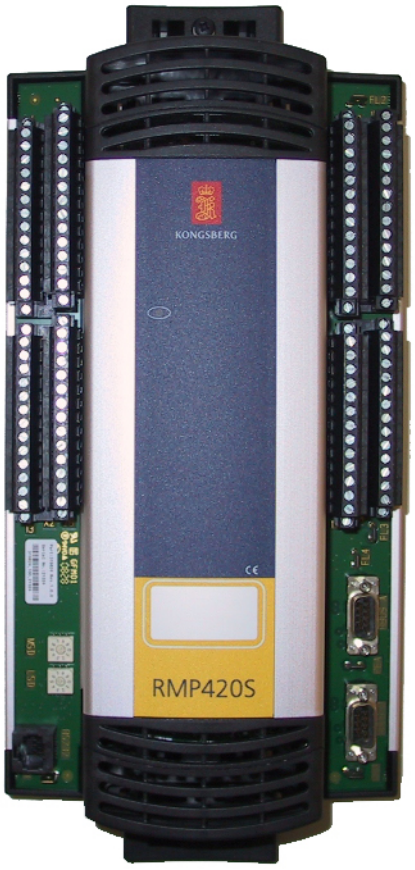
RMP420S

Hardware Module Description

Kongsberg Maritime Part no. 319824



323935/B
February 2010

Document history

Document number: 323935		
Rev. A	September 2009	First version.
Rev. B	February 2010	Missing Ex descriptions. / Added details on AIV and AIC, Ex text added to the Overview, Technical Specifications, Configuration and Installation chapters. Added Safety HW loop typical information to Function chapter.

Note

Warning

The equipment to which this manual applies must only be used for the purpose for which it was designed. Improper use or maintenance may cause damage to the equipment and/or injury to personnel. The user must be familiar with the contents of the appropriate manuals before attempting to operate or work on the equipment.
Kongsberg Maritime disclaims any responsibility for damage or injury caused by improper installation, use or maintenance of the equipment.

Comments

To assist us in making improvements to the product and to this manual, we welcome comments and constructive criticism.
e-mail: km.documentation@kongsberg.com

Kongsberg Maritime AS
P.O.Box 483
N-3601 Kongsberg,
Norway

Telephone: +47 32 28 50 00
Telefax: +47 32 28 50 10
Service: +47 815 35 355
www.kongsberg.com

Table of contents

Glossary

1oo2	“One out of two” voting redundancy configuration
ADC	Analog to Digital Converter
AI	Analog Input
AIC	Analog Input Current
AIV	Analog Input Voltage
AO	Analog Output
BIST	Built-In Self test
CPLD	Complex Programmable Logic Device
DI	Digitial Input
DO	Digital Output
DSP	Digital Signal Processor
EFI	Earth Fault Indicator
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
FD	Field Device
GB	Ground Benign
GND	Module 0 V reference
HW	Hardware
HSD	High Side Driver
IE	Instrumentation Earth
I/O	Input/Output
KM	Kongsberg Maritime
LED	Light Emitting Diode
LSD	Least Significant Digit
MSD	Most Significant Digit
MTBF	Mean Time Between Failure
NS	Naval Sheltered
PE	Protective Earth
RAM	Random Access Memory
RBUS	Remote I/O Bus
RCU	Remote Control Unit
RFI	Radio Frequency Interference
RIO	Remote I/O
RMP420S	Remote Multi Purpose module series 420 and S

RS485	RS-485 (Recommended Standard 485) is a standard for serial binary data signals connecting between a DTE (Data Terminal Equipment) and a DCE (Data Circuit-terminating Equipment).
SW	Software
TN-S-DC	Terra Neutral Separated Direct Current DC supply network type with protective earth conductor.
WD	Watchdog

1 OVERVIEW

The advanced remote I/O module RMP420S is approved according to Safety Standard IEC 6150S Safety Integrity Level 3. The module is designed to interface field I/O in both single and redundant topologies. 32 AI field I/O channels are interfaced to the host control computer via a remote I/O process bus interface (RBUS).

Out of range monitoring is implemented on the module. If real time in-range monitoring is mandatory for the application, this shall be handled by the SIF (Safety Instrument Function) field device (e.g. a SIL 2 safety function requires a SIL 2 qualified sensor etc.).

The RMP420S is for safety use, and the RMP420 is for general use.

