KONGSBERG

RMP420

Hardware Module Description

Kongsberg Maritime Part no. 306712

311165/B

Document history

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Rev. A	April 2007	First version.
Rev. B	December 2010	Updated. Removed grounding options.

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
www.kongsberg.com

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Glossary

AI	Analog Input
AO	Analog Output
BITE	Built-In Test Equipment
CPLD	Complex Programmable Logic Device
DI	Digitial Input
DO	Digital Output
DSP	Digital Signal Processor
ESD	Electrostatic Discharge
GND	Module 0 V reference
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
PE	Protective Earth
RAM	Random Access Memory
RBUS	Remote I/O Bus
RCU	Remote Control Unit
RIO	Remote I/O
RMP420	Remote Multi Purpose module series 420
RTD	Resistance Temperature Detection
WD	Watchdog

1 Module overview

The Remote I/O MultiPurpose module RMP420 is an advanced interface module. The module interfaces a total of 32 combined digital/analog inputs/outputs on the I/O side through a single or dual remote I/O process bus (RBUS) to the host computer(s).

Features of RMP420:

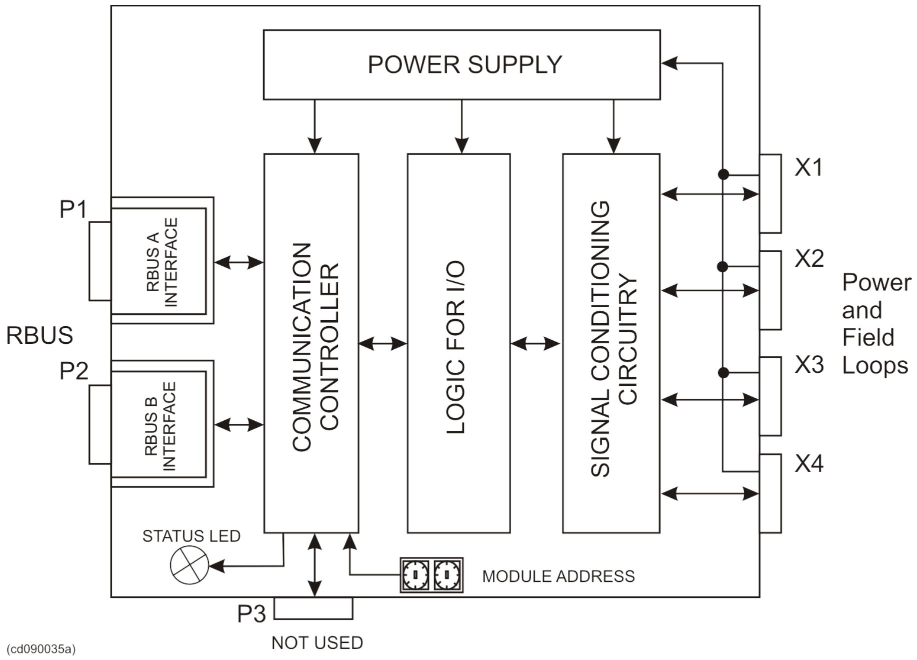
- 32 configurable analog/digital input/output channels.
- RTD: e.g PT100
- Potmeter:
  - Single: Max.load 18 K Ω
  - Sin/Cos: Max load 6 K Ω
- Two remote process bus interfaces (RBUS A and RBUS B) for redundant communication to the controller computer(s)
- High accuracy, 16 bits A/D and D/A converters
- I/O channels can be configured when the 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 the 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
- Dynamic calibration of A/D converter off-set and gain error
- 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
- Fully grounded to PE or IE
- Ex Zone 2 type approval

2 Module function

The RMP420 module is a stand alone interface unit between 32 multipurpose channels on the field side and a single or dual remote process bus (RBUS) connected to a host controller computer (RCU). All channels handle DI, DO, AI, AO, Potentiometer and PT100 signal types. Two channels (ch. 31, ch. 32) handle pulse, frequency and encoder signal types in addition to the common signal types.

