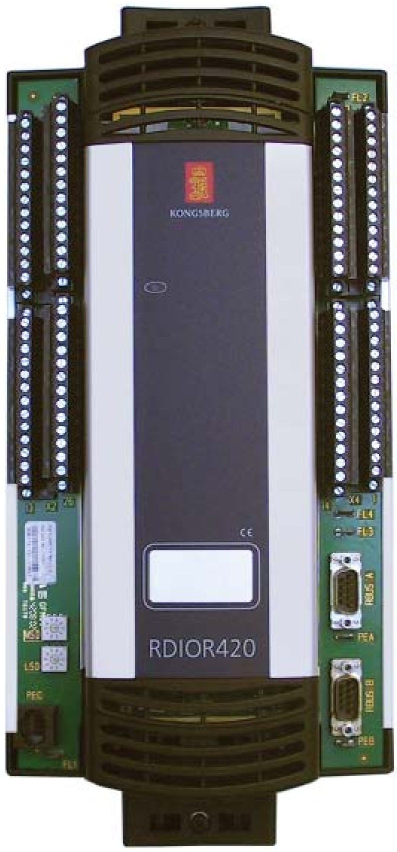
RDIOR420

Hardware Module Description

Kongsberg Maritime Part no. 306713



311163/B

Document history

Document number: 311163		
Rev. A	April 2007	First version.
Rev. B	February 2011	Updated grounding information, figures and added environmental information.

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.
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Glossary

BITE	Built-In Test Equipment
CPLD	Complex Programmable Logic Device
CPU	Central Processing Unit
DI	Digitial Input
DO	Digital Output
DSP	Digital Signal Processor
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
GND	Module 0 V reference
HSD	High Side Driver
IE	Instrumentation Earth
IEC	International Electrotechnical Commission
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
RCU	Remote Control Unit
RDIOR420	Remote Digital I/O Relay series 420
RFI	Radio frequency Interference
RIO	Remote I/O
RBUS	Remote I/O Bus
TN-S-DC	Terra Neutral Separated Direct Current
WD	Watchdog

1 Module overview

The Remote Digital Input Output Relay module RDIOR420 is an advanced interface module. The module design is a fixed combination of 16 SW configurable DI/DO solid state channels and 16 relay channels (Dry Contact). The module interfaces the field I/O through a single or dual remote I/O process bus (RBUS) to the host computer(s).

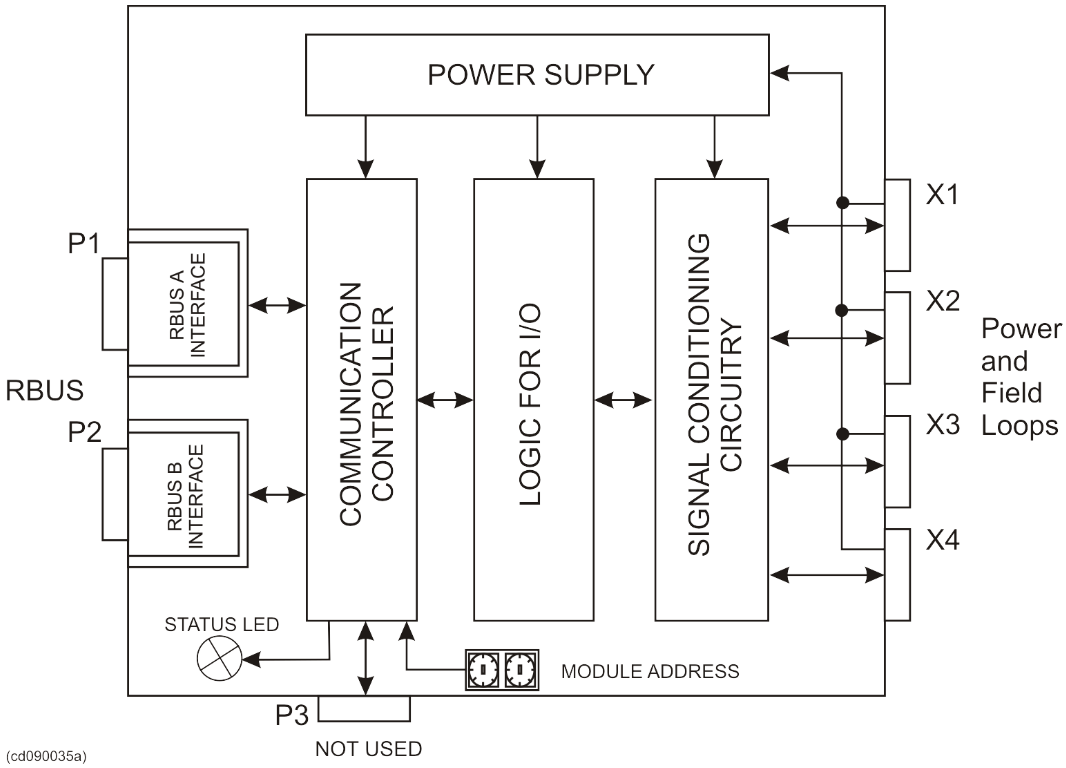
Features of RDIOR420:

- 16 solid-state digital inputs or 16 solid-state digital outputs, individually configured
- 16 relay channels (Dry Contact)
- Two remote I/O process bus interfaces (RBUS A and RBUS B) for redundant communication to the controller computer(s)
- Each remote I/O bus interface is galvanically 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 shows running or error status
- Loop monitoring of solid-state digital inputs and outputs
- Relay coil monitoring for relay outputs
- Dynamic calibration of A/D converter off-set and gain error
- Embedded temperature sensor
- I/O channels can be configured when the system is running
- Loop-check and debugging possible from operator station or local data terminal
- Short-circuit protected I/O loop current drivers
- Fail-safe activation of outputs upon loss of communication
- Built-in tests for self-diagnostics and fault identification while running
- Fully grounded to PE or IE

2 Module function

The RDIOR420 is a stand alone interface unit between up to 16 combined digital inputs/outputs and 16 relay outputs on the field side and a single or dual remote I/O process bus (RBUS) connected to a controller computer.

Figure 1 RDIOR420 block diagram



The RDIOR420 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

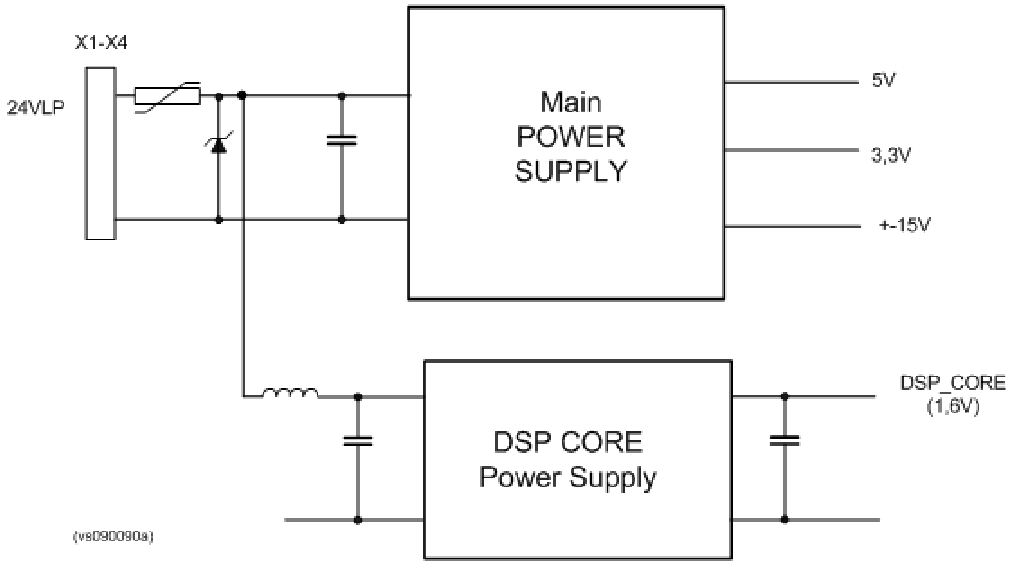
24 VDC loop power to the RDIOR420 is provided via the terminal blocks X1 through X4. The four power terminals are interconnected and feed the 16 HSD circuits and the 16 relays.

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 16 channels are of the solid-state output type, the total current consumption can reach 16 A (1A from each HSD).