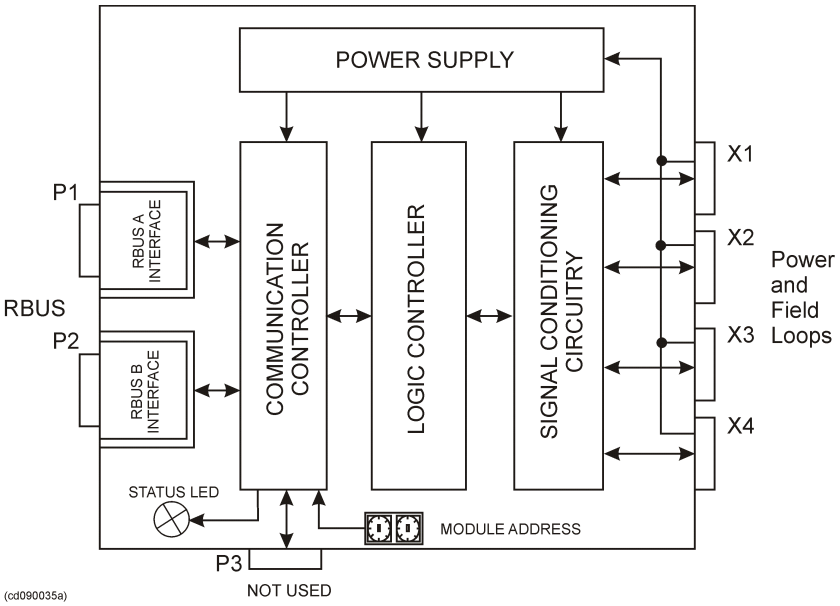
Features of RMP420S:

- 32 solid-state configurable analog input current (AIC) and analog input voltage (AIV) channels.
- Two remote I/O bus interfaces (RBUS A and RBUS B) for redundant communication to the controller computer(s)
- High accuracy, 16 bits A/D and D/A converters
- I/O channels can be configured when system is running
- The remote I/O process bus interface circuitry is galvanic isolated from other circuitry on the module.
- Easy installation and replacement:
  - DIN-rail mounting
  - Plug-in connections
  - Two digit address switch
- Status LED on the front indicates running or error status
- Loop-check and debugging possible from operator station
- Short-circuit protected I/O loop current drivers
- RIO module and I/O loop, powered from the same source
- Embedded over-voltage protection, which safeguards the field instruments
- Automatic Recovery Protection: Automatic restart of faulty channel
- Automatic calibration in run-time to compensate for drift by temperature change
- Fail-safe activation of outputs upon loss of communication
- Soft and hard fail-safe modes available on outputs (equal to module reset and power ON status)

- Extended built-in self test (BIST) features for controller self-diagnostics and fault identification during start-up and run-time
- Suitable for use in SIL applications:
  - SIL 2 as single module configuration
  - SIL 3 as redundant module configuration
- Fully grounded to PE or IE
- Ex Zone 2 type approved

2 FUNCTION

Figure 1 Block diagram



The RMP420S provides a number of interfaces and functions. The main function blocks are:

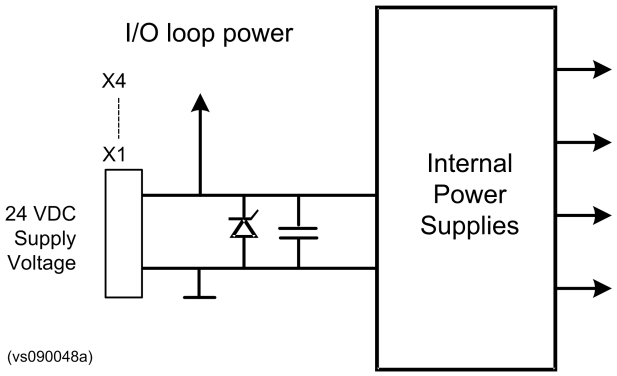
- Power supply
- RBUS interfaces
- Communication controller
- I/O with signal conditioning circuitry
- Self diagnostics

2.1 Power supply and loop power

24 VDC loop power to the RMP420S is provided via the terminal blocks X1 to X4. The four power terminals are interconnected.

The module uses the loop power to make several internal voltages (see illustration below). To protect the power supply components against overvoltage a tranzorber is connected on the input side. However, external fuses must be fitted on the power input to limit input current.

Figure 2 Power supply principles



2.2 RBUS interface

The bus design consists of multidrop RS485 serial lines. RBUS A and RBUS B are galvanically isolated from each other and from the I/O part of the module.

Manchester Coding is used in order to avoid timing problems and reduce cabling cost.

The RBUS cable also supply power (+24 VDC) to the isolated part of the RS485 line.

The RBUS's 24 VDC power supply can be the same as the host controller computer supply.

Note

For cable requirements see section 3 on page 17.

2.3 Status LED

The module is provided with a two-coloured LED for visual status indication. The LED is located on the front of the module. It is green when the system is running and no error is detected. It is red otherwise.

Table 1 Status indicators on module front

LED name	Colour, state	Function
Status	Green, fixed	Module has been configured and is ready to run.
	Green - dark, flashing	Normal operation. Dark flashing for each scan, i.e. input/output messages are received.
	Red, fixed	Serious HW or SW error condition occurred. Fail-safe is activated.
	Red - Green, flashing	Illegal address switch setting (00).

2.4 Module address

Each module must be set to a unique address number that identifies this module among the others connected to the same remote I/O process bus (RBUS). The address number is represented by two decimal switches, MSD (most significant digit) and LSD (least significant digit).

The address is compared with the RBUS address set out from the host controller computer (RCU). If they are equal, the module responds.