Figure 1 RMP420 block diagram



The RMP420 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

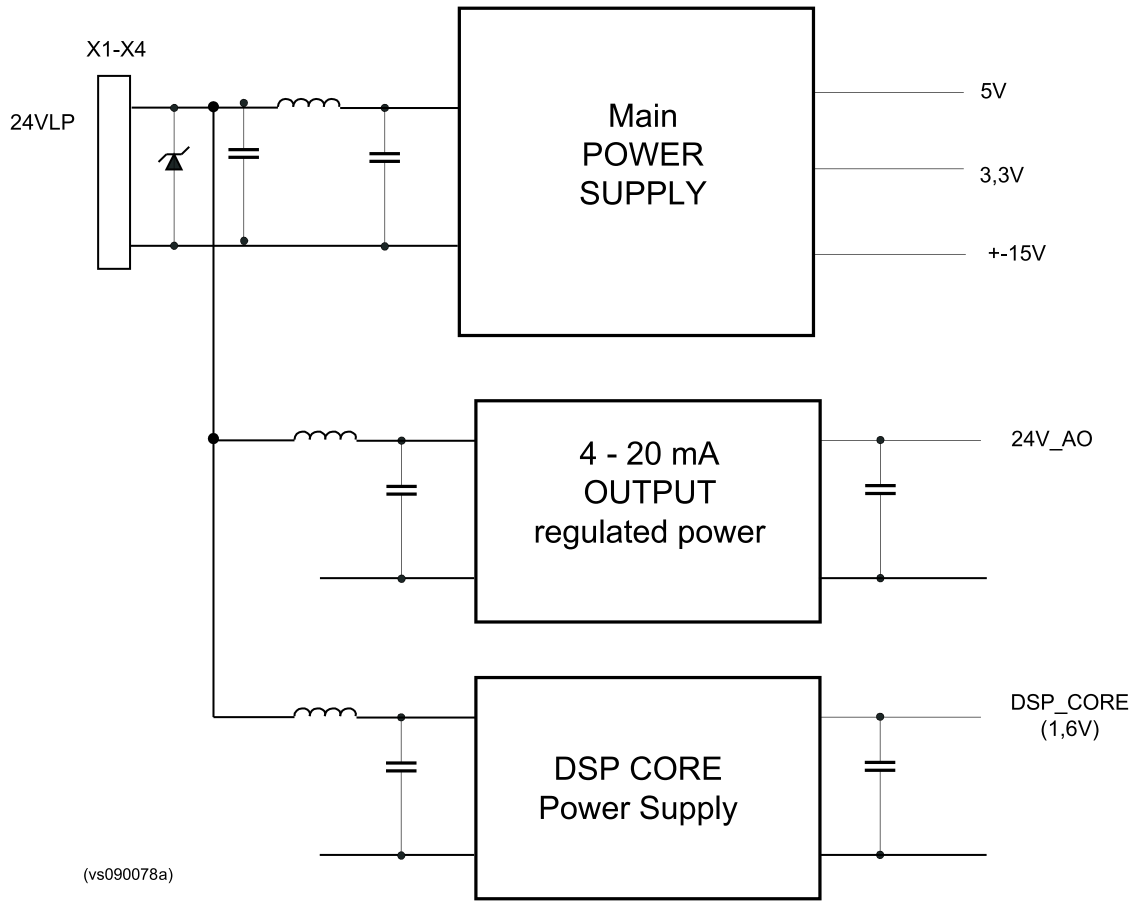
24 VDC loop power to the RMP420 is provided via the terminal blocks X1 to X4. The four power terminals are interconnected and feed the 32 HSD circuits.

Note

If several digital output loops are used, it is mandatory to wire the external loop power to at least two terminal groups (X2 and X4) to get sufficient cross section of the connection. Remember, if all 32 channels are of the solid-state output type, the total current consumption can reach 32 A (1A from each HSD).

The module uses the loop power to generate 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 used on the power input to limit input current.

Figure 2 Power supply principles



2.2 RBUS interface

Two multidrop RS485 serial lines are used. 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 24VDC power supply can be the same as the host computer supply.

2.3 Status LED

The module is provided with a two-coloured status LED. 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 multidrop remote I/O 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 RCU. If they are identical, the module responds.

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

2.5 Field-loop power-driver capability

The RMP420 has for each of the 32 multipurpose channels a High Side Driver (HSD) for providing 24 VDC loop power.

The HSDs are designed for both resistive and inductive loads and offers short circuit protection of the loop.

