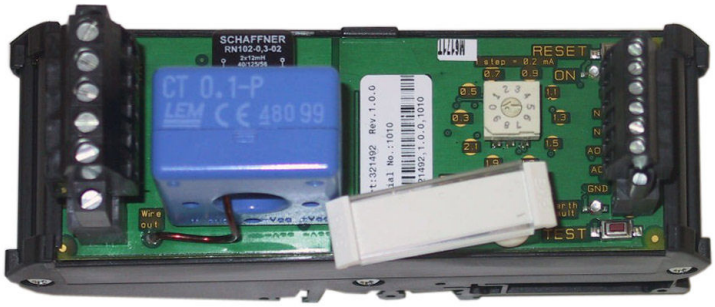
KONGSBERG

EFI-16 - Earth Fault Indicator 16 A

Hardware Module Description

Kongsberg Maritime Part no.321492



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Document history

Document number: 324876		
Rev. A	August 2008	First version.
Rev. B	February 2010	Corrected Figure 4. Text on X1 pin 4 and 5 swapped.
Rev. C	December 2010	Corrected according to new review of the document.

Note

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Comments

To assist us in making improvements to the product and to this manual, we welcome comments and constructive criticism.
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Table of contents

Glossary

AI	Analogue Input
AO	Analogue Output
DI	Digital Input
DO	Digital Output
EFI-16	Earth Fault Indicator 16 Ampere
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
Ex	Explosive atmosphere
GND	Signal ground
IE	Instrumentation Earth
IEC	International Electrotechnical Commission
I/O	Input/Output
KM	Kongsberg Maritime
LED	Light Emitting Diode
MTBF	Mean Time Between Failure
PE	Protective Earth
RFI	Radio Frequency Interference
RIO	Kongsberg Maritime Remote I/O module family
TN-S-DC	Terra Neutral Separated Direct Current

Overview

Document user

This document is intended to be used for HW engineering, hook-up and maintenance. Physical interfaces and capabilities are described.

Module

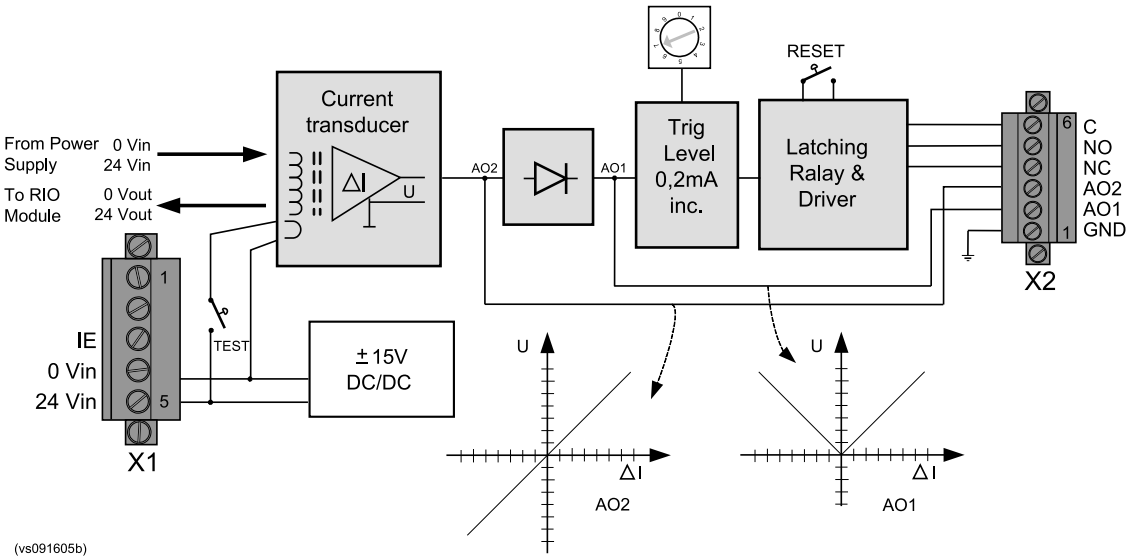
The Earth Fault Indicator 16 A (EFI-16) is a leakage-current sensor module. It monitors the difference in power supply current to and from a single RIO or other similar module. Thus the monitoring system can detect the exact RIO module where an earth fault has been introduced, and proper action can be taken.

