard with a resolution of 0.1 degree.

- Analog display

Heel angle is indicated by the pointer on the gauge and is refreshed every 0.1 second. The heel angle scale has a range from 45 degrees port to 45 degrees starboard and is numbered every 10 degrees. Division marks are displayed every 1 degree.



NOTICE

When heel angle exceeds the analog display range (45 degrees port to 45 degrees starboard) under extreme situations, the pointer will stay at the end of the heel angle scale and therefore does NOT indicate the actual heel angle value.

Please refer to the digital reading instead of analog reading for heel angle greater than 45 degrees.

2.3.2. Roll Period

Numeric display for roll period is located on the upper right corner of the screen with a resolution of 0.1 second. The value of roll period is determined by the time interval between the maximum values of the rolling oscillation and is updated twice during each period of rolling oscillation.

Figure 5 illustrates the determination and update of roll period.

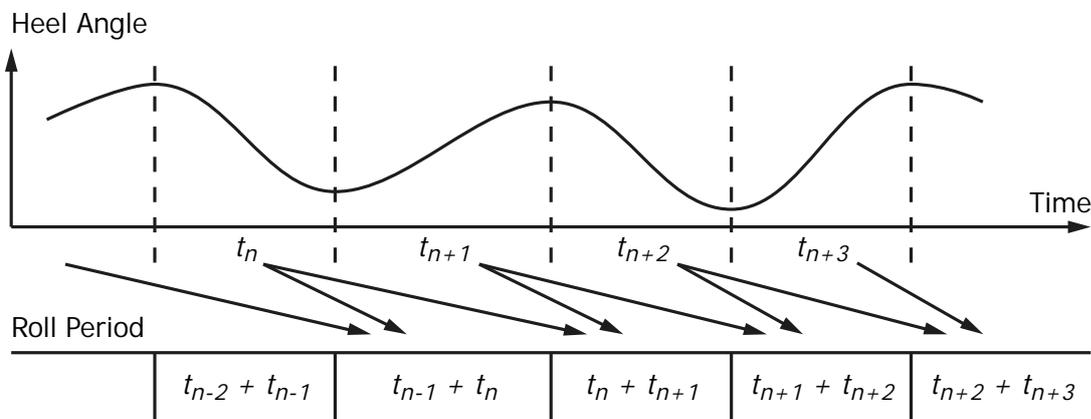


Figure 5: Determination and Update of Roll Period

2.3.3. Roll Amplitude

Numeric displays for roll amplitude to port and starboard are located respectively on the left and right side of the screen with a resolution of 0.1 degree. The roll amplitude value to port/starboard is updated immediately if heel angle exceeds the previously determined roll amplitude value to port/starboard, or else, is updated as soon as the roll amplitude value of the new oscillation period is determined.

Figure 6 illustrates the determination and update of roll amplitude.

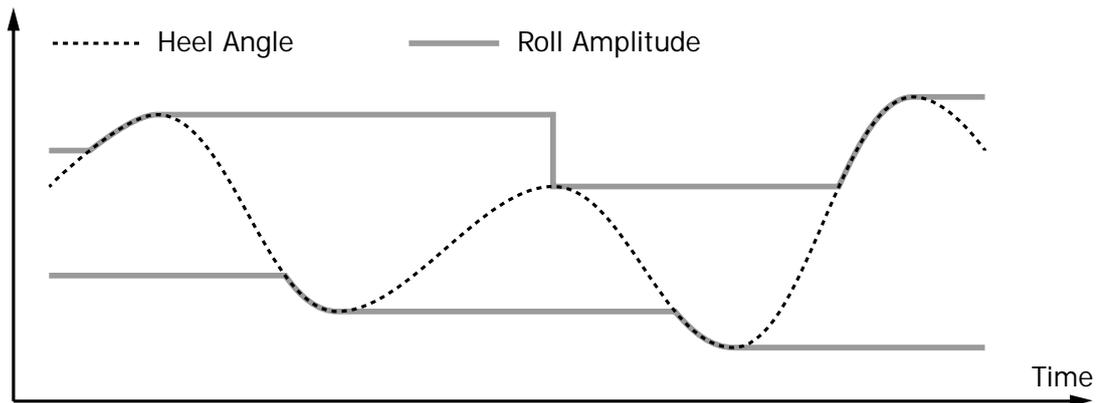


Figure 6: Determination and Update of Roll Amplitude

Besides the numeric display, roll amplitude values are also indicated by the red (port) and green (starboard) dashed lines on the gauge.

 NOTICE	<p>The analog display range of heel angle also applies to the analog display of roll amplitude.</p> <p>Please refer to the digital reading instead of analog reading for roll amplitude greater than 45 degrees.</p>
--	--

2.3.4. Pitch Angle

Numeric display for pitch angle is located on the upper left corner of the screen with a resolution of 0.1 degree.

The value is refreshed every 0.1 second.

2.3.5. Power Supply Status

Power supply status is indicated on the top of the screen. When the main power supply is in normal condition, the text "POWER OK" will be displayed. Otherwise, if the main power supply fails, the EI-1 Electronic Inclinometer will operate on the emergency power supply and the text "MAIN POWER FAILURE" will be displayed.

2.3.6. Other Visual Elements

- Brightness level

The current brightness level is shown on the lower left corner of the screen. Refer to section 2.7.4 for more information about brightness adjustment.

- Running Indication

A rotating line is shown on the lower left corner of the screen as a running indication. It shall be always rotating as long as the display unit is running properly.

- Master/Slave Indication

Depending on the usage of the display unit (as master or slave), the text "MASTER" or "SLAVE" is shown on the lower left corner of the screen.

2.4. Alerts

The Display unit, when configured as master, may generate some alerts. All the alerts are Category B Warnings.

2.4.1. Warning States and Presentation

A warning may be in one of the following states:

- (N) Normal: alert condition not existing.
- (V) Active - Unacknowledged: alert condition still present, alert not acknowledged. Flashing yellowish orange marker will be shown on the display, and two short audible signals will be generated. If not acknowledged, the two short audible signals will be repeated every minute.
- (S) Active - Silenced: alert condition still present, alert silenced by the operator. The warning will return to Active - Unacknowledged state in 30 seconds if not rectified, acknowledged, or responsibility transferred.
- (A) Active - Acknowledged: alert condition still present, alert acknowledged by the operator. Static yellowish orange marker will be shown on the display without audible signal.
- (O) Active - Responsibility Transferred: alert condition still present, the INS with additional system knowledge has taken over.
- (U) Rectified – Unacknowledged: alert condition rectified, alert still unacknowledged.

2.4.2. Heel Angle Warning

Heel Angle Warning can be enabled by the user in order to warn the user that the heel angle has exceeded the preset thresholds.

The Heel Angle Warning is activated as soon as heel angle exceeds the preset limit, and is rectified as soon as it returns to the normal range.

Please also refer to section 2.7.3 for more information about Heel Angle Warning settings.



Figure 7: Heel Angle Warning Display

2.4.3. Sensor Failure Warning

When the display Unit fails to receive valid data from the Sensor Unit, a Sensor Failure Warning will be activated. Besides the standard presentation of warnings, the following display will also change:

- Numeric readings are displayed as "N/A";
- The heel angle pointer, amplitude lines and acceleration bar are not displayed;

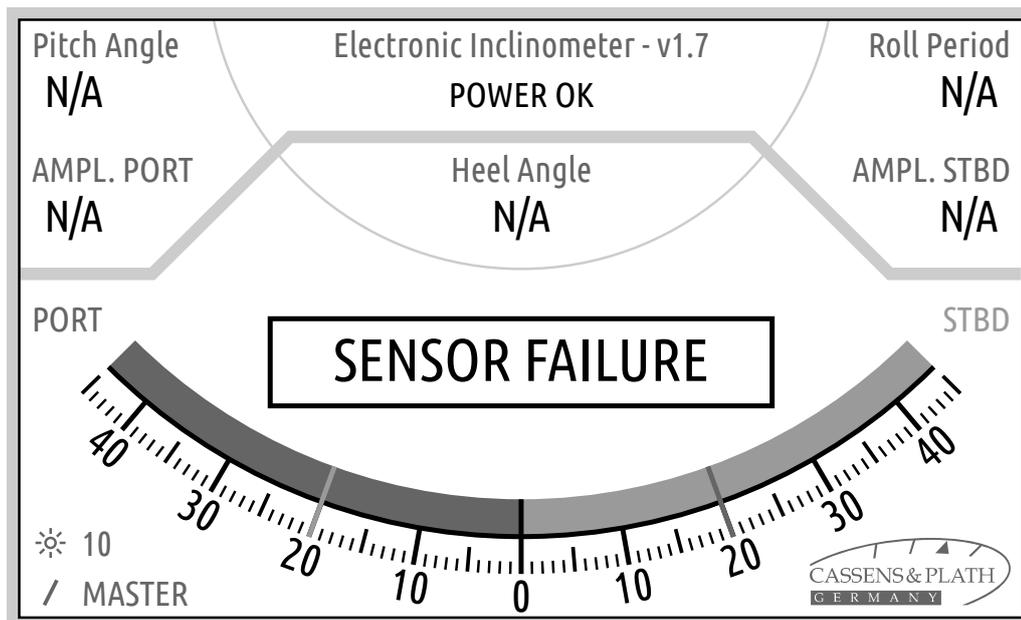


Figure 8: Sensor Failure Warning



NOTICE

The numeric display of heel angle and pitch angle will turn red if sensor data is temporarily (within a few seconds) not available. Sensor Failure Warning will not be generated unless the Display Unit fails to receive valid sensor data for more than 5 seconds.