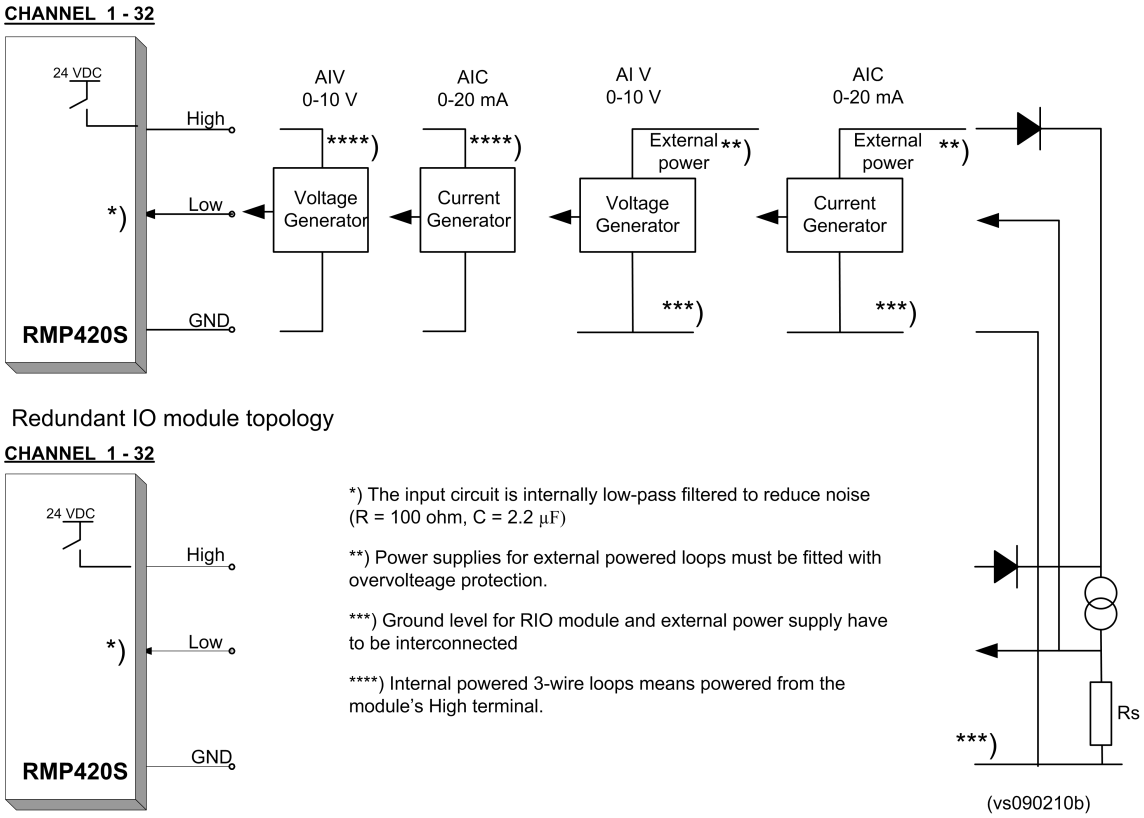
The total number of RIO modules on one RBUS is 99 (address range 1 to 99).

2.5 Analog inputs

The +24 VDC Loop Power terminals are interconnected between terminal blocks X1 through X4, and the Loop Power Ground terminals are interconnected in the same way. The zero voltage is connected to common ground inside the module.

Inside the module all output terminals (CHnHi) have been individually protected against over-voltage by power diodes connected to the loop power terminal and the ground terminal (embedded over-voltage protection).

Figure 3 Signal loop types



Note

Regarding earth fault detection, if external I/O power topology is implemented, KM supplied earth fault monitoring solution (EFI) will not provide a fully functional earth fault monitoring.

For detailed I/O loop information see the appropriate KM generic HW loop-typical drawing describing the specific I/O loop.

Note

*This note is for **KM internal use only**:*

The available HW loop typicals for Safety use are described at the KM internal web publishing location KSWEB (http://ksweb/pck/). This web location is available to all KM employees.

To open the description page, follow this procedure:

1. Open web page http://ksweb/pck/
2. Click **IO Driver Information** in the left pane
3. Click **RBUS** link in the table.
4. Click **Design documents** link under **Content**
5. Click **RMP420S-32 ChannelCodeTable** link in **RIO Module specific documents** table
6. Click **rmp420S-32_channel_codes_2** link in **RMP420S Design documents** table.

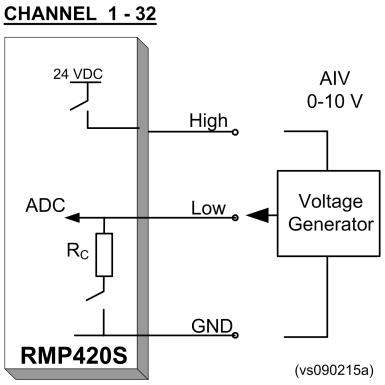
See also section 3 on page 17 for interface information and section 4.5 on page 22 for terminal allocation description at field device.