The module uses the loop power to generate several internal voltages (see illustration below). To protect the power supply component an automatic resetable fuse and a tranzorber are connected on the input side. However, external fuses must be fitted on the power input in order to limit the 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's 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 otherwise red.

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 equal, 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 RDIOR420 has for each of the 16 combined in/out channels a High Side Driver (HSD) for driving the 24 VDC digital input or output loop.

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

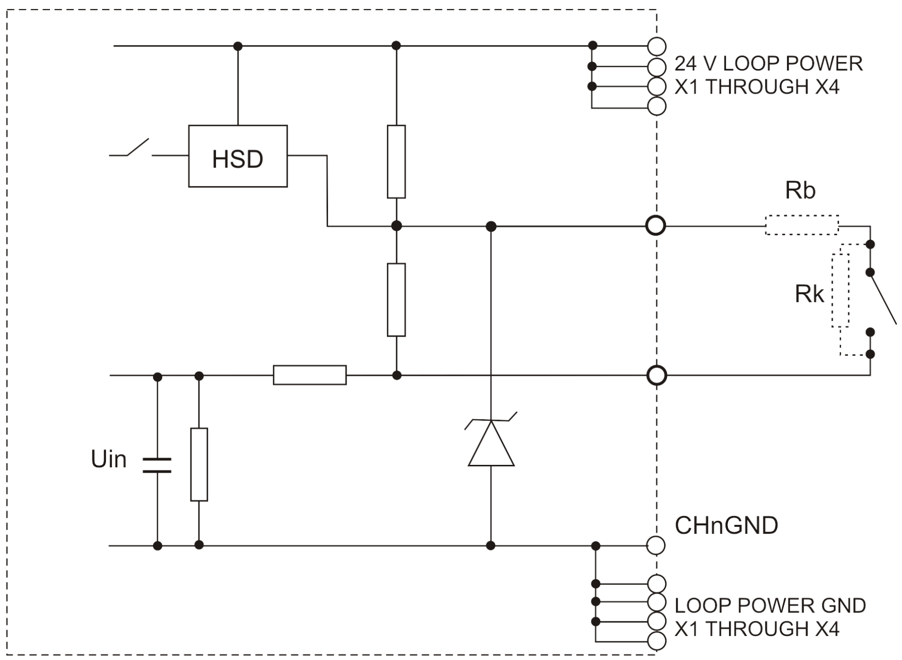
A software based fuse function protects the HSD from overheating if the current exceeds 1A. At overload, which may occur if the output loop is short circuit, the High Side Driver (HSD) is switched off by the application software, and status is reported to the system operator. By operator command the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

2.6 Digital input

The HSD provides the loop current for the input channel.

The 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 dotted resistors of the input loop shown in Figure below, open or short circuit loop can be detected.

Figure 3 Digital input interface principle diagram



(Cd2708m)

Note

For detailed loop information see the appropriate KM loop typical drawing.

2.7 Digital output

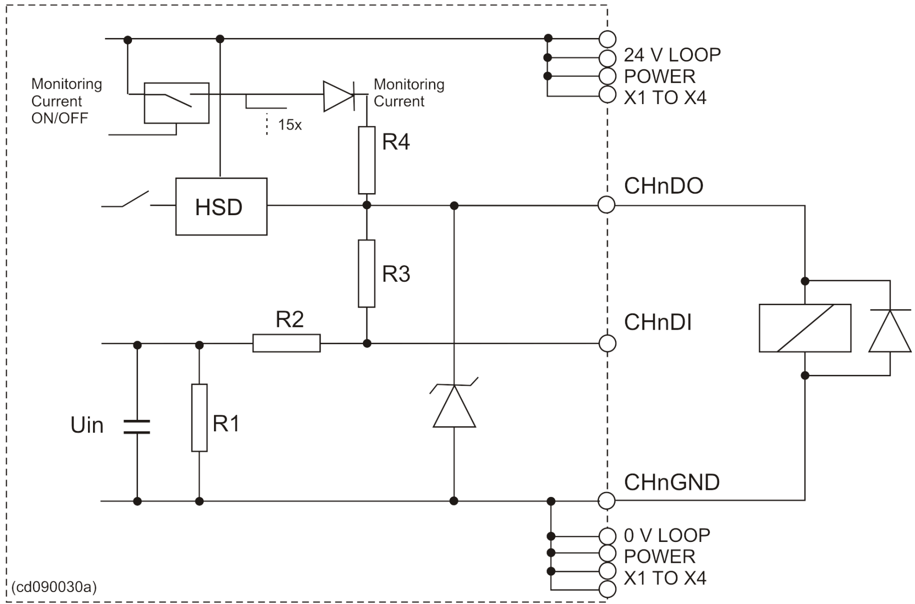
The High Side Driver (HSD) is used for switching the digital output ON/OFF.