2.4.4. Power Failure Warning

When the main power supply fails, the EI-1 Electronic Inclinometer will operate on the emergency power supply and a Power Failure Warning will be activated.



Figure 9: Power Failure Warning

2.4.5. Warnings on the Slave Display Unit

The Slave Display Unit synchronously shows the warning status on the Master Display Unit. But the user cannot acknowledge any warning on the Slave Display Unit. The Slave Display Unit does not output \$ICHRM, \$ICALF, \$ICALC or \$ICHBT sentences.

Besides the warnings generated on the Master Display Unit, the Slave Display Unit also generates a warning itself when it fails to receive data from the network. This warning can be acknowledged locally.

2.5. Trend Plots

The EI-1 Electronic Inclinometer provides the following trend plots:

- Heel angle, for the last 3 minutes;
- Roll amplitude to port and to starboard, for the last 30 minutes.

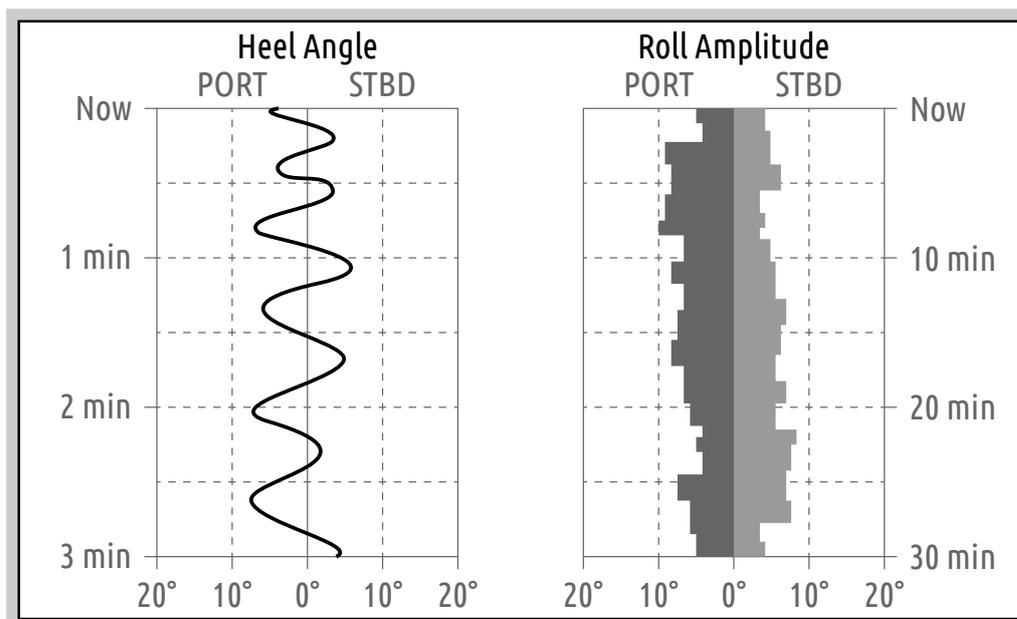


Figure 10: Trend Plots

The trend plots (as shown in Figure 10) will be shown by pressing **MENU/ENTER** key from the main screen.

The horizontal scale can be adjusted by pressing **▲** / **▼** keys.

Press **ALERT/ACK.** key to return to the main screen.

2.6. Acceleration Indications

The EI-1 Electronic Inclinometer also measures acceleration on three axes:

- X axis (the FWD/AFT axis, surge);
- Y axis (the PORT/STBD axis, sway);
- Z axis (the UP/DOWN axis, heave).

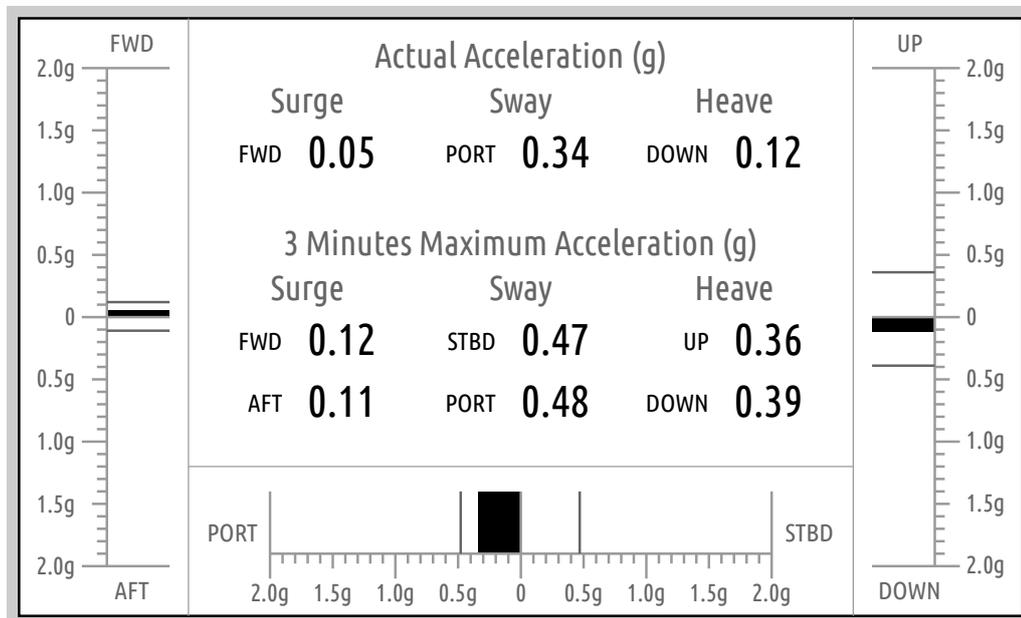


Figure 11: Acceleration Indications

The acceleration values are shown in digital and analog forms. Maximum acceleration values in recent three minutes are also indicated.

The acceleration indications screen will be shown by pressing **MENU/ENTER** key from the trend plot screen.

Press **ALERT/ACK.** key to return to the main screen.

2.7. Settings and Adjustments

2.7.1. Settings Menu

Settings menu can be accessed by pressing **MENU/ENTER** key from the acceleration indications screen.

Figure 12 shows the screen display of the menu.

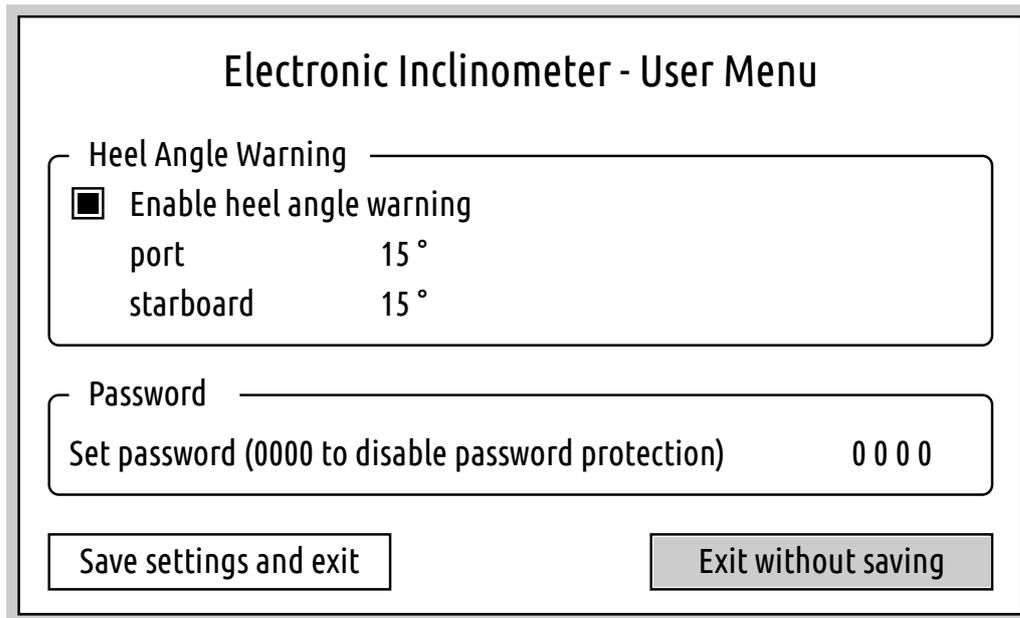


Figure 12: Settings Menu

The cursor is on the **Exit without saving** button by default. **▲** and **▼** keys are used to move the cursor among all available items in the menu.