The EFI-16 contains the following features:

- Both analog-voltage outputs and relay outputs are available
- Main module load current range is from 6 A to 16 A
- Current difference measurement range is from 0.1 mA to 2.4 mA
- Bidirectional measurement range.
- The EFI-16 analogue output voltage provided with a high-accuracy difference-current sensor for accurate detection
- The EFI-16 digital output provided with 10 selectable trigger levels
- Separate RESET switch for releasing output relay
- Separate TEST button for internal test function
- Snap-on-to-DIN-rail mounting of the module
- Compliant to standards IEC 60945 and IACS E10
- Ex zone 2 approved

Function

Figure 1 EFI-16 function diagram



EFI-16 is a module designed for detecting earth fault or current leakage through a connected RIO module caused by any events on one of its I/O signals. The principle is based on measuring the difference between the RIO module to-and-from power supply currents. If there is a difference, there is a leakage. A leakage can be considered as small or large. Larger leakages should be detected and repaired immediately to avoid degraded system performance.

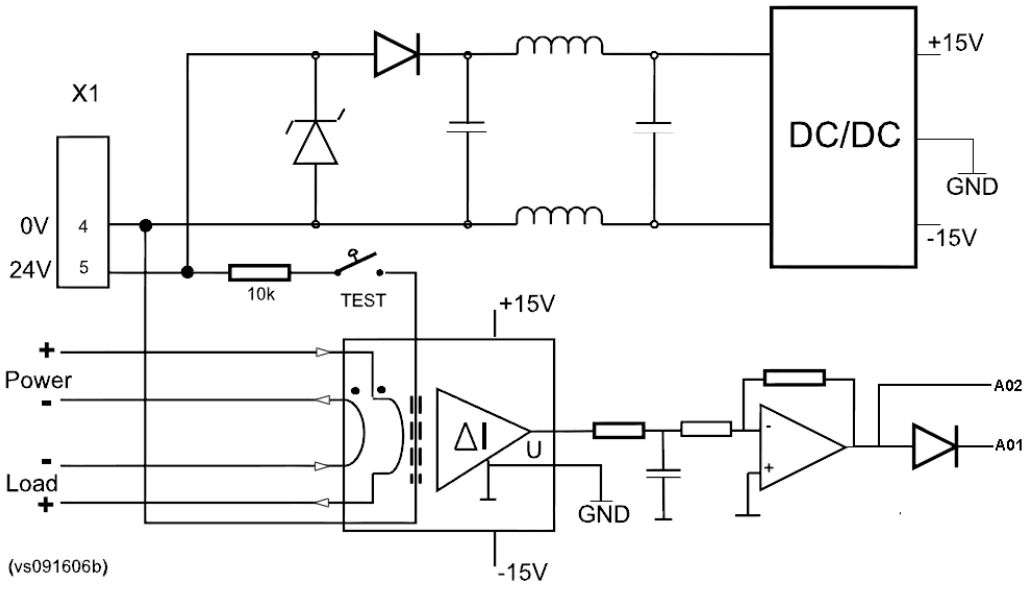
Power supply input and RIO supply output

The EFI-16 accepts single 24 VDC as supply voltage. The power supply wires are connected to the X1 terminal block (Vin).

The power supply wires (+24 V and 0 V) to the monitored RIO module are routed through the 11 mm diameter hole in the current transducer. The current transducer can thus measure the current difference.

The internal power circuits are protected against over-voltage and wrong polarity.

Figure 2 Power circuits



Analog output options

The EFI-16 module is based on the net sum principle and thus can sense any difference between input and output currents powering the RIO module, and scale it to a useful voltage value (AO). The output voltage range is 0 - 10V (A01) or ±10V (A02).

The AO1 voltage output provides only positive values in order to fit RIO input channels handling only positive input voltage.

The AO2 voltage output provides positive and negative values which also indicates the galvanic direction of the ground leakage. Negative values are measured at AO2 when a current source on the field side is driving current through the current transducer (-I). Positive values are indicating that the leakage is driven from the positive terminal of the power supply through the current transducer (+I).

Digital output options

The module is provided with a latching relay for digital output (DO) purpose. The relay has a potential free contact set, Common (C), Normally Open (NO) and Normally Closed (NC). The Normally Closed terminal can for example be used for daisy chaining outputs from several EFI-16s and then be connected to one DI channel for monitoring one RIO cabinet.