A software based fuse function protects the HSD from overheating if the current exceeds 1A. At overload, which may occur if the output loop is short circuited, the High Side Driver (HSD) is switched off by the embedded firmware, and status is reported to the system operator. By performing an operator command in the application system, the system then resets the HSD to correct state after the short is repaired or has disappeared.

2.6 Analog/digital inputs/outputs

The RMP420 provides interface for a variety of signal loop types (see Figure 3).

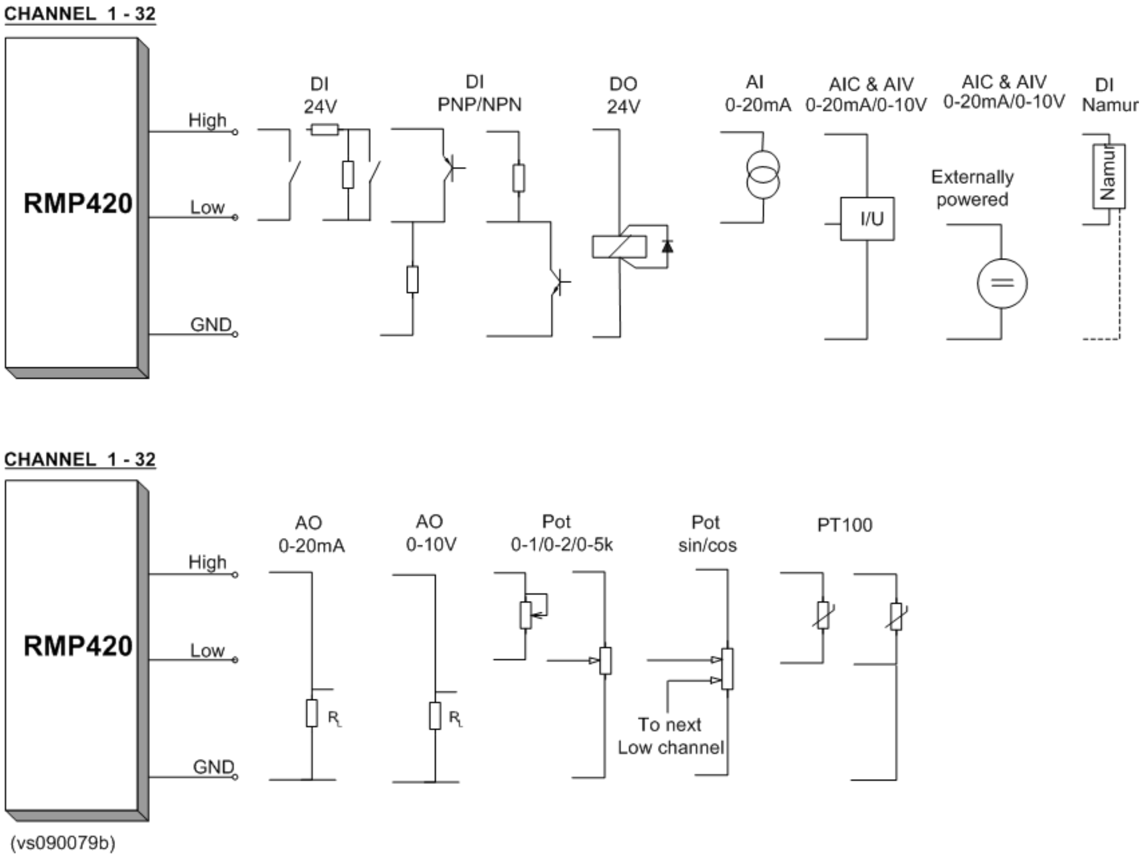
All channels have the same ground reference. The +24 V Loop Power terminals are interconnected between terminal blocks X1 through X4, and the Loop Power Ground terminals are interconnected in the same way.

All output terminals (CHnHi) have been individually protected against over-voltage by power diodes. Over-voltage will thus be clamped to the power rails.

Digital input is read as an analog voltage, which makes it possible to test the loop for different states of validity (see also Self diagnostics). Using the resistors of the digital input loop, as shown in the figure below (the DI 24 V typical), open circuit and short circuited loops can this be detected.

The input circuit is internally low-pass frequency filtered to reduce noise (R = 100 ohm, C = 2.2 μF).

Figure 3 Signal loop principles



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.

See also Technical Specifications section for interface information.