- Save settings and exit

To save settings and return to the main screen, move the cursor to the **Save settings and exit** button and press **MENU/ENTER** key.

The settings will be applied immediately when returning to the main screen.

- Exit without saving

To return to the main screen discarding any changed settings, move the cursor to the **Exit without saving** button and press **MENU/ENTER** key.

Besides the abovementioned user operations, the system will quit settings menu and return to the main screen in the following two cases:

- Timeout

The settings menu has a timeout of 15 seconds. If no key is pressed within 15 seconds, the system will automatically discard any changed settings and return to the main screen.

2.7.2. Password Protection

Settings menu can be password protected from operations by unauthorized personnel. By default, the settings menu is not password protected. When the user set a password other than "0000", password protection is then activated. The correct password needs to be entered before any access to the settings menu.

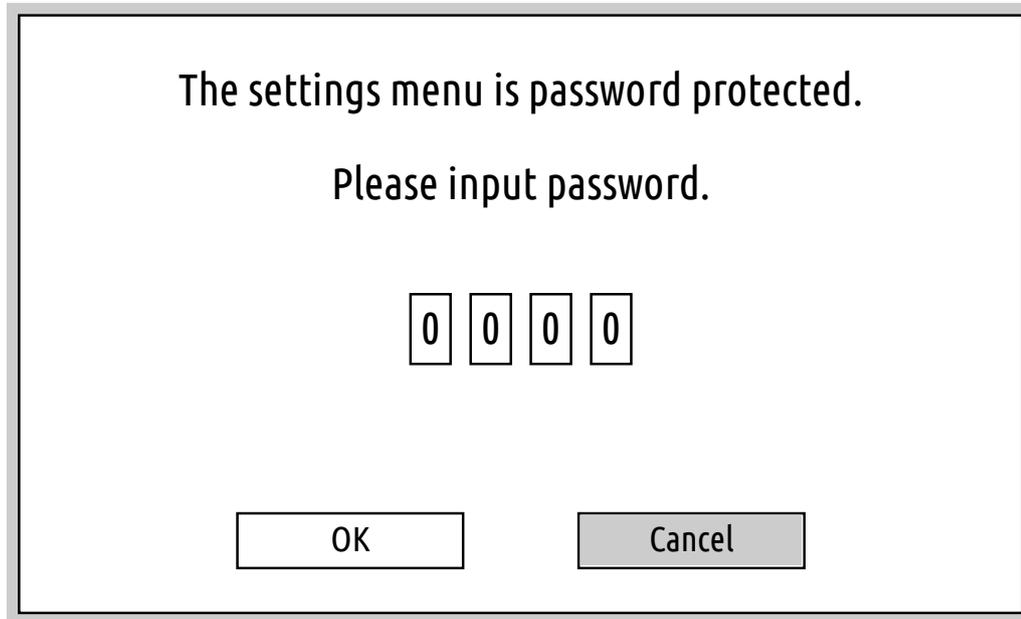


Figure 13: Password Protection

To disable password protection, just set password to "0000" in the settings menu.

2.7.3. Heel Angle Warning Settings

The following operations can be performed to set up the Heel Angle Warning.

- Enable/disable Heel Angle Warning

Move the cursor to **Enable heel angle warning**. The enable/disable status of Heel Angle Warning is indicated by the checkbox. Press **MENU/ENTER** key to toggle the status. When the checkbox is not checked, the rest options of Heel Angle Warning are not accessible.

- Change thresholds

Move the cursor to **port** or **starboard**, and press **MENU/ENTER** key. The cursor will move to the numbers on the right. Use **▲** / **▼** keys to increase / decrease the threshold value. Press **MENU/ENTER** key again when finished adjusting the value.

When the Heel Angle Warning is enabled, the thresholds will be displayed on the main screen as two yellow lines on the gauge, for port and starboard respectively.

2.7.4. Display Brightness Adjustment

When the main screen is active, the brightness of the screen (LCD backlight) and illumination intensity of the keys can be adjusted from level 0 (darkest) to level 10 (brightest). Use  /  keys to increase / decrease the brightness level.

When both  and  keys are pressed, the brightness level will be reset to the default value (8).

The brightness can also be adjusted remotely by transmitting DDC sentence from other devices. Refer to Appendix B for details.

2.7.5. Display Angle Adjustment

When the Display Unit is mounted with the E11U01K01 mounting kit on the desktop, wall, or roof, it can be adjusted to a preferred angle by the user. To adjust the angle:

- Loose (typically 2~3 turns) the two handwheels on both sides to allow the rotation of the Display Unit;
- Turn the Display Unit to a suitable angle;
- Tighten the two handwheels firmly to lock the adjusted angle.

2.8. Data Logging

The Master Display Unit has a built-in data logging feature. It records the following data:

- Heel angle and pitch angle;
- Acceleration on all three axes;
- UTC time (if \$GPRMC sentence is available).

The above data is collected every second, however, the data log is written to the internal storage every a few minutes to minimize the wear to the internal storage. The Master Display Unit will generate a new log file every time it starts, and keeps writing to the same log file until it is shut down.

The log files can be downloaded from the Master Display Unit using a web browser. To download and view the log files:

- Prepare a computer with wired Ethernet port and web browser. Set the computer's IP address so that it is in the same subnet as the Master Display Unit and not conflicting with any other host on the network.
- Connect the computer to the same network that the Master Display Unit is connected to. If the Master Display Unit is not connected to any network, the computer can be connected directly to the Master Display Unit using a patch cable.

- Open the web browser on the computer and input the IP address of the Master Display Unit into the address bar.

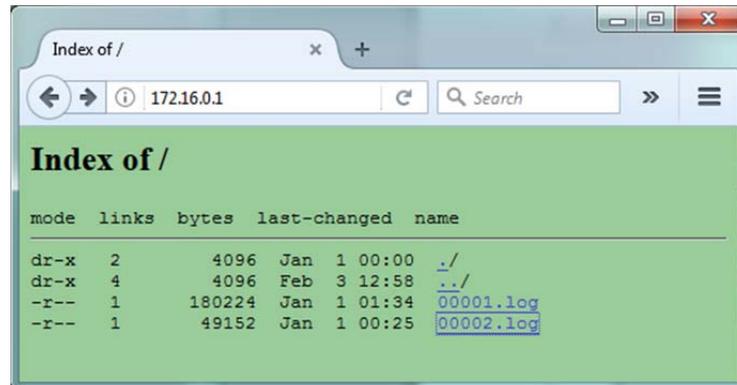


Figure 14: List of Log Files in the Web Browser

- Then the web browser should show the list of log files available on the Master Display Unit, like in Figure 14. Each log file has a hyperlink in the list. Use the web browser to download log files to the local computer. The log files are named in chronological order: the Master Display Unit will start from 00001.log when it is powered on for the first time. Then the next time it starts, it generates a new log file named 00002.log. The log file with the biggest number is the current log file that the Master Display Unit is writing to. It will be updated every a few minutes as aforementioned.
- Use "EI-1 Log Data Viewer" software to view the downloaded log file, as shown in Figure 15.