Digital output fault-trigger level

The trigger level for this relay is set by a rotary switch, and the relay latches if trigger level is reached. The relay must then be reset by pressing the RESET button (see separate section). If the ground leakage is still present, the relay will re-trigger immediately.

Table 1 Rotate switch positions and trigger levels

Position	Trigger level at current difference [mA]
0	0.3
1	0.5
2	0.7
3	0.9
4	1.1
5	1.3
6	1.5
7	1.7
8	1.9
9	2.1

Note

Note that the highest value to be selected (2.1 mA) is lower than the defined test current (2.4 mA). This is to ensure that a test performed on an EFI-16 module will always be picked up by the process control system, then creating an appropriate alarm as long as the signal loop and control system works properly.

Power-On LED

A green-coloured LED is lit whenever the module is powered, else it is dark.

Earth Failure LED

A red-coloured LED indicates whether an earth fault has been detected. More precisely it shows the state of the output relay. Dark LED means relay is **not** triggered, lit LED means triggered.

Test button

The module is provided with a TEST button to test the EFI-16 functionality by forcing a defined test current (2.4 mA (= 24 VDC/10 kohm)) through the current transducer. If everything is working properly, the DO output alarm relay is latched and the Earth Failure LED is then lit red. Thus, an alarm should be detected by the process monitoring and control system.

Restet button

The module is provided with a RESET button to release the latched relay. This means that although the failure causing the relay to trigger has been removed, the relay will stay triggered until the RESET button has been pressed. If the failure is still there after performing a reset, the relay will re-trigger immediately.

Topology illustrations

The EFI-16 module may be connected in various topologies depending of the site specific installation. Examples in figures 3, 4 and 5 are only guidelines.