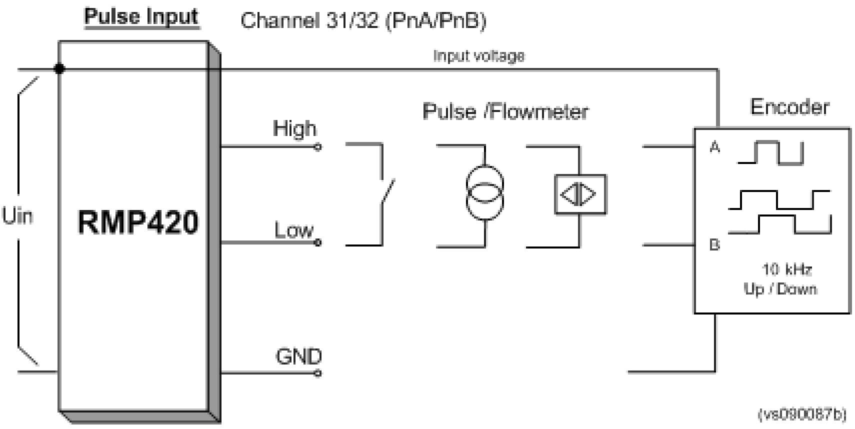
2.7 Pulse input (channels 31 and 32 only)

The pulse/frequency/encoder input can be 0 - 5 V or 0 - 24 V compatible (configurable from system user interface).

The pulse input can be configured to perform the following functions.

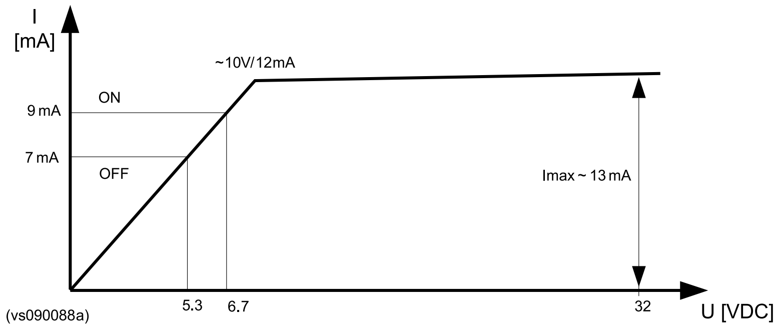
- Pulse counter on
- Pulse frequency (maximum 10 kHz) on
- Encoder counter up or down frequency (maximum 2.5 kHz)

Figure 4 Pulse input interface principles

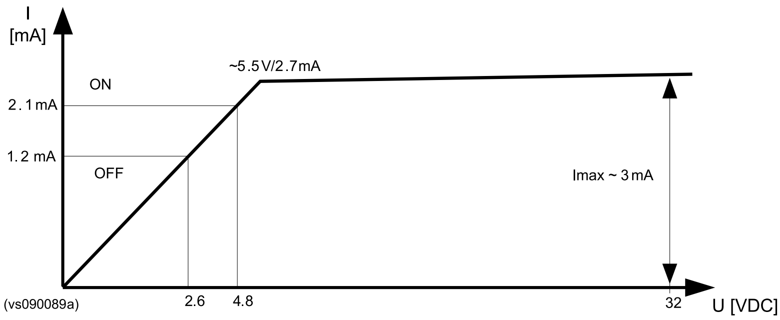


The module will accept switch/open collector, current transmitter (7/9 mA), Namur or Encoder input. In order to reduce power dissipation and thermal stress of components, the inputs have the following characteristics:

Current transmitter 7/9 mA



Namur transmitter



2.8 Failure handling

2.8.1 Software controlled fail-safe

SW fail-safe is based on programmed settings. While the fail-safe function is enabled and the module either loses contact with the RCU or the RCU stops, either of the following fail-safe modes can then be achieved:

- **Configured value**

  Each output enters a predefined fail-safe value after a programmed delay has elapsed (default value is 6 seconds). The configurable fail-safe value is individually set for each channel.

- **Freeze**

  The last received data values from the RCU are kept on the outputs.

The controller computer can send a command to the module that immediately sets the module in an active fail-safe state, which results in output values based on either of the two bullet-marked items above.

All setting of the fail-safe function is available from the system configuration tool.

2.8.2 Major failure

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).

2.9 Power ON/OFF

At module power ON (before the communication with the RCU is established) and at power OFF, all outputs will be de-energized.