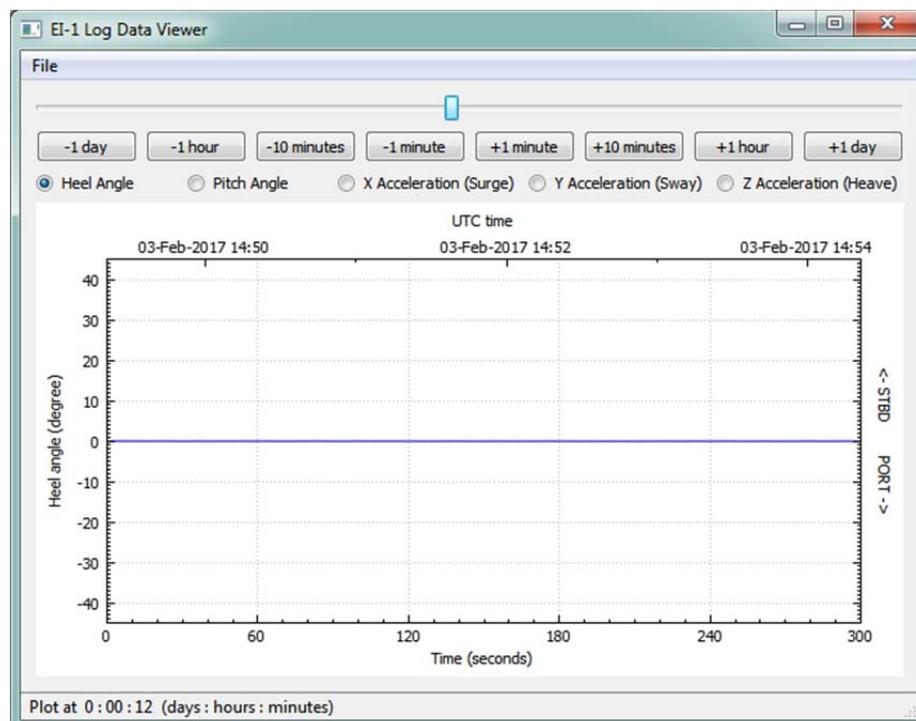


Figure 15: EI-1 Log Data Viewer Software

2.9. Settings for Slave Display Unit

Figure 16 shows the settings menu on Slave Display Unit.

The screenshot shows a menu titled "Electronic Inclinator - Slave Display". It is divided into two main sections: "Network Configuration" and "Password".

Network Configuration

IP Address	172.016.000.002
Master SFI	IC 0001
Slave SFI	IC 1001

Password

Set password (0000 to disable password protection)	0000
--	------

At the bottom of the menu, there are two buttons: "Save settings and exit" and "Exit without saving".

Figure 16: Settings Menu on Slave Display Unit

The IP address of the Slave Display Unit should be configured so that it is in the same subnet as the Master Display Unit and not conflicting with any other host on the network. In an IEC 61162-450 network, the IP address shall be in the range 172.16.0.1 to 172.31.255.254, to be compliant with the standard.

The Master SFI shall be set to the SFI of the Master Display Unit from which the slave display receives data. The Slave SFI can be set to any number as long as it does not conflict with other devices on the IEC 61162-450 network.

Password protection is also available for slave display settings. Please refer to section 2.7.2 for detail.

3. Installation Instructions

3.1. General Instructions

In general, the following instructions should be applied:

- In order to get best performance and longest life, it is recommended to install the equipment in air-conditioned rooms to keep its operating temperature neither too low nor too high.
- In the area of the wheel house, the distance from each unit to the magnetic compass must not be less than the Compass Safe Distance (refer to Table 1 for detailed data). This distance is measured from the center of the magnetic system of the compass to the nearest point on the corresponding unit concerned.
- The accessibility for maintenance and service must be considered when selecting the installation location.

Table 1. Compass Safe Distance

Component	Standard Compass	Steering Compass
Display Unit	0.70 m	0.40 m
Sensor Unit	1.45 m	0.90 m

3.2. Mounting the Display Unit

The Display Unit shall be installed in the wheelhouse. Different mounting options are provided as follows.

3.2.1. Flush Mounting

Flush mounting into a bridge console is the recommended way of mounting the EI-1 Display Unit, as shown in Figure 17.

Mounting Procedure

- Prepare a cutout at the place of installation to embed the Display Unit and drill six holes for the mounting screws;
- Put the Display Unit into the cutout;
- Secure the Display Unit with six M3 screws with flat washers and lock washers.

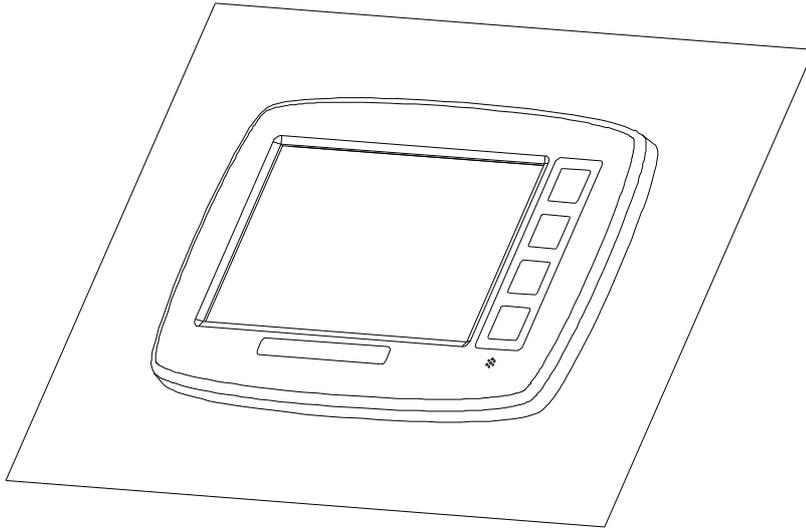


Figure 17: Flush Mounting

3.2.2. Desktop, Wall or Roof Mounting

When equipped with the E11U01K01 mounting kit, the Display Unit can be installed on the desktop, wall or roof, as shown in Figure 18.

Mounting Procedure

- Securely mount the brackets to the place of installation;
- Put the two silicone washers on the two handwheels and screw them slightly into the Display Unit;
- Put the Display Unit into the brackets and make sure the silicone washers are between the Display Unit and the brackets.
- Adjust the Display Unit to the user preferred angle and firmly fasten the handwheels to lock the Display Unit.

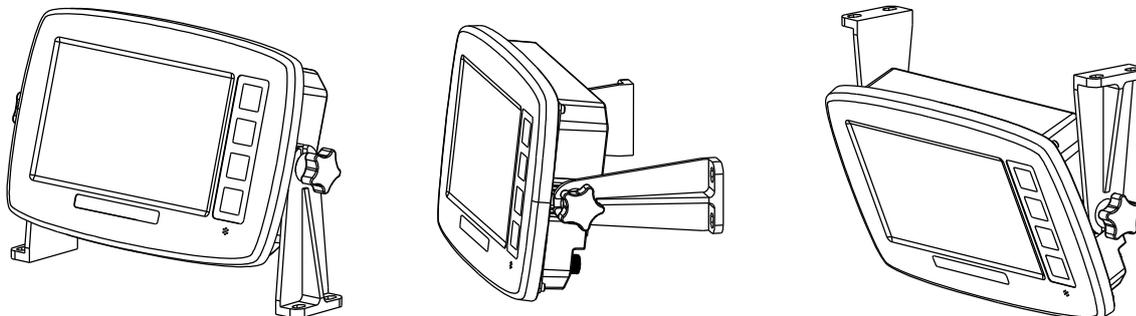


Figure 18: Desktop, Wall and Roof Mounting

3.2.3. Embedded Wall Mounting

When equipped with the EI1U01K02 mounting kit, the Display Unit can be embedded into a thick wall, as shown in Figure 19.

Mounting Procedure

- Prepare a cutout at the place of installation to embed the Display Unit;
- Mount the Display Unit onto the plate using six M3 screws with flat washers and lock washers;
- Mount the plate with the Display Unit onto the wall using appropriate screws.

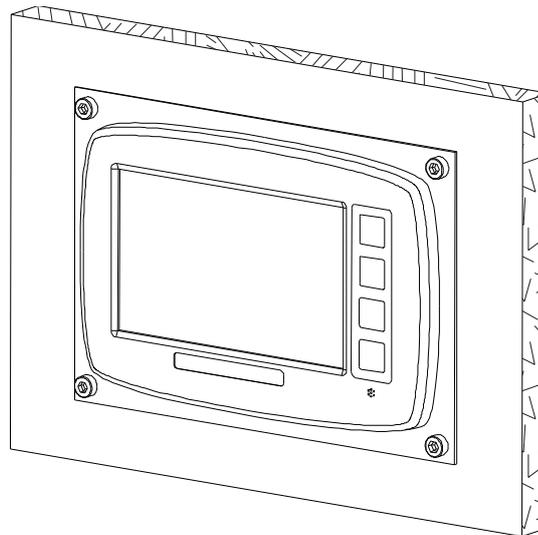


Figure 19: Embedded Wall Mounting

3.3. Mounting the Sensor Unit

The sensor unit shall be installed on a horizontal surface and aligned with the ship's axes. Figure 20 shows the orientation of the Sensor Unit.