Figure 3 Power net sum pr. IO module

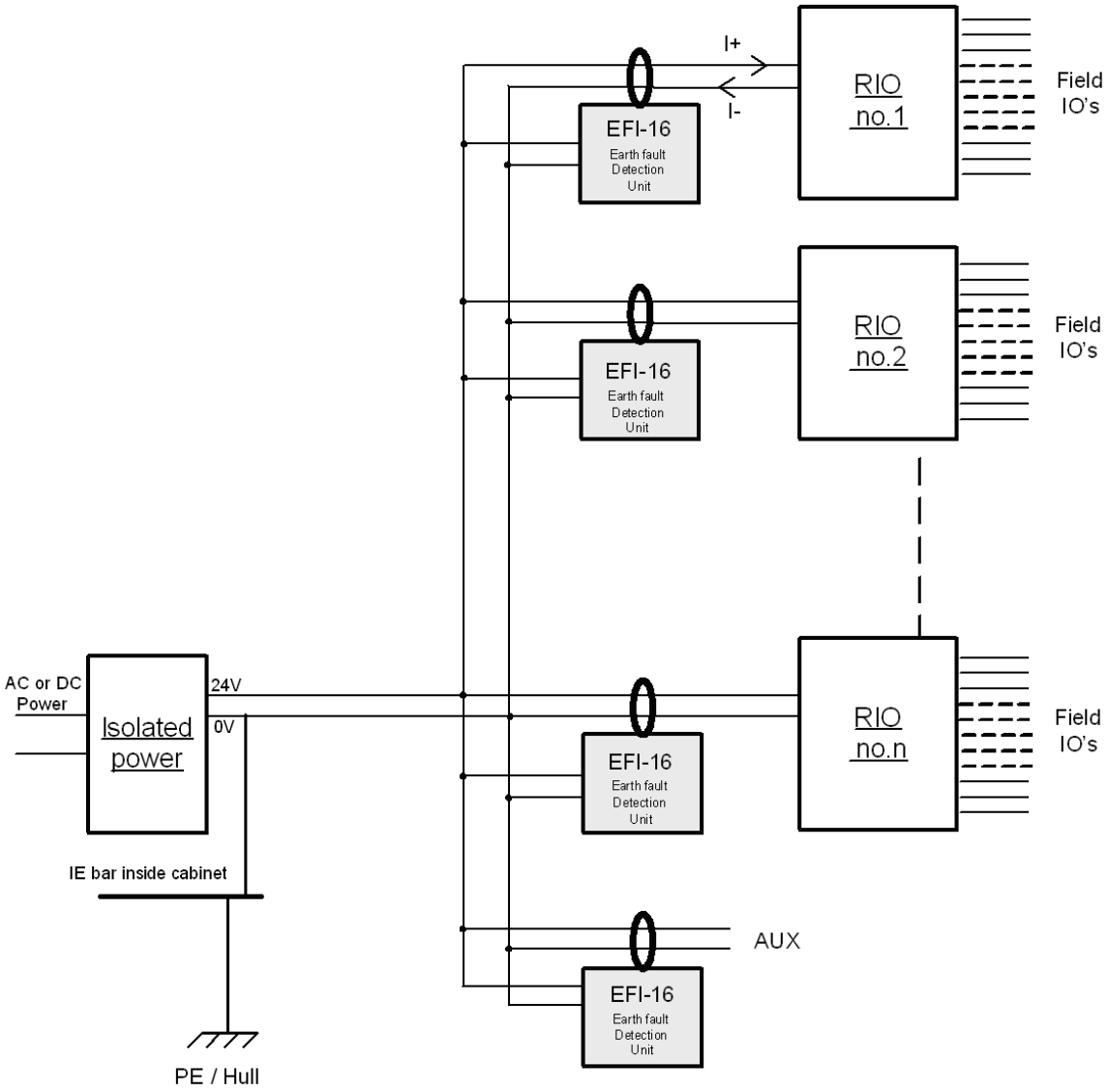


Figure 4 Return current monitoring