2.10 Module grounding

Module ground is wired to the system ground (IE or PE).

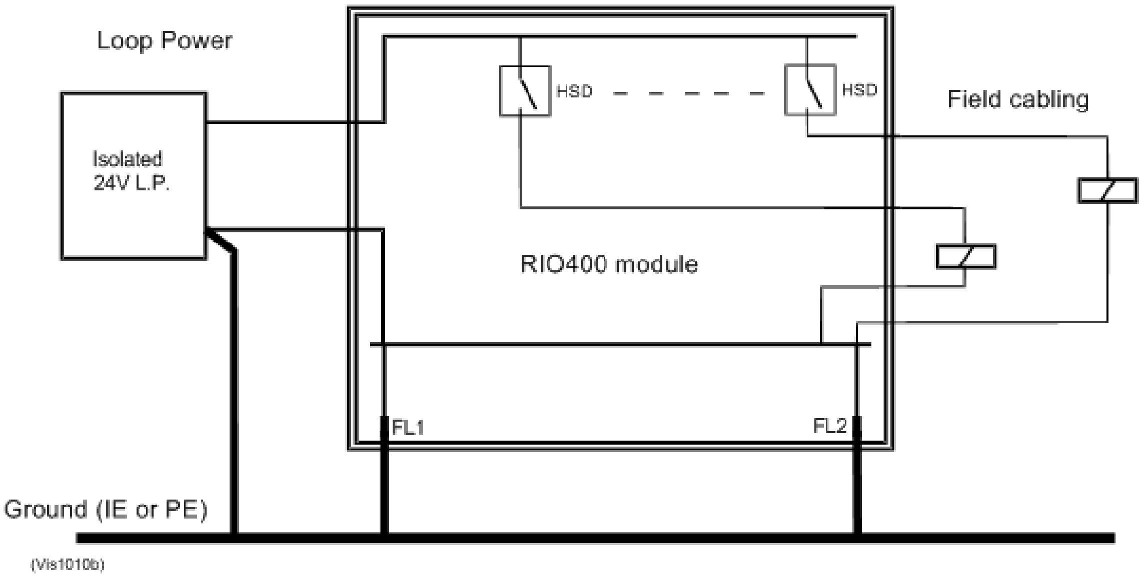
In a TN-S-DC system the module can be grounded to IE or PE using the fast-on terminals FL1 and FL2 according to IEC 60364.

Earth fault detection can be done by using external devices.

Note

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

Figure 5 Module grounding in a TN-S-DC system according to IEC 60364



2.11 Self diagnostics

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

2.11.1 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.

2.11.2 Monitoring using watchdog

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

2.11.3 Status shown on front LED

See *Status LED* on page 9 for details.

2.11.4 I/O loop status

The input signal or read back of output signals can be examined for out-of-range values, and faults can be detected, such as:

- open circuited loops
- short circuited loops

The signal loop type selected decides what can be detected (see *Signal loop principles* on page 11).

2.11.5 Internal circuitry tests

2.11.5.1 Running diagnostics

The Analog to Digital Converter (ADC) is continuously tested by using an internal reference voltage (2.5 VDC). In addition, all internally generated voltages on the module are monitored.

2.11.5.2 Manual test

The analog output voltage is individually calibrated at 0 V, +10 V for each channel during manufacturing test.

The current output is calibrated at +4 mA and +20 mA for each channel during manufacturing test.

2.11.5.3 Temperature

There are two temperature-based functions in the module.

- Temperature can be continuously monitored by the system software.
- Temperature based shut-down with de-energized output, controlled by the module itself, enabled and triggered by a 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 mm2Phoenix COMBICON MDSTBV 5.08 mm
Maximum overvoltage	Input voltage + 0.5 VDC without damage
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 %
Measurement accuracy	±0.15 % of full scale
Offset	±30 mV
Voltage output	0 - 10 V, ±0.5 %, internal resistance 1 kohm
Current output	0 - 20 mA
Linearity	0.1 % of full scale
Offset	±0.1 mA
Gain	0.1 % of full scale
Measurement accuracy	±0.35 % of full scale
Maximum load resistance	500 ohm
Digital output	1 A High Side Driver, minimum 10 mA, 0.5 mJ open loop energy
Leakage current	Maximum 100 µA
Short circuit protection	1.4 A at 20°C, typical 2.5 A at 25°C and 4.8 A at -20°C
PT100 interface:	

Table 2 Technical specifications (cont'd.)