Accuracy of the sensor may be severely degraded due to misalignment during installation. However, the Sensor Unit does not need to be installed on the centerline of the ship. It is designed to work at any location as long as its axes are aligned with the ship's axes.

The sensor unit is pre-mounted on EI1U02K01 mounting kit (including a metal plate, four rubber grommets and four special screws). The mounting kit shall always be used together with the Sensor Unit.

Mounting Procedure

- Carefully choose a horizontal surface for installation;
- Put the Sensor Unit with mounting plate on the horizontal surface and align the Sensor Unit with the ship's axes;

- Use M6 screws to fix the mounting plate at the installation location.

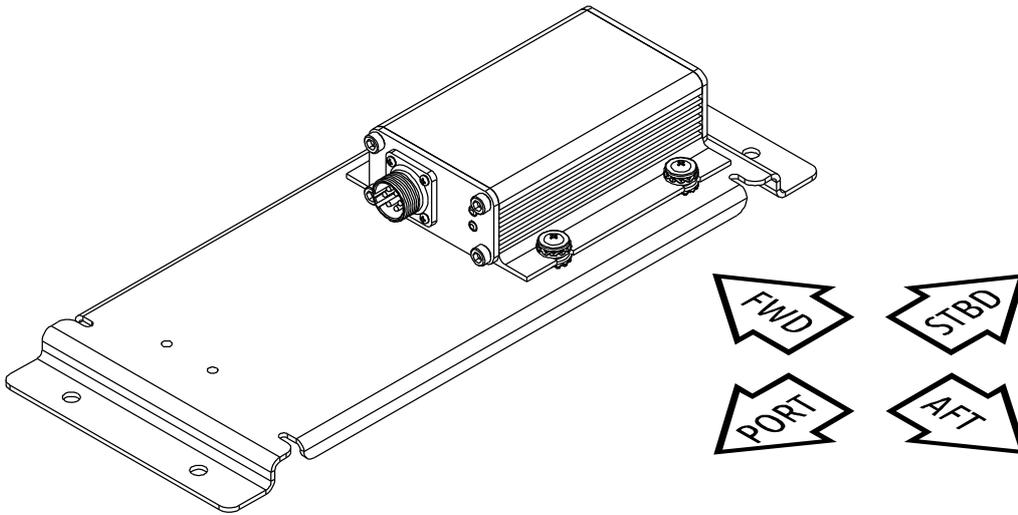


Figure 20: Sensor Unit Installation Orientation

3.4. Electrical Connections

3.4.1. Power Supply

The Display Unit requires two 24V DC power supplies, one from the ship's main power source and the other from the emergency power source.

To connect the power supply:

- Get the "Power Supply" cable from the cable kit;
- Insert and fasten the plug at one end of the cable into the 4-pin circular connector receptacle on the Display Unit;
- Connect the wires to the ship's 24V DC main and emergency power supply, or to terminal blocks and then to the ship's 24V DC main and emergency power supply using additional cable;
- If possible, ground the shielding of the cable.

3.4.2. Data Connection

EI-1 provides IEC 61162-1/-2 and Ethernet interfaces.

To connect the IEC 61162-1/-2 talker output and listener input signals to VDR, INS and other devices:

- Get the "Serial Interface" cable from the cable kit;
- Insert and fasten the plug at one end of the cable into the 6-pin circular connector receptacle on the Display Unit;

- Connect the talker signals to VDR/INS, or to terminal blocks and then to VDR/INS using additional cable;
- Connect the listener signals to INS, or to terminal blocks and then to INS using additional cable;
- If possible, ground the shielding of the cable.
- When connecting to multiple listeners, use daisy-chain topology and minimize the stub length.

To connect the Ethernet interface to the network:

- Prepare a CAT5 STP cable (not supplied) with RJ45 plug at only one end;
- Connect the RJ45 plug to the port on the network switch;
- Lay the cable to the Display Unit;
- Pass the cable through the cable gland (supplied) and terminate the cable using an RJ45 plug;
- Insert the cable into the RJ45 port on the Display Unit, and tighten the cable gland.

3.4.3. Sensor Unit

The Sensor Unit needs to be connected to the Display Unit:

- Get the "Sensor Unit" cable;
- Insert and fasten the plug at one end of the cable into the 4-pin circular connector receptacle on the Display Unit;
- Insert and fasten the other plug at the other end of the cable into the 6-pin circular connector receptacle on the Sensor Unit.

3.4.4. Grounding

It is recommended to ground the Display Unit in order to minimize the possibility of electromagnetic compatibility problems:

- Get the grounding wire from the cable kit;
- Fasten the crimped terminal on the grounding wire to the grounding bolt on the Display Unit;
- Fasten the other end of the grounding wire to the nearest grounding point.

3.5. Finalizing the Installation

After the mechanical and electrical installation is finished, the following tasks need to be performed to finalize the installation.

3.5.1. Initialization and General Examination

Turn on the power switch and perform the following tasks:

- Confirm that the green LED on the rear side of the Display Unit is illuminated;
- Confirm that the LCD backlight and keypad illumination is all right;
- Confirm that the green LED on the Sensor Unit is illuminated and the yellow LED keeps blinking;
- Wait for approximately 1 minute, confirm that the system boot is successful and the user interface is shown on the screen;
- Confirm that the LCD backlight and keypad illumination adjustment function is working properly.

3.5.2. User Settings

Enter the settings menu and perform the following tasks:

- Set the heel angle warning parameters according to the user requirement;
- Set the language of the user interface;
- Save the settings.

3.5.3. Functional Verification

Perform the following tasks:

- Rotate the Sensor Unit along its two horizontal axes and confirm the heel angle and pitch angle reading varies correspondingly;
- If heel angle warning is enabled, rotate the Sensor Unit to trigger the warning and confirm the warning function is working properly.
- Power off the Display Unit and securely fix the Sensor Unit to its installation place.

3.6. Service Menu Settings

Service menu can be accessed by pressing **ALERT/ACK.** and **MENU/ENTER** keys simultaneously. The operating of the service menu is similar to the user menu. Figure 21 shows the screen display of the service menu.

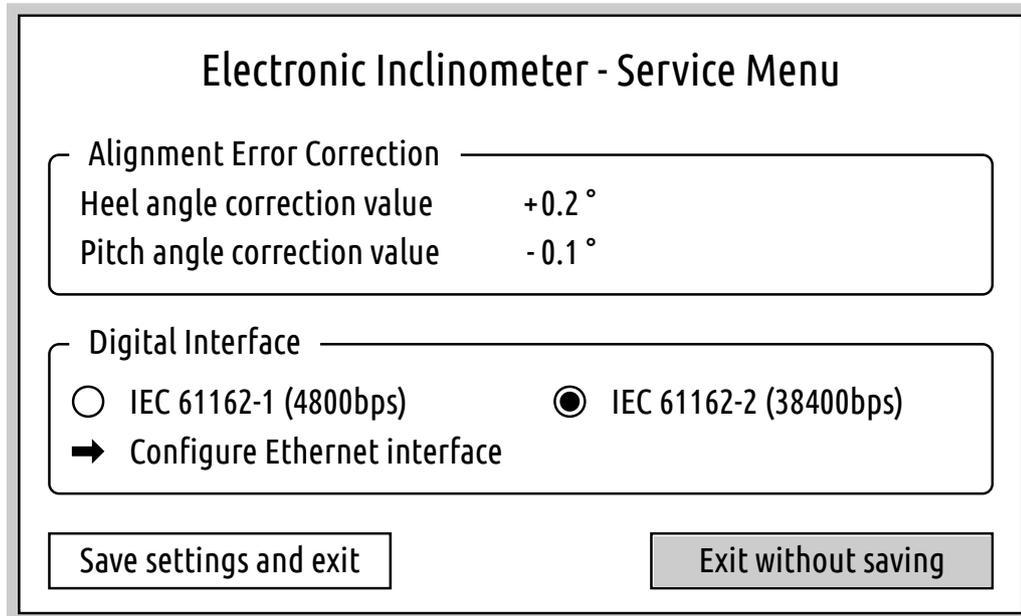


Figure 21: Service Menu

3.6.1. Alignment Error Correction

Alignment error may be produced during the installation of the sensor unit and will add a constant offset to the heel angle and pitch angle measurements. The alignment error can be corrected by setting the correction values in the service menu, which shall be the opposites of the heel angle and pitch angle readings when the ship's actual heel angle and pitch angle are both zero.

Example: the ship's actual heel angle and pitch angle are both zero, the inclinometer reading is: heel angle -0.2 degree (port) and pitch angle +0.1 degree (bow up). The correction values shall be: +0.2 degree for heel angle and -0.1 degree for pitch angle.