2.5.1 Differences between AIV and AIC modes of operation

The built-in Analog to Digital Converter (ADC) reads the process-signal value from the field sensors as voltage.

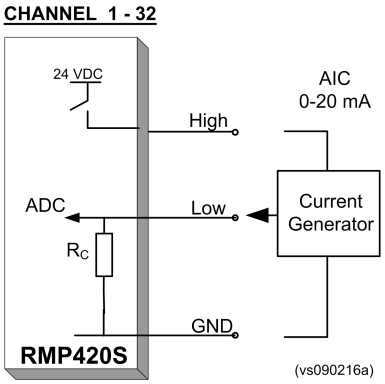
AIV - Analogue Input Voltage

In AIV mode the field sensors feed voltage directly to the built in ADC (Analogue to Digital Converter).



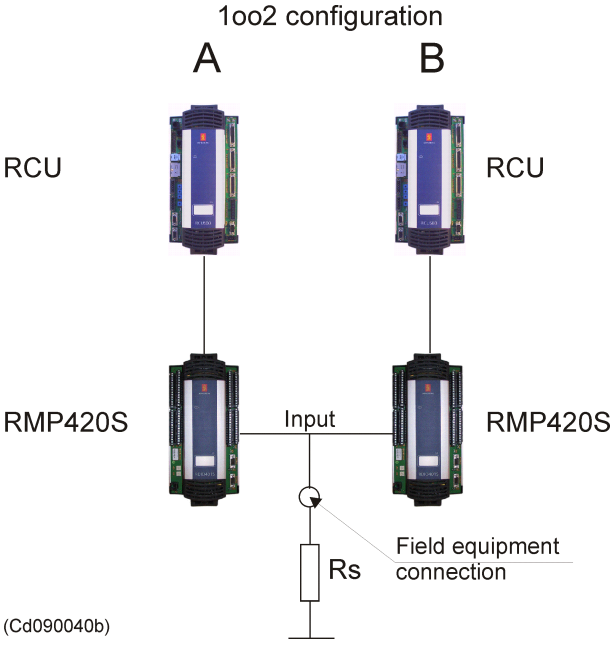
AIC - Analogue Input Current

In AIC mode the field sensors feed current through a measuring resistor (R_C)at the channel input, The voltage dropped across this resistor feeds the built in ADC.



2.6 Redundancy configuration

In a redundant 1oo2 I/O system, field equipment can only be connected to RMP420S channels configured as Analog Input Voltage (AIV) (see illustration below).



The figure represents a logical view of the connection. Physical connection of the signals to the dual redundant RIO modules may be done internally in the field equipment if supported, or by cross termination within the RCU/RIO cabinets, i.e. the physical connection can be a redundant connection as opposed to a single connection.

Note

For detailed I/O loop information see the appropriate KM generic HW loop-typical drawing describing the specific I/O loop.

2.7 Failure handling

The module is provided with a HW watchdog logic and DSP failure output.

- If a serious HW error occurs in the module, all output channels are set to high impedance.
- If the DSP stops, the communication interface outputs are set to high impedance (no communication with the RCU(s) is possible).

2.8 Power ON/OFF

At module power ON (before the communication with the RCU is established) and at power OFF, all outputs will be set to high impedance.

2.9 Module grounding

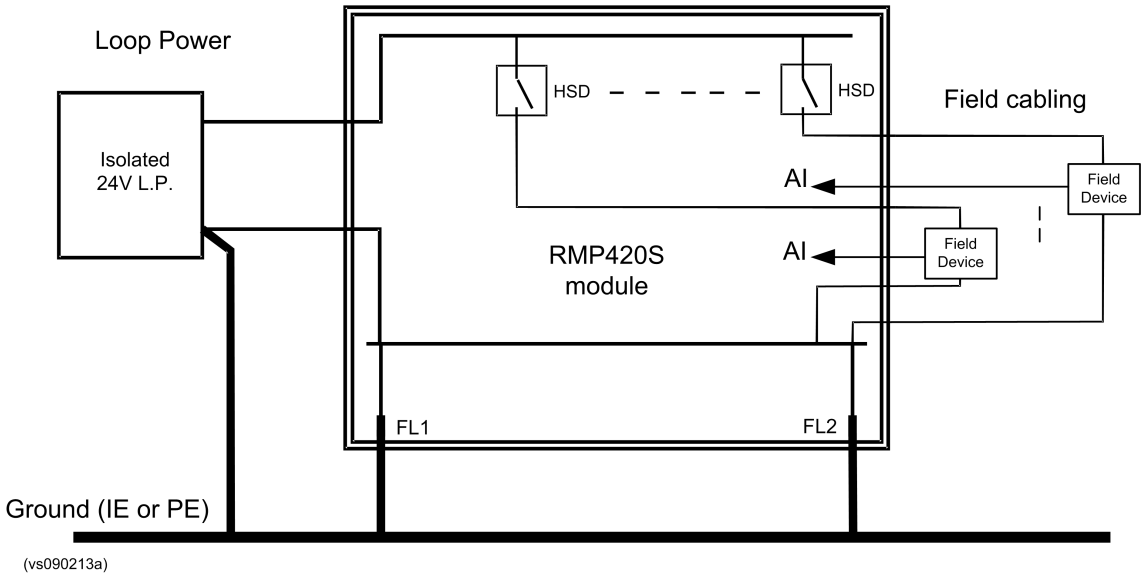
In a TN-S-DC system the module can be grounded to IE or PE using the fast-on terminals FL1 and FL2 according to IEC 60364.