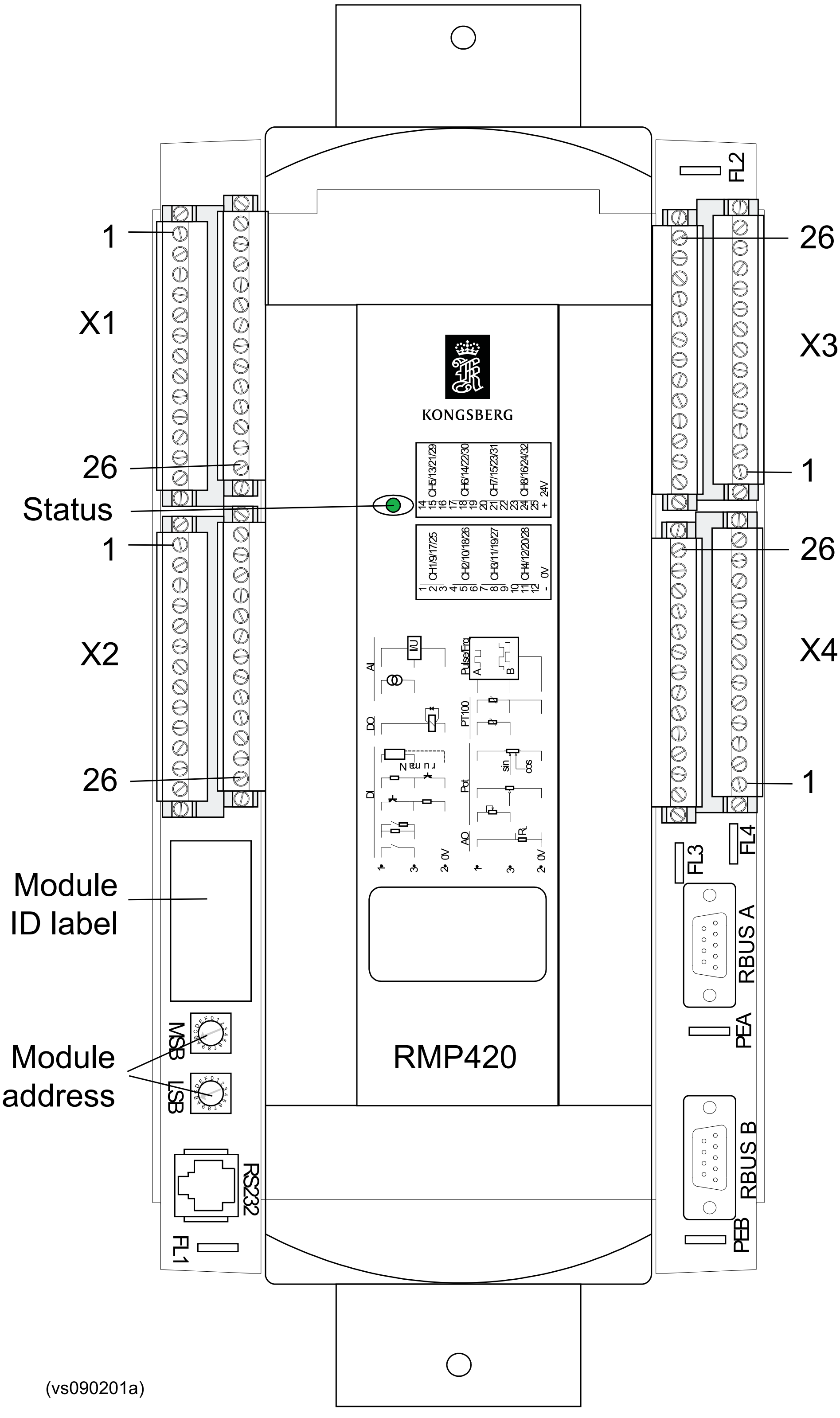
Power supply requirements and specifications	
Temperature range	-200 - +620°C
Resolution	±0.5°C
Accuracy	±0.4 % of full scale
Temperature drift	±50 ppm/°C
Maximum wire resistance	25 ohm/wire
Response time	1000 ms
Pulse/frequency interface (Ch. 31 and 32)	
Maximum input frequency	Pulse count UP/frequency: 10 kHz
	Encoder count UP/DOWN: 2.5 kHz (revolutions, 4 counts/revolution)
Duty-cycle	Minimum pulse width: 11 µs at 10 kHz range
Pulse level Namur transmitter (Configuration #1)	I_{ON} > 2.1 mA, I_{OFF} < 1.2 mA, R_{in} < 2.2 kohm, $I_{maximum}$ = 3 mA
Pulse level Current transmitter (Configuration #2)	I_{ON} > 9 mA, I_{OFF} < 7 mA, R_{in} < 1 kohm, $I_{maximum}$ = 13 mA
Accuracy (oscillator)	100 ppm over the whole temperature range (-15 - +70°C), at 25°C: typical 25 ppm
Analog to Digital Converter ADC	
Voltage ranges	0 - 4 V and 0 - 10 V
Resolution	16 bit
Accuracy:	
Linearity	*±0.01 % of full scale*
Offset	*±30 mV*
Gain	*±0.02 % of full scale*
Temperature drift	*±20 ppm/°C*
Digital to Analog Converter DAC	
Voltage range	0 - 10 V
Resolution	16 bit
Accuracy:	
Linearity	*±0.02 % of full scale*
Offset	*±30 mV*
Gain	*±0.03 % of full scale*
Temperature drift	*±30 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.)