An internal feedback resistor (R3) provides monitoring of the digital output loop to detect if loop is broken or shorted.

The monitoring current via R4 can be turned ON or OFF for the whole module (16 channels). If monitoring of output loops is required, R4 is powered from 24 VDC loop power. If small current relays or LED lamps are used, the monitoring current should be OFF. Monitoring is possible only at de-energised loops.

The digital output interface with a typical load is shown in the figure below.

Figure 4 Digital output interface principle diagram



Note

For detailed loop information see the appropriate KM loop typical drawing.

2.8 Relay output

Each of the 16 relay output channels has a relay driver that controls the relay output (see the figure below).

Note

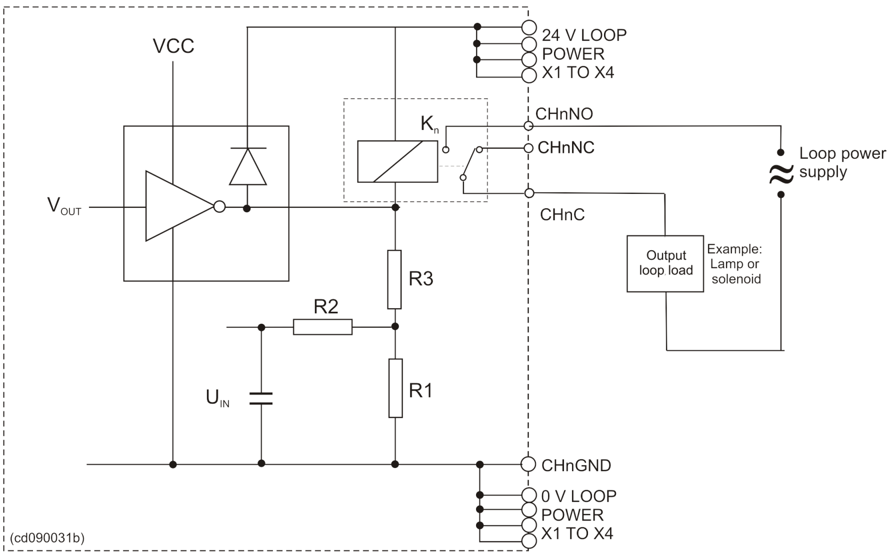
For information about RDIOR420 relay performance see Technical Specification section and particularly Figure 7 and Figure 8. However, inductive and capacitive loads should be carefully designed into the system and within specified limits.

With special attention on the following options:

- Switch off, inductive load → generate high voltage
- In-rush current, capacitive load → generate high current

Thus, extensive attention should be carried out when interfacing field equipment to module internal relay circuitry. Always consider to implement snubber circuitry in the total loop if relevant in order to not stress the relay contacts.

Figure 5 Digital output relay interface principle diagram



The relay driver circuit has a built-in diode for draining the induced current from the relay coil when turning off the driver.

The relay driver circuitry is provided with feed back facilities to allow the controller to detect if the relay coil functions properly.

Note

Recommended rule of thumb regarding engineering: Preferably no interfacing of AC I/O to KM Field Station Cabinets. AC interfaced I/O to be separated in dedicated barrier cabinet.

2.9 Failure handling

2.9.1 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.

2.9.2 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 OFF.
- If the DSP stops, the communication interface outputs are set to high impedance (no communication with the RCU(s) is possible).