Earth fault detection can be done by using external devices. If so, FL1 and FL2 shall not be connected to IE/PE.

Note

This is the recommended ground alternative due to high noise immunity, over-voltage protection as well as EMC (ESD, RFI etc).

Figure 4 Module grounding in a TN-S-DC system according to IEC 60364



2.10 Self diagnostics

Extensive self diagnostics are built into the module to detect faults related to it.

2.10.1 Module identification code

Every module has been programmed with a unique identification code (ID-code). This ID-code also identifies the type of module it is, so that the system can supervise that the correct type of module is installed with the correct address.

2.10.2 Monitoring using watchdog

A watchdog (WD), controlled from the module SW, controls whether the module will go to fail-safe.

2.10.3 Status shown on front LED

See section 2.3 on page 10 for details.

2.10.4 I/O loop status

The input signals or the read-back of output signals can be examined for out-of-range values, and faults can be detected.

The signal loop type selected decides what signal type and range can be detected (see section 2.5 on page 11).

2.10.5 Internal circuitry tests

2.10.5.1 Running diagnostics

The Analog to Digital Converter (ADC) is continuously tested by read-back of an internal reference voltage (2.5 VDC).

2.10.5.2 Temperature

There are two temperature-based functions in the module.

- Temperature can be continuously monitored by the system software.
- Temperature based shut-down, controlled by the module itself and at fixed shut-down temperature.

3 TECHNICAL SPECIFICATIONS

Table 2 Technical specifications

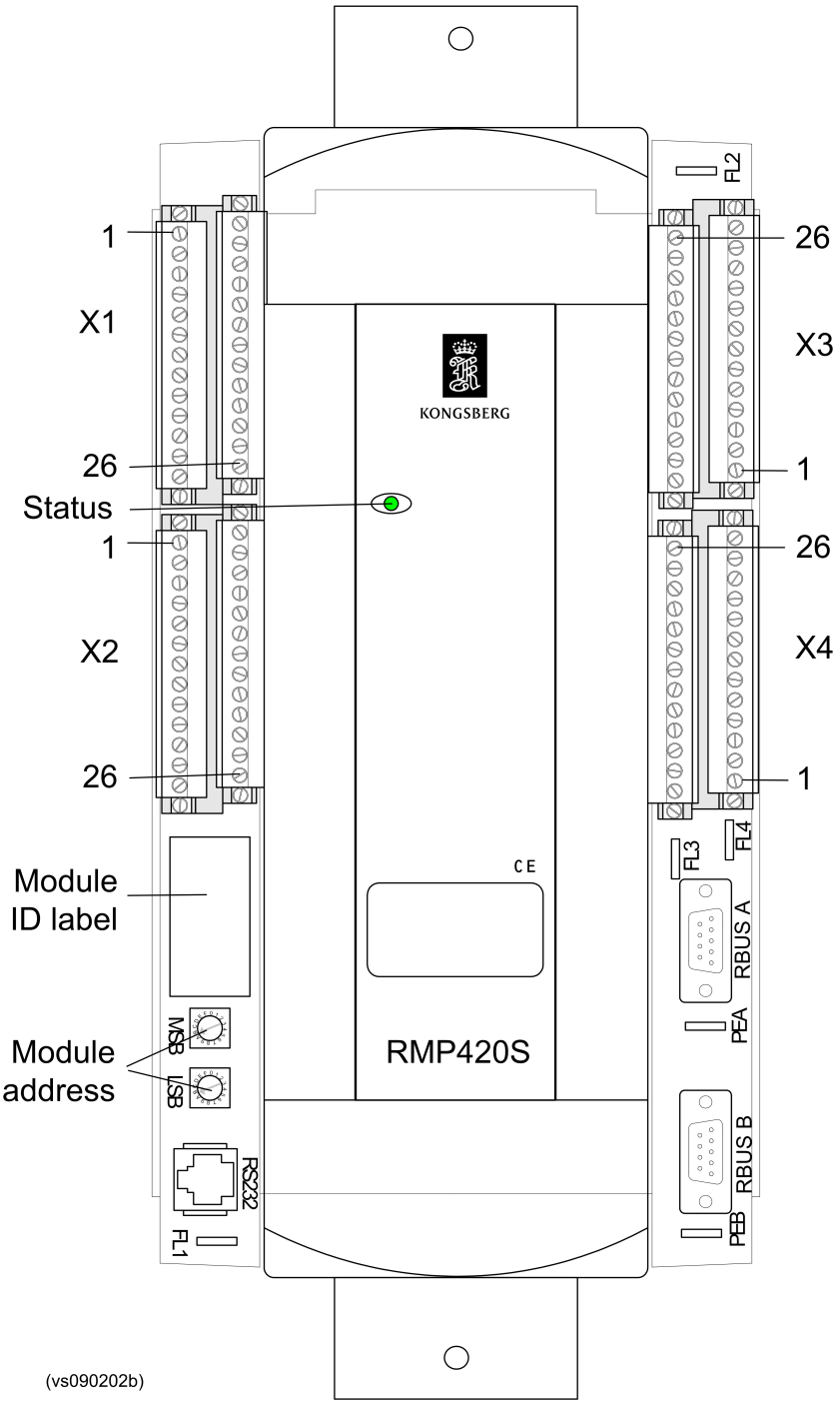
Power supply requirements and specifications	
Input voltage	24 VDC +30% -25%
Current consumption	Idle current ≈ 0.35 A + loop current maximum 32 A (maximum 1 A per channel)
Heat dissipation	10 W typical
Surge energy (inrush energy at power on of module)	0.6 J (joule) for 1 ms
Power rise time at power ON	Maximum 20 ms/V monotonic slope
I/O channel common	
X1 - X4 connectors	Screw terminals 2.5 mm² Phoenix COMBICON MDSTBV 5.08 mm
Overvoltage	Maximum Input supply voltage + 0.5 VDC without damage
Loop Power Capability	
Loop voltage	Input supply voltage
Front end device	Short circuit proof High Side Driver
Loop output	Maximum 1 A, minimum 10 mA
Loop driver trip current	Approximately 1.4 A at 20°C (reset by command)
Loop driver OFF leakage current	Maximum 100 µA at 24 VDC supply voltage
Channel 1 - 32 specifications	
Voltage input	0 - 4 V, 0 - 10 V
Current input	0 - 20 mA
Input resistor to ground	150 ohm, ± 0.1 %
Automatic protection	26 mA
Measurement accuracy	±0.15 % of full scale
Offset	±30 mV
Analog to Digital Converter ADC	
Voltage ranges	0 - 4 V and 0 - 10 V
Resolution	16 bit
Accuracy (correlated with *linearity, offset, gain* and *temperature drift* parameters listed below)	±0.15 % of full scale
Linearity	±0.01 % of full scale
Offset	±30 mV
Gain	±0.02 % of full scale
Temperature drift	±20 ppm/°C
RBUS	
Number of addresses	99
Number of channels	2
Power supply	24 VDC ±20 % (maximum 50 mA)