for power distribution node

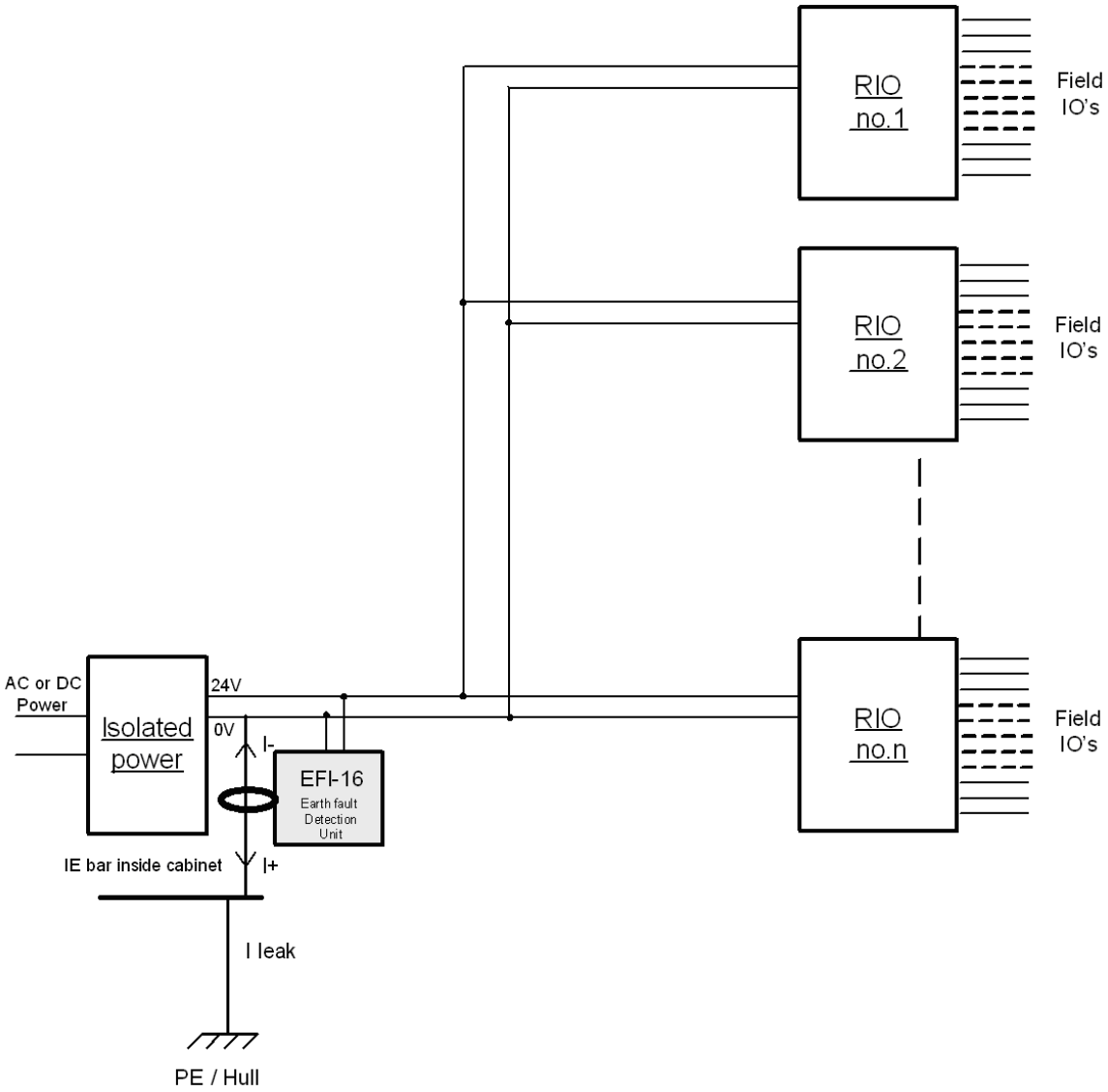
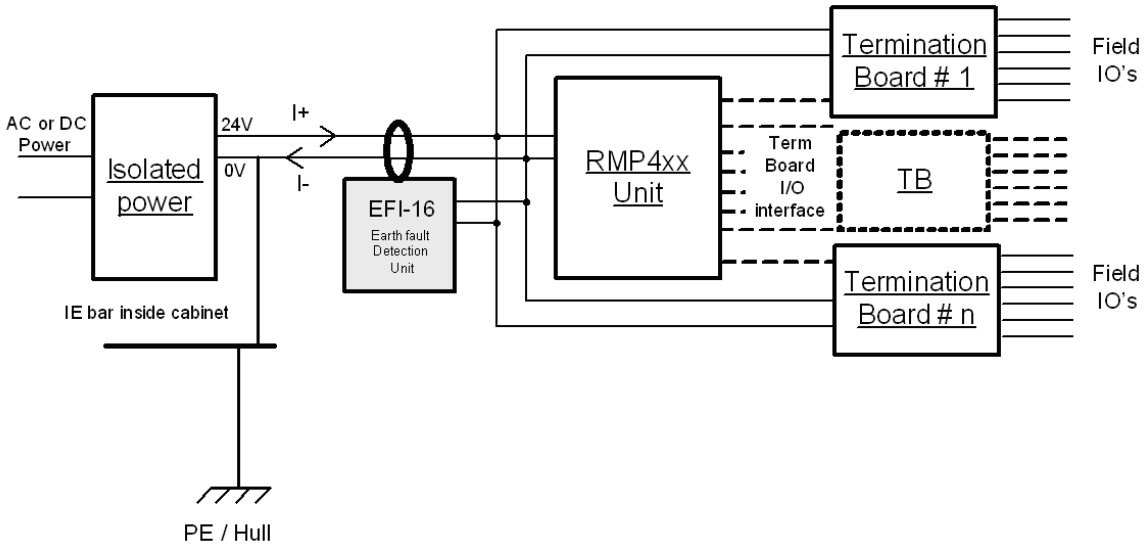