2.10 Power ON/OFF

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

2.11 Module grounding

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

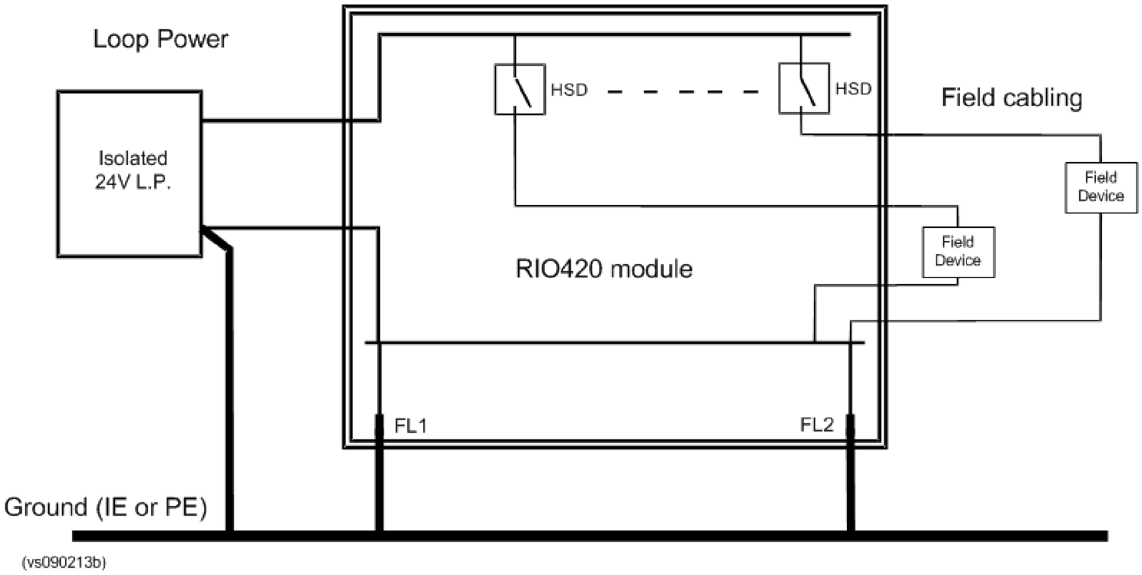
In a TN-S-DC system the module can be grounded to IE or PE using the fast-on terminals FL1 and FL2 according to IEC 60364.

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



2.12 Self diagnostics

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

2.12.1 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.

2.12.2 Monitoring using watchdog

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

2.12.3 Status shown on front LED

See *Status LED* on page 8 for details.

2.12.4 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. Such faults are:

- wire breaks
- short circuits

The signal loop type selected decides what can be detected (see figure *Digital input interface principle diagram* on page 9).

2.12.5 Internal circuitry tests

2.12.5.1 Running diagnostics

The Analog to Digital Converter (ADC) is continuously tested by using an internal reference voltage (5.0 VDC). All module powers are internally monitored.

2.12.5.2 Temperature

There are two temperature-based functions in the module.

- Temperature can be continuously monitored by the system software.
- Temperature based shut-down, with de-energized output controlled by the module itself at a fixed shut-down temperature.

3 Technical specifications

Table 2 Technical specifications

Power supply requirements	
Power supply voltage (loop power voltage)	24 VDC +30% - 25%
Power consumption 16 DI	Maximum 0.25 A
Power consumption 16 DO	Maximum 16 A
Heat dissipation	Maximum 10 W
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
Input/output common	
Number of I/O channels	16 relay DO 16 solid-state DI/DO
I/O configuration of 16 solid-state DI/DO channels	Individually set to DI or DO
X1 - X4 connectors	Screw terminals 2.5 mm2Phoenix COMBICON MDSTBV 5.08 mm
Overvoltage	Maximum Input voltage +0.5 VDC without damage
Digital input (solid-state type)	
Input loop current	Maximum 4 mA at 24 VDC loop power
Channel "OFF" current	< 0.5 mA (application dependent)
Channel "ON" current	> 3 mA (application dependent)
Maximum input voltage	Loop power
Sampling rate	Maximum 100 samples/sec.
Digital output (solid-state type)	
Driver	1 A short circuit protected High Side Driver (Each loop power connection: maximum 8 A)
Short circuit trip	Minimum 1.4 A
Driver leakage	Maximum 2 mA at 24 VDC loop power
Relay Channel	
DC load	15 to 300 VDC, min. 100 mA, max. 5 A at Cos φ = 1

Table 2 Technical specifications (cont'd.)