Table 2 Technical specifications (cont'd.)

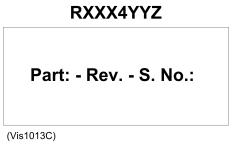
Connector	9 Pin DSUB female
Bit rate	2 Mbit/sec
Signal code	Manchester encoded (self-clocked)
Copper wire technology:	
Insulation	500 V (optocoupler)
Physical layer	RS-485 multidrop
Cable attenuation	< 6.5 dB/100 m at 10 MHz (CAT 5)
Cable length	Maximum 200 m between repeaters. Maximum 3 repeaters.
Fibre optics technology:	
Insulation	Galvanic
Fibre cable	62.5/125 µm, multi-mode
Connector	ST
Maximum cable length	1000 m (point to point), 500 m if fitted in patch panel topology
Hard fail safe	
Watch-dog response	Minimum 65 ms
Internal test error (DSP)	Instantly set
Soft fail safe (down counter)	
Programmed down-counter, time range	100 ms - 65 s (default 6 s)
Mechanical specifications	
Module size (W x H x D)	158 x 355 x 87 mm
Weight	1.35 kg
Mounting	Screw locks on DIN-rail T35–15/7.5
Compatibility	
EMC directive	CE mark compliant. Conform to 2004/108/EC
Atex directive	94/9/EC
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
Safety directive	SIL 3 approved according to IEC 61508
Environmental requirements	
Operating temperature	-15°C – +70°C
Storage temperature	-25°C – +70°C
IP class	IP 20
Life cycle specifications (predicted data)	
Predicted failure rate (T = 25°C, env. = GB) (60% confident based on chip suppliers data)	38.5 years
Predicted failure rate (T = 35°C, env. = NS) (Environmental de-rating based on Rome Laboratory tool-kit)	10.4 years

4 CONFIGURATION

Figure 5 Component layout



4.1 Module identification



For any communication in writing with Kongsberg Maritime on this module you should refer to the module name (RMP420S) and the information on the module identification label.

4.2 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.

4.3 RBUS A (P1), RBUS B (P2) pin allocation

RBUS A and RBUS B are 9-pin male D-sub connectors.