Figure 5 Power net sum pr. IO module for retrofit applications



Monitoring digital input/output loops

When Digital Output/Input loops are used, the Digital Input loops are the most critical loops and most sensitive loops also. Output loops can stand heavy leakage without malfunction, while input loops are sensitive in the range of a few mA. Therefore, a reasonable level for digital loops will be about 1 mA. The main goal is to set the trigger level as high as possible, thereby preventing false alarms and maintaining signal integrity.

Monitoring analog loops

For analogue loops the same philosophy as for digital loops is valid. A 4-20 mA input loop is the most sensitive loop and a leakage over 1 mA will corrupt signal integrity. In order to keep signal integrity, the analogue error voltage is used. This output has a sensitivity of micro-ampere, though influenced by temperature and offset, and should be monitored and controlled by an “intelligent” module in order to detect ground leakage that can corrupt signal integrity.

TN-S_DC distribution system

As a thumb of rule, KM recommend to make all system installations as TN-S-DC according to IEC60364. This is the recommended grounding alternative due to high noise immunity, over voltage protection as well as EMC (ESD, RFI etc.).

Technical specifications

Table 2 Technical specifications

Power specifications	
Input voltage	+24 VDC nominal (+18 - +32 VDC)
Current consumption	Stand-by current: 65 mA Typical power ON surge at 24 VDC: 10 A for 0.1 ms.
Galvanic isolation (power input to module logic)	500 VDC
Connector	Screw terminals (slotted)
Cable cross-section power	2.5mm²
Current transducer specifications	
Difference current sensitivity	1000 mV/mA
Maximum difference current	10 mA (=> maximum output voltage: 10 VDC)
Sensor gain error	±20 mV/mA (estimated)
Sensor offset voltage	±150 mV (estimated)
Sensor temperature drift	±25 mV/°C
Sensor hole diameter	10 mm
Output signal specification	
Analog output signal AO1	0 - 10 V (0 - +10 mA)
Analog output AO2	±10 V (-10 mA - +10 mA)
Digital output relay contacts	Maximum 100 mA at 32 VDC and resistive load
Digital output trigger levels	10 levels from 0.3 mA to 2.1 mA with increments 0.2 mA and at value accuracy ±0.3 mA
Connector	Screw terminals (slotted)
Cable cross-section signal	1.5mm²
Mechanical specification	
Size (WxHxD) included Phoenix UM 108 cassette	126 x 43 x 80 mm
Weight	130 g
Mounting	Snap on DIN-rail
Compatibility	
EMC directive	CE mark compliant. Conform to 2004/108/EC
Atex directive	94/9/EC

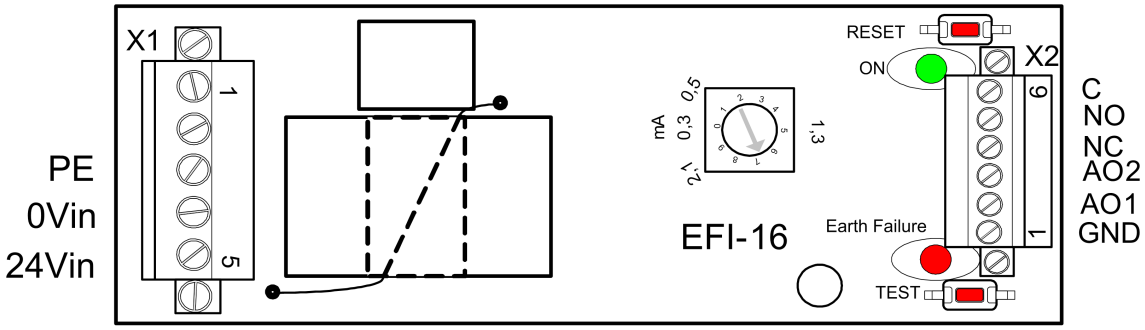
Table 2 Technical specifications (cont'd.)

EN directive 60079 for Electrical apparatus for explosive gas atmospheres	Ex nA II T4
Ex-protection specifications	II 3G EEx nA II T4 Ta: 55°C
Environmental requirements	
Operating temperature	-15 °C - +70 °C
Storage temperature	-25 °C - +70 °C
IP class	00
Compliant to standards	IEC 60945 and IACS E10
Life cycle prediction	
Predicted failure rate @ GB 25°C (60% confident, based on chip suppliers data)	72.2 Years
Predicted failure rate @ NS 35°C (Environmental de-rating based Rome Laboratory toolkit)	19.5 Years

Configuration

The illustration below shows the layout of the EFI-16.

Figure 6 Layout of EFI-16



(vs091604b)

The following sections describe the module label layout, and the connectors' layout.

X1 terminal block (Power input and output)

The X1 terminal block is of type Weidmuller BLZ 5.08/5/90F, 0.2 - 2.5 mm². It is provided with five screw terminals.

Table 3 X1 terminal-block terminal allocation

Terminal number	Terminal name	Function
1		not used
2		not used
3	IE/PE	Protective Earth terminal
4	0 Vin	0 VDC, power input terminal
5	24 Vin	+24 VDC power input terminal

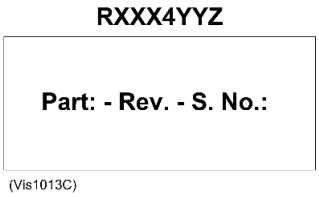
X2 terminal block (Status output)

The X2 terminal block is of type Weidmuller BL 3.5/5/90F, 0.2 - 1.5 mm^2. It is provided with six screw terminals.