3.6.2. Digital Interface Options

The following digital interfaces are supported:

- IEC 61162-1 (4800 bps) or IEC 61162-2 (38400 bps), exclusively;
- Ethernet interface (incl. IEC 61162-450 and other protocol).

The IEC 61162-1/-2 digital interface is always enabled and the baud rate can be set during commissioning.

The Ethernet interface is an option independent from the IEC 61162-1/-2 interface.

3.6.3. Ethernet Interface Configuration

The Ethernet configuration menu will be shown when enabling the Ethernet interface in the service menu. Figure 22 shows the screen display of the Ethernet configuration menu.

Electronic Inclinometer - Ethernet Interface

Protocol IEC 61162-450 MER

Detailed Settings

SFI	IC0001		
IP address	172.016.000.001	Mask	255.255.0.0
Destination	239.192.000.005	Port	60005

Figure 22: Ethernet Configuration Menu

The following protocols are supported:

- IEC 61162-450: use IEC 61162-450 protocol only;
- MER: use MER protocol and IEC 61162-450 protocol.

The following settings are available:

- SFI: the four digits can be set from 0000 to 9998. SFI will be used by IEC 61162-450 protocol. When using MER protocol, the four digits will be used as ID number (shall be in the range 0001 to 0020).
- IP address: local IP address of the electronic inclinometer. When using IEC 61162-450 protocol, the IP address shall be in the range 172.16.0.1 to 172.31.255.254.
- Mask: subnet mask. When using IEC 61162-450 protocol, the subnet mask shall be set to 255.255.0.0.
- Destination: destination IP address. When using IEC 61162-450 protocol, the destination IP address is 239.192.0.5 and cannot be changed.
- Port: destination UDP port. When using IEC 61162-450 protocol, the port is 60005 and cannot be changed.

Appendix A. List of Installation Drawings

Drawing No.	Rev.	Title
EI1CD01	D	EI-1 Electronic Inclinometer Connection Diagram
EI1CD02	A	EI-1 Electronic Inclinometer Slave Display Connection
EI1CD03	A	EI-1 Electronic Inclinometer Master + Slave System
EI1U01MD01	C	EI-1 Display Unit Outline Drawing
EI1U01MD02	B	EI-1 Display Unit Flush Mounting
EI1U01MD03	C	EI-1 Display Unit Desktop Mounting
EI1U01MD04	B	EI-1 Display Unit Embedded Wall Mounting
EI1U02MD01	B	EI-1 Sensor Unit Outline Drawing
EI1U02MD02	A	EI-1 Sensor Unit Installation Drawing

Appendix B. IEC 61162 -1 and -2 Digital Interface

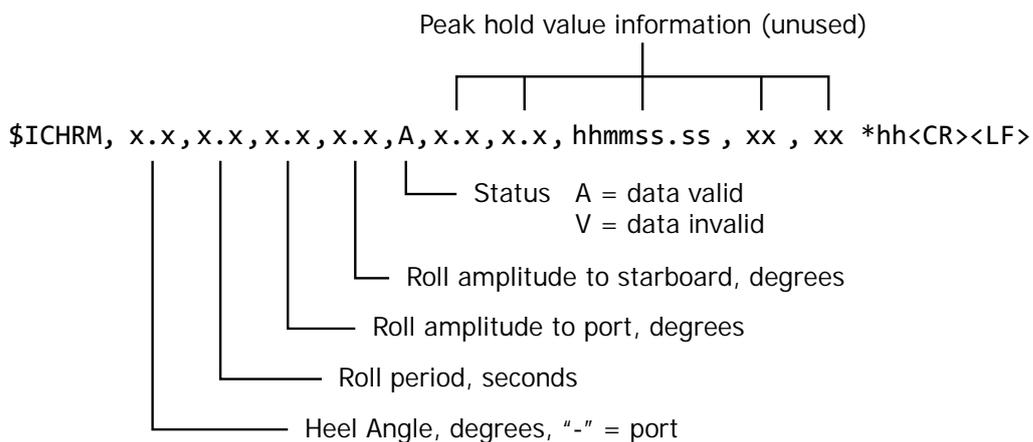
B.1. General Specifications

Compliant with	IEC 61162-1 Ed.4 (2010) IEC 61162-2 Ed.1 (1998)
Talkers	1
Listeners	1
Talker Identifier	IC
Supported Sentences	Talker: HRM, ALF, ALC, HBT, POSSIMU Listener: ACN, HBT, DDC, RMC
Output Drive Capability	Standard RS-422/485 transceiver characteristics
Transceiver Circuit	Isolated RS-485 transceiver
Connector Type	6-pin circular connector

B.2. Supported Sentences

- **HRM – Heel angle, roll period and amplitude**

This sentence is used to transmit the actual heel angle, roll period and amplitude information to other systems like, e.g. the voyage data recorder (VDR), with a constant update rate of 5 Hz.



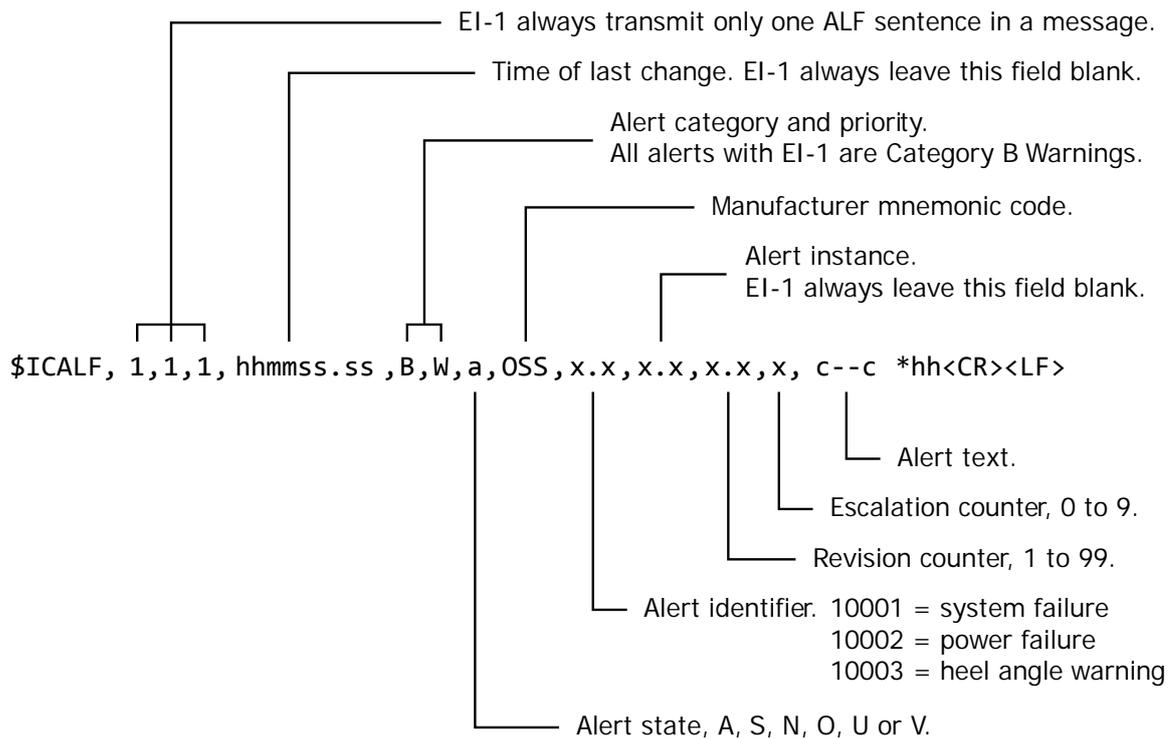
NOTE: This sentence will be suppressed when the digital interface is configured as IEC 61162-1 (4800bps), according to the requirements of the standard. For normal operation, the digital interface shall be configured as IEC 61162-2 (38400bps). This sentence is always available on the Ethernet interface, regardless of the configuration of serial interface (4800bps or 38400bps).

HRM Sentence Examples

Sentence	\$ICHRM,-2.2,11.1,3.3,4.4,A,,,,*00
Information	Heel angle: 2.2 degrees, to port Roll period: 11.1 seconds Roll amplitude to port: 3.3 degrees Roll amplitude to starboard: 4.4 degrees Data is valid
Sentence	\$ICHRM,-2.2,11.1,3.3,4.4,V,,,,*17
Information	Data is temporarily out of date Possibly due to unstable connection of the sensor unit
Sentence	\$ICHRM,,,,,V,,,,*0B<CR><LF>
Information	Data is unavailable, possibly due to disconnected or failed sensor unit

▪ **ALF – Alert sentence**

This sentence is used to report an alert condition and the alert state.