Power supply requirements and specifications	
Connector	9 Pin DSUB female
Bit rate	2 Mbit/sec
Signal code	Manchester encoded (self-clocked)
Copper wire topology:	
Insulation	500 V maximum (optocoupler)
Physical layer	RS-485 multidrop
Cable attenuation	< 6.5 dB/100 m @ 10 MHz (CAT 5)
Cable length	Maximum 200 m between repeaters. Maximum 3 repeaters.
Fibre optics topology (w/additional fibre media converter):	
Fibre cable	62.5/125 µm, multi-mode
Connector	ST
Maximum cable length	1000 m (point to point), 500 m if used in patch panel topology
HW fail safe	
Watch-dog response	Maximum 65 ms
Internal test error (DSP)	Instantly set
SW 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 predictions	
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

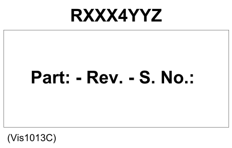
4 Module pin and connector description

Figure 6 Module layout



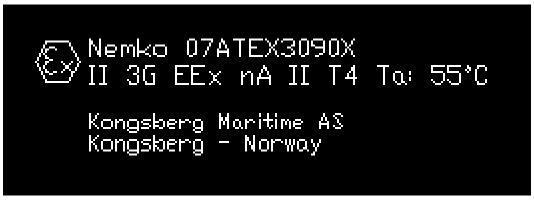
4.1 Module identification (when contacting KM)

For any written communication with KM regarding the RMP420 module, please refer to the module name (RMP420) and the information in the rectangle (Assembly-Revision -Serial No.).



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 7 RBUS A and B connector pin layout

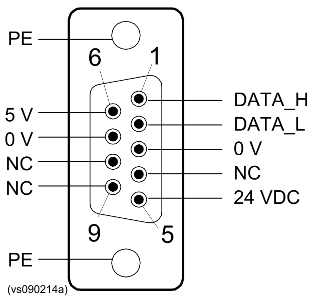


Table 3 RBUS A and RBUS B pin allocation

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
4			Not used (NC = Not Connected)
5	A_24V	B_24V	+24 VDC for isolated RS485 transmitter/receiver
6	A5V	B5V	Isolated +5V for the RBUSline (termination use only)
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 8 X1 to X4 with channel and terminal layout and names