Figure 6 RBUS A and B connector pin layout

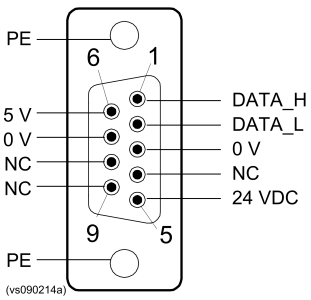


Table 3 RBUS A and RBUS B pin allocation

Pin no.	RBUS A	RBUS B	Function
1	A_DATA_H	B_DATA_H	RS485 serial line H
2	A_DATA_L	B_DATA_L	RS485 serial line L
3	A_0V	B_0V	0 V, ground reference for isolated RS485 transmitter/receiver

Table 3 RBUS A and RBUS B pin allocation (cont'd.)

Pin no.	RBUS A	RBUS B	Function
4			Not used (NC = Not Connected)
5	A_24V	B_24V	+24 VDC for isolated RS485 transmitter/receiver
6	A_5V	B_5V	Termination voltage
7	A_0V	B_0V	0 V, ground reference for isolated RS485 transmitter/receiver
8			Not used (NC = Not Connected)
9			

4.4 Local terminal (P3)

Local terminal is an 8-pin female RJ45 connector. It is not in use.

4.5 X1, X2, X3, X4 terminal allocation

Each Xn terminal group consists of two terminal blocks, one for terminal 1 through 13 and one for terminal 14 through 26. All field signals are connected via the four terminal groups (X1 to X4). Each terminal group handles eight I/O channels.