Table 4 X1 terminal-block terminal allocation

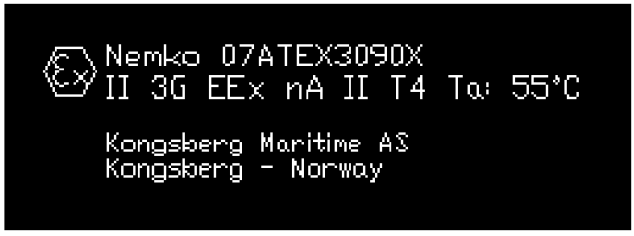
Terminal number	Terminal name	Function
1	GND	Ground reference for analogue output signals
2	AO1	Analogue output signal with no direction indication of leakage
3	AO2	Analogue output signal with ± direction indication of leakage
4	NC	Relay Normally Closed terminal
5	NO	Relay Normally Open terminal
6	C	Relay common terminal

Module identification



There is a module identification label on each module. For any communication with Kongsberg Maritime on this module you should refer to the part number (Part#), revision (Rev.) and serial number. (Serial#). A bar code is also added to the label.

Ex label



The Ex label contains two lines of information:

- Nemko 07ATEX3090X is the type approval certificate number.
- II 3G EEx nA II T4 Ta: 55ºC are the Ex requirements satisfied by the module.

Installation

Ex Zone 2 installation requirements

The choice of enclosure, placement of modules, components and free volume inside enclosure will affect the temperature.

When the module is used in Ex Zone 2, the following requirements must be met:

- The RIO module shall be mounted in an enclosure which complies with the requirement of clause 26.3 of EN 60079-15 and fulfil IP 54, or alternatively is mounted in an EEx e-enclosure.
- Maximum surface temperature shall not exceed temperature class T4 corrected for the maximum ambient temperature at service (Ta: 55°C) within the safety margin of 5°K.
- Maximum ambient temperature inside enclosure shall not exceed 75°C.

Installation procedure

Caution

Electrostatic discharge can damage components on the module when terminating wires and cables to it. Therefore always wear a correctly-connected earthing strap when working on the module.

1 Label the board.

2 Set the rotary Trigger Level switch as appropriate if relevant.

3 Clip the EFI-16 Phoenix cassette on to the DIN-rail.

4 Connect the wires as appropriate to the screw terminals on X1.

5 Connect the wires as appropriate to the screw terminals on X2.

6 Thread the power wires for the RIO module through the aperture in the current sensor and terminate the wires at both ends as appropriate.

7 Turn ON the power circuit to the RIO module(s).

8 Verify that the EFI-16 Power-ON LED is lit green.

9 Verify that the EFI-16 works properly by pressing the TEST button.

The red Earth Fault LED shall be lit.

See if it also creates an alarm in the system.

10 Click the RESET button to clear the test.

11 Verify that the RIO system works properly.

Replacement

Caution

Electrostatic discharge can damage components on the module when terminating wires and cables to it. Therefore always wear a correctly-connected earthing strap when working on the module.

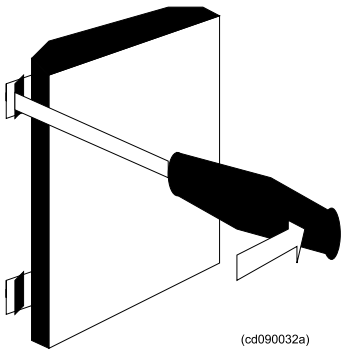
1 Turn OFF the power circuit to the RIO module(s).

2 Disconnect power wires by unscrewing the end-screws and pull off the snap-on header of terminal block X1.

3 Disconnect signal wires by unscrewing the end-screws and pull off the snap-on header of terminal block X2.

4 Disconnect the RIO module power wires from the RIO module and unthread them from the current sensor aperture.

5 Remove the module to be replaced by detaching the EFI-16 Phoenix cassette from the DIN-rail (see illustration).



6 Label the new module.

7 Remove the snap-on headers from the terminal blocks X1 and X2 of the new module.

8 Set the rotary Trigger Level switch to the same value as was for the old module, if relevant.

9 Clip the EFI-16 Phoenix cassette on to the DIN-rail.

10 Reconnect the terminal block headers on X1 and X2 and fix them with the end screws.

11 Thread the power wires for the RIO module through the aperture in the current sensor and terminate the wires as appropriate.

12 Turn ON the power circuit to the RIO module(s).

13 Verify that the EFI-16 Power-ON LED is lit green.

14 Verify that the EFI-16 works properly by pressing the TEST button.
The red Earth Fault LED shall be lit.
See if it also creates an alarm in the system.

15 Click the RESET button to clear the test.

16 Verify that the RIO system works properly.

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