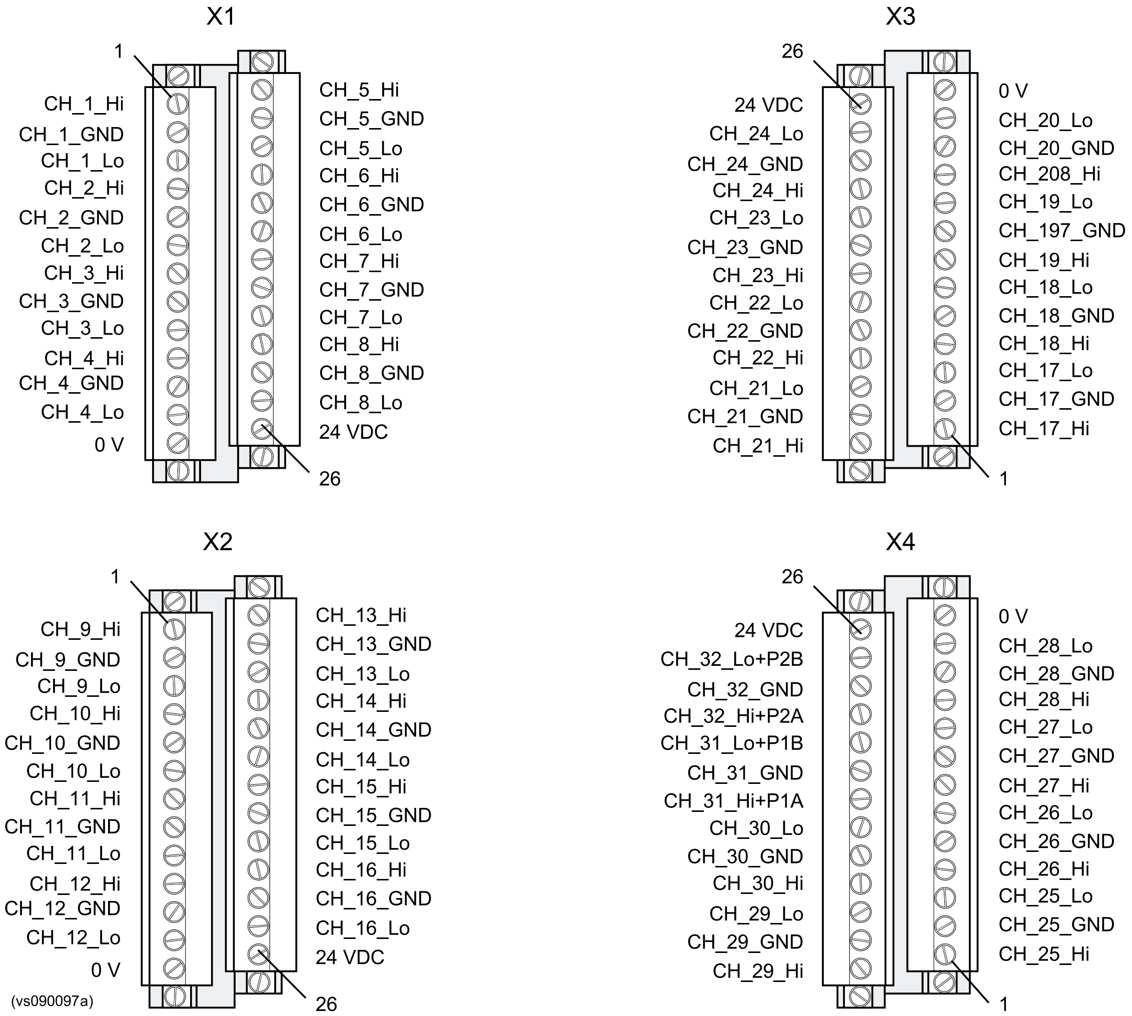


Table 4 X1, X2, X3, X4 terminal allocation

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/P1A
21	CH7GND	CH15GND	CH23GND	CH31GND
22	CH7Lo	CH15Lo	CH23Lo	CH31L/P1B
23	CH8Hi	CH16Hi	CH24Hi	CH32H/P2A
24	CH8GND	CH16GND	CH24GND	CH32GND
25	CH8Lo	CH16Lo	CH24Lo	CH32L/P2B
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
PnA	Pulse/frequency /encoder channel n (channel 31 and 32 only) A input terminal
PnB	Pulse/frequency /encoder channel n (channel 31 and 32 only) B input terminal
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 for the RIO module. The module is grounded by wiring to external earth bar. The two terminals are normally connected to IE, but can also be connected to PE.

4.7 FL3

Note

Not in use.

4.8 FL4

Note

Not in use.

4.9 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 Module 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.

Note

No static electricity precautions needs to be taken during installation of the RIO module.

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 2.4 on page 9).

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 Module replacement

Note

No static electricity precautions needs to be taken during replacement of the RIO module.

6.1 Replacement procedure

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 2.4 on page 9).

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.