Figure 7 X1 to X4 with channel and terminal layout and names

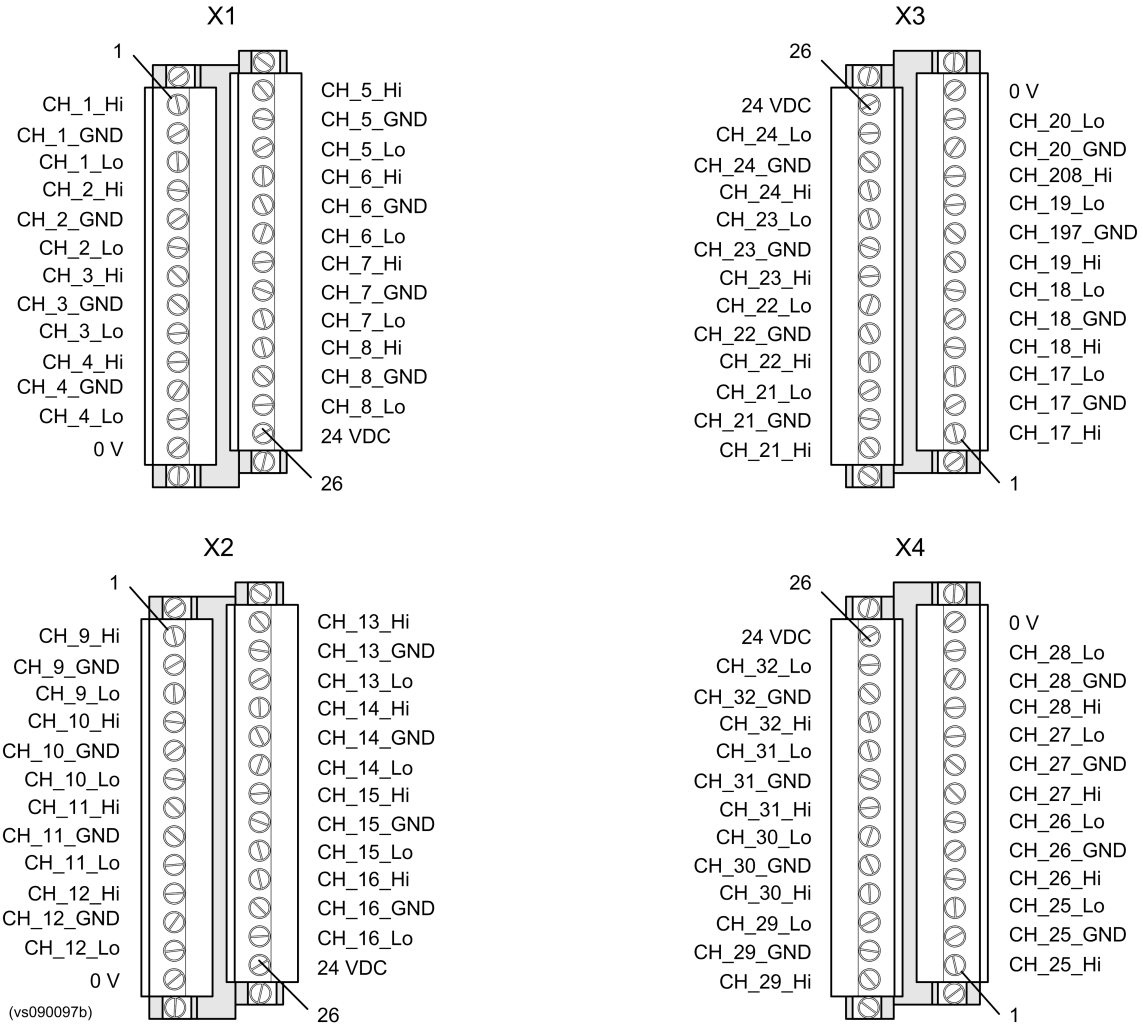


Table 4 X1, X2, X3, X4 terminal allocation

Term no.	X1 term. group	X2 term. group	X3 term. group	X4 term. group
1	CH1Hi	CH9Hi	CH17Hi	CH25Hi
2	CH1GND	CH9GND	CH17GND	CH25GND
3	CH1Lo	CH9Lo	CH17Lo	CH25Lo
4	CH2Hi	CH10Hi	CH18Hi	CH26Hi
5	CH2GND	CH10GND	CH18GND	CH26GND
6	CH2Lo	CH10Lo	CH18Lo	CH26Lo
7	CH3Hi	CH11Hi	CH19Hi	CH27Hi
8	CH3GND	CH11GND	CH19GND	CH27GND
9	CH3Lo	CH11Lo	CH19Lo	CH27Lo
10	CH4Hi	CH12Hi	CH20Hi	CH28Hi
11	CH4GND	CH12GND	CH20GND	CH28GND
12	CH4Lo	CH12Lo	CH20Lo	CH28Lo
13	0 V	0 V	0 V	0 V
14	CH5Hi	CH13Hi	CH21Hi	CH29Hi
15	CH5GND	CH13GND	CH21GND	CH29GND
16	CH5Lo	CH13Lo	CH21Lo	CH29Lo
17	CH6Hi	CH14Hi	CH22Hi	CH30Hi
18	CH6GND	CH14GND	CH22GND	CH30GND
19	CH6Lo	CH14Lo	CH22Lo	CH30Lo
20	CH7Hi	CH15Hi	CH23Hi	CH31H
21	CH7GND	CH15GND	CH23GND	CH31GND
22	CH7Lo	CH15Lo	CH23Lo	CH31L
23	CH8Hi	CH16Hi	CH24Hi	CH32H
24	CH8GND	CH16GND	CH24GND	CH32GND
25	CH8Lo	CH16Lo	CH24Lo	CH32L
26	+24 V	+24 V	+24 V	+24 V

Table 5 X1, X2, X3, X4 terminal description

Name	Function
CHnHi	Channel #n high – loop drive terminal
CHnLo	Channel #n low – loop return terminal
CHnGND	Channel #n 0V – signal ground reference for channel #n
0 V	Module power 0 V – power voltage reference
+24 V	Module power +24 VDC – loop power

4.6 FL1 and FL2

Two fast-on terminals FL1 and FL2 are connected to 0 V of the RIO module.

4.7 PEA and PEB

PEA and PEB are two fast-on terminals respectively connected to the two RBUS connectors P1 and P2 (9-pin D-sub) inner cable shields. They are normally connected to IE or to system ground (PE). RBUS cable outer shield is normally connected to PE.

5 INSTALLATION

Note

The module is mounted vertically on a DIN-rail. The module's top and bottom can be mounted with no spacing to any cabinet top, bottom, DIN-rail modules etc.

5.1 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.

5.2 Installation procedure

1 Label the module.

2 Set correct module address by rotating the two decimal switches to correct values (see section 2.4 on page 11).

3 Fix the module to the rail by fastening the screw on top and bottom.

4 Connect wires to the fast-on terminals FL1 and FL2, PEA and PEB as appropriate.

5 Connect all field wires and power wires to the appropriate screw terminals on X1 to X4.

6 Connect the RBUS cables to the RBUS A and RBUS B connectors and fasten the connectors by using the plug's end bolts.

7 Turn on the power supply to the module.

8 Verify from the operator station that the module is working OK.

6 REPLACEMENT

1. Turn off the power circuit that supplies the RIO module to be replaced.
2. Disconnect field wiring and power wiring by unscrewing the end-bolts and pulling off the eight snap-on terminal blocks for X1 to X4.
3. Disconnect the RBUS A and RBUS B connectors by loosen the end bolts and unplug.
4. Disconnect wires to the fast-on terminals FL1 and FL2, PEA and PEB as appropriate.
5. Loosen the top and bottom screws that fasten the module to be replaced and remove it.
6. Unscrew the end-bolts and pull off the snap-on terminal blocks X1 to X4 of the **new** RIO module.
7. Label the new module.
8. Set correct module address by rotating the two decimal switches to correct values (see section 2.4 on page 11).
9. Fix the module to the rail by fastening the screws on top and bottom.
10. Connect wires to the fast-on terminals FL1 and FL2, PEA and PEB as appropriate.
11. Reconnect all field wires and power wires to the appropriate connector X1 to X4 by snapping on the eight connector headers and fastening them by using the end bolts.
12. Plug the RBUS cable plugs to the RBUS A and RBUS B connectors and fasten the plug's end bolts.
13. Turn on the power supply to the module.
14. Verify from the operator station that the module is working OK.

Kongsberg Maritime AS

P.O.Box 483
N-3601 Kongsberg,
Norway

Telephone: +47 32 28 50 00
Telefax: +47 32 28 50 10
Service: +47 815 35 355
www.kongsberg.com

KONGSBERG