Refer to 2.4.1 for detailed description of alert states.

ALF Sentence Examples

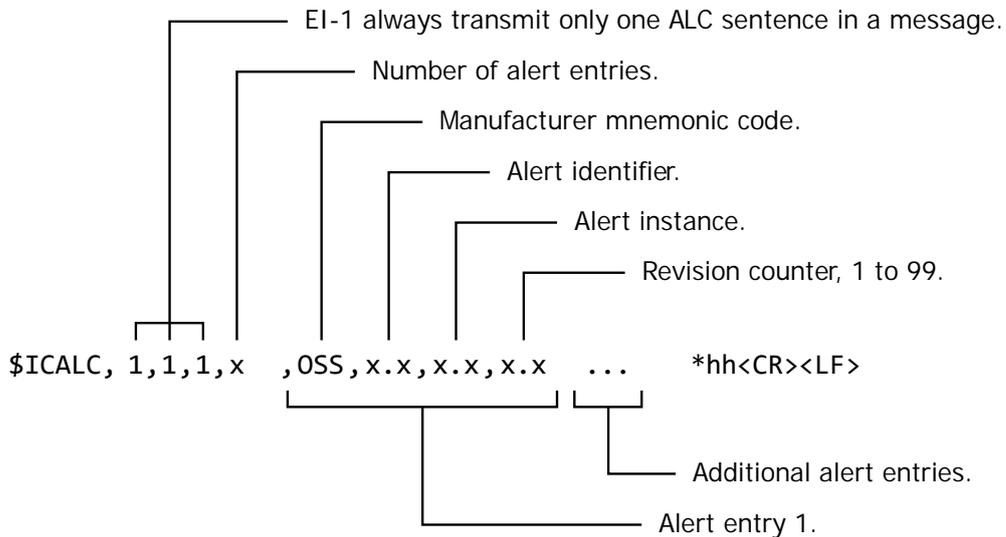
Sentence	\$ICALF,1,1,1,,B,W,N,OSS,10001,,12,0,SENSOR OK*79
Information	Alert state: normal Alert identifier: 10001 (system failure) Alert message: "SENSOR OK"

ALF Sentence Examples

Sentence	\$ICALF,1,1,1,,B,W,A,OSS,10002,,34,0,MAIN POWER FAILURE*57
Information	Alert state: active - acknowledged Alert identifier: 10002 (power failure) Alert message: "MAIN POWER FAILURE"
Sentence	\$ICALF,1,1,1,,B,W,V,OSS,10003,,56,3,THRESHOLD (P20 S20) EXCEEDED*3C
Information	Alert state: active - unacknowledged Alert identifier: 10003 (heel angle warning) Alert escalation counter: 3 Alert message: "THRESHOLD (P20 S20) EXCEEDED"

▪ **ALC – Cyclic alert list**

The ALC sentence provides condensed ALF sentence information. It is transmitted every 26 seconds by EI-1.



For EI-1, the number of alert entries can be 0, 1, 2 or 3.

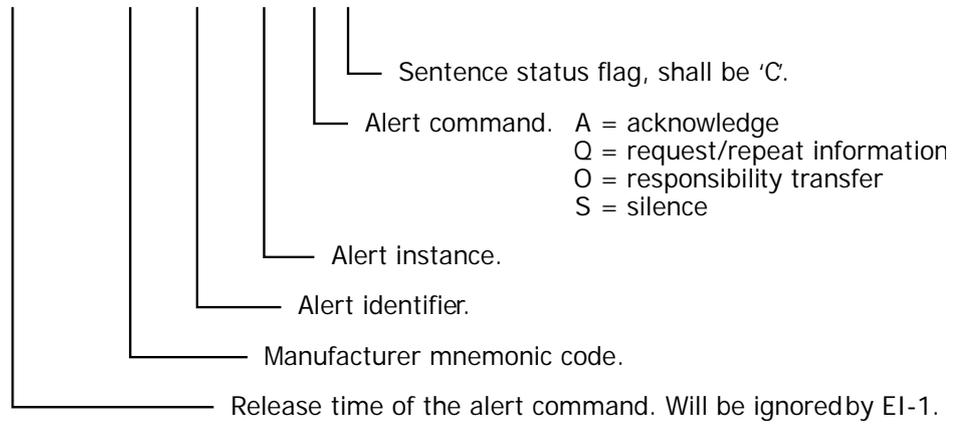
ALC Sentence Examples

Sentence	\$ICALC,1,1,1,0*45
Information	Number of alert entries: 0, i.e. all alerts are in normal state
Sentence	\$ICALC,1,1,1,1,OSS,10001,,12*38
Information	Number of alert entries: 1 Alert entry 1: OSS,10001,,12
Sentence	\$ICALC,1,1,1,3,OSS,10001,,12,OSS,10002,,34,OSS,10003,,56*3F
Information	Number of alert entries: 3 Alert entry 1: OSS,10001,,12 Alert entry 2: OSS,10002,,34 Alert entry 3: OSS,10003,,56

▪ **ACN – Alert command**

EI-1 receives ACN sentence for acknowledge, silence, responsibility transfer and request repeat of alerts.

`$--ACN, hhmmss.ss ,OSS ,x.x ,x.x ,a ,C *hh<CR><LF>`



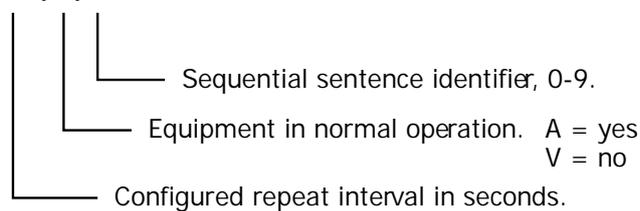
ACN Sentence Examples

Sentence	<code>\$INACN,123456.78,OSS,10001,,A,C*10</code>
Information	Acknowledge OSS 10001 alert. The release time (12:34:56.78) is specified but will be ignored by EI-1.
Sentence	<code>\$INACN,,OSS,10002,,Q,C*10</code>
Information	Request to retransmit ALF sentence for OSS 10002 alert. The blank field of release time is also accepted by EI-1.

▪ **HBT – Heartbeat supervision sentence**

EI-1 receives HBT sentence from INS or alert management system. If an alert is in responsibility transferred state but EI-1 does not receive HBT sentence within a minute, it will automatically set the alert to active – unacknowledged state.

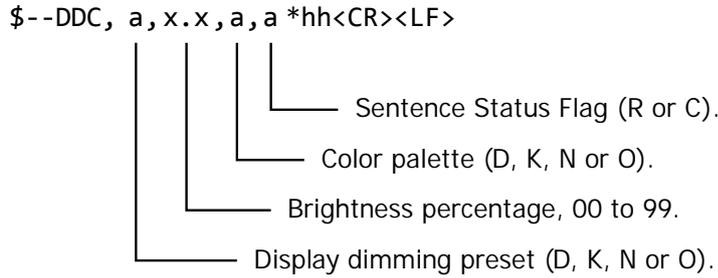
`$--HBT, x.x ,A ,x *hh<CR><LF>`



EI-1 also transmits HBT sentence every 26 seconds.

▪ **DDC – Display Dimming Control**

EI-1 receives DDC sentence from other devices for remote dimming control.



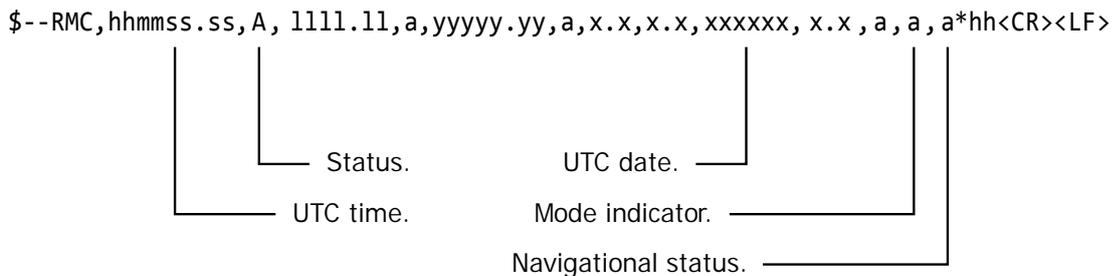
The sentence status flag shall be set to 'C' for dimming control.

Display dimming preset and color palette fields will be ignored as EI-1 has only one color scheme. EI-1 will adjust its brightness according to the value in the brightness percentage field and the following table.

Brightness Percentage in DDC Sentence	00 04	05 14	15 24	25 34	35 44	45 54	55 64	65 74	75 84	85 94	95 99
EI-1 Brightness Level	0	1	2	3	4	5	6	7	8	9	10

▪ **RMC – Recommended Minimum Specific GNSS data**

EI-1 receives RMC sentence from GPS receiver. It uses only the UTC date and time information for data logging feature. If RMC sentence is not transmitted to EI-1, the data logging feature will still work, but the time information will be unavailable.



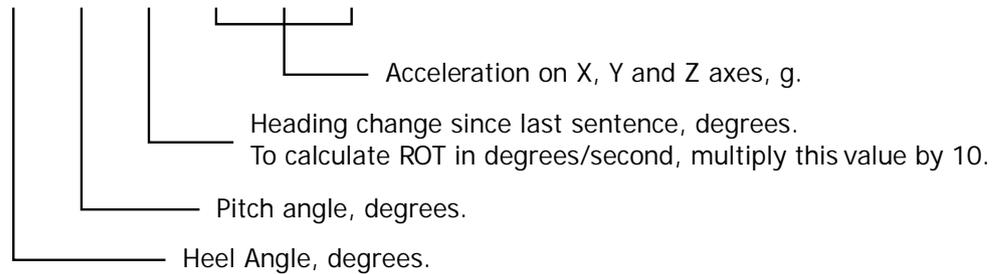
Although EI-1 does not use the data in some fields, it still checks the integrity and validity of all data fields. If a sentence has invalid data in any field, EI-1 will not use the UTC date and time information in it.

The last field (navigational status) is not defined by the previous version of IEC 61162 standard and not supported by a lot of old and existing GPS receivers. Therefore, for compatibility reason, EI-1 will accept RMC sentence without the last field.

▪ POSSIMU – 6-Axis Motion Data

This is a proprietary sentence containing heel angle, pitch angle, heading change and acceleration data. When enabled, this sentence will be transmitted at 10 Hz.

\$POSSIMU, x.x,x.x,x.x,x.x,x.x,x.x *hh<CR><LF>



NOTES:

1. This sentence is disabled by default. To enable transmission of this sentence, please specify this requirement when placing the order, or ask an authorized service engineer to enable this sentence.
2. Because of its high update rate, this sentence will not be transmitted if the digital interface is configured as IEC 61162-1 (4800bps).
3. This sentence is not available on the Ethernet interface.

Appendix C. IEC 61162-450 Digital Interface

C.1. General Specifications

Compliant with	IEC 61162-450 Ed.1 (2011)
IEEE 802.3 Interface	100BASE-TXS
Cable Category	CAT5 STP or better
Connector Type	Rugged and sealed RJ-45 connector

C.2. UDP Multicast Datagram

Transmission Group	VDRD	PROP
Multicast Address	239.192.0.5	239.192.0.8
Destination Port	60005	60008
Supported Sentences	HRM, ALF, ALC, ACN, HBT, DDC and RMC (refer to B.2 for detail)	POSSEID, POSSAXL, POSSELD and POSSELR (refer to C.3 for detail)

The EI-1 Master Display Unit transmits HRM, ALF, ALC and HBT sentences to VDRD Transmission Group. The source identification (s) and line-count parameter (n) are used in the TAG block of the transmitted UDP datagrams.

The EI-1 Master Display Unit also receives ACN/HBT sentences from VDRD Transmission Group for alert command and supervision. The destination identification (d) in the TAG block of the received UDP datagram will be checked. If it does not match the SFI of the Master Display Unit, the UDP datagram will be discarded even if it contains a valid ACN or HBT sentence.

The EI-1 Slave Display Unit does not transmit any sentence to VDRD Transmission Group. But it receives sentences from VDRD and PROP Transmission Groups to synchronize data and presentation with the Master Display Unit. The source identification (s) in the TAG block of the received UDP datagram will be checked. If it does not match the Master SFI setting, the datagram will be discarded.

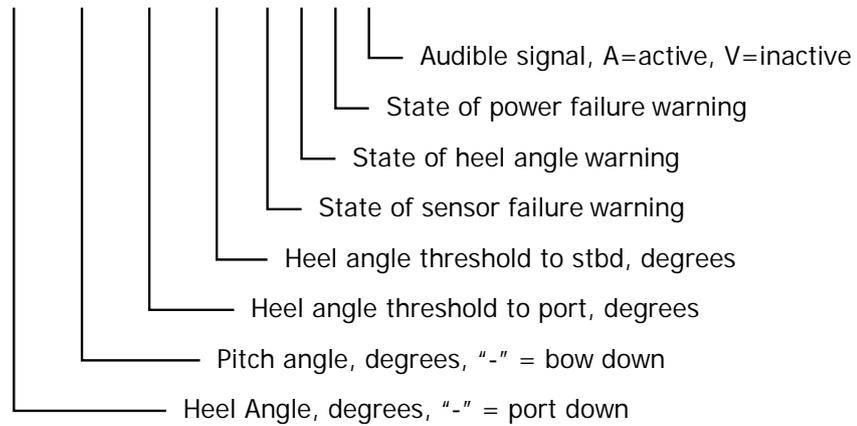
C.3. Proprietary Sentences

Besides the UDP multicast datagram described in C.2, EI-1 also transmits and receives proprietary sentences. The transmission group PROP (239.192.0.8:60008) is used for these proprietary sentences.

▪ POSSEID – Electronic inclinometer data

This sentence is used to transmit necessary information from Master Display Unit to Slave Display Unit and other listeners, with a constant update rate of 10 Hz.

\$POSSEID, x.x, x.x, x.x, x.x, a, a, a, A *hh<CR><LF>

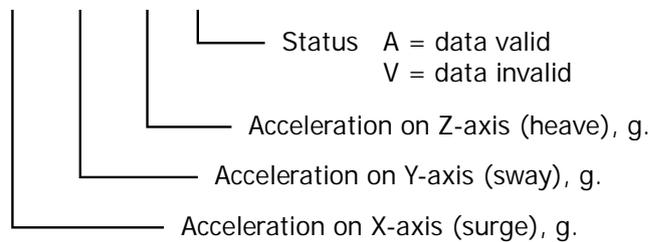


The source identification (s) and line-count parameter (n) are used in the TAG block of the transmitted UDP datagrams.

▪ POSSAXL – Acceleration data

This sentence is used to transmit acceleration data from Master Display Unit to Slave Display Unit and other listeners, with a constant update rate of 10 Hz.

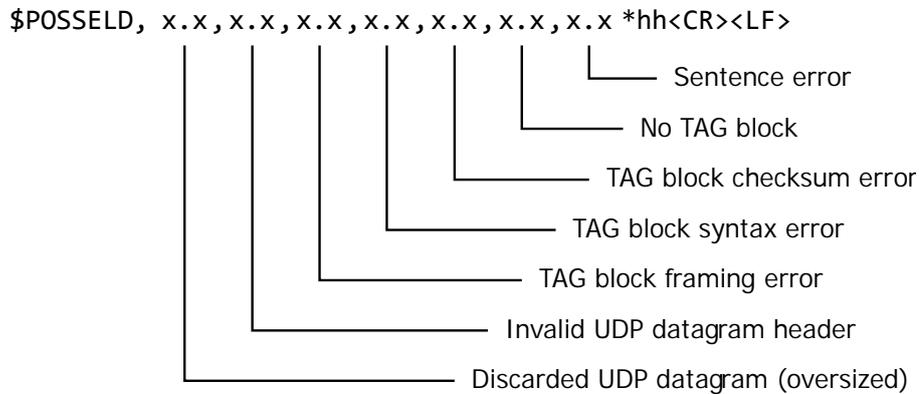
\$POSSAXL, x.x, x.x, x.x, A *hh<CR><LF>



The source identification (s) and line-count parameter (n) are used in the TAG block of the transmitted UDP datagrams.

▪ POSSELD – IEC 61162-450 error logging data

This sentence is used to report IEC 61162-450 error logging data from Master Display Unit. It is transmitted every 10 seconds.



The source identification (s) and line-count parameter (n) are used in the TAG block of the transmitted UDP datagrams.

▪ POSSELR – IEC 61162-450 error logging reset

This sentence is received by Master Display Unit to reset IEC 61162-450 error logging counters. The sentence has the fixed content of "\$POSSELR*44<CR><LF>". Once received, all the error logging counters will be reset to zero.

The destination identification (d) in the TAG block of the received UDP datagram will be checked. If it does not match the SFI of the Master Display Unit, the UDP datagram will be discarded.