AC load	15 to 250 VAC, max 2 A recommended at Cos φ = 0.4
Breaking capability:	
	0.1A: 300 V *0.3A: 60 V* *5A: 24 V*
Electrical endurance:	
Cos φ = 0.4:	*2 000 000 operations at 0.1 A* *250 000 operations at 1 A* *120 000 operations at 3 A*
Cos φ = 1:	*6 000 000 operations at 0.1 A* *1 300 000 operations at 1 A* *300 000 operations at 3 A*
Note *Snubber circuitry required*	
Field loop power requirement (for relay contacts)	15 - 300 VDC or 15 - 250 VAC
Relay performance	Maximum 5 A switching current, minimum 100 mA switching current. Limits for DC load voltage versus load current according to diagram in Figure *Maximum DC load versus load current* on page 18 below.
Mechanical operations	Guaranteed 10exp7 at resistive load. Guaranteed 10exp5 at load 2A and 250 VAC and cos φ = 0.4.De-rating according to diagram in Figure *De-rating of relay operations due to load current* on page 18 below.
Coil resistance	3390 Ohm +- 10%
RBUS	
Number of addresses	99
Number of channels	2
Power supply	24 VDC ±20 % (maximum 50 mA)
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)

Table 2 Technical specifications (cont'd.)

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
Environmental requirements	
Operating temperature	-15°C – +70°C
Storage temperature	-25°C – +70°C
IP class	IP 20
Life cycle prediction	
Predicted failure rate (T = 25°C, env. = GB) (60% confident based on chip suppliers data and MIL-HDBK-217F)	28.15 years
Predicted failure rate (T = 35°C, env. = NS) (Environmental de-rating based on Rome Laboratory tool-kit)	7.6 years
Environmental requirements	
RoHS compliant 	Compliant to EU directive 2002/95: Restriction of the use at certain hazardous substances in Electrical and Electronic Equipment (RoHS).
Recycling	Module recycling according to EU directive 2002/96: Waste Electrical and Electronical Equipment (WEEE).

Figure 7 Maximum DC load versus load current

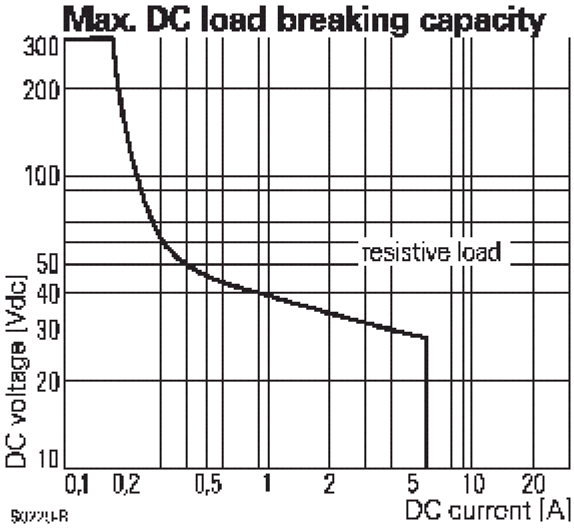
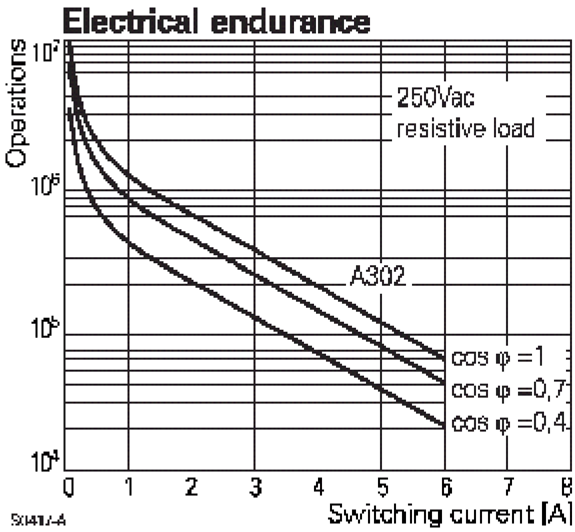


Figure 8 De-rating of relay operations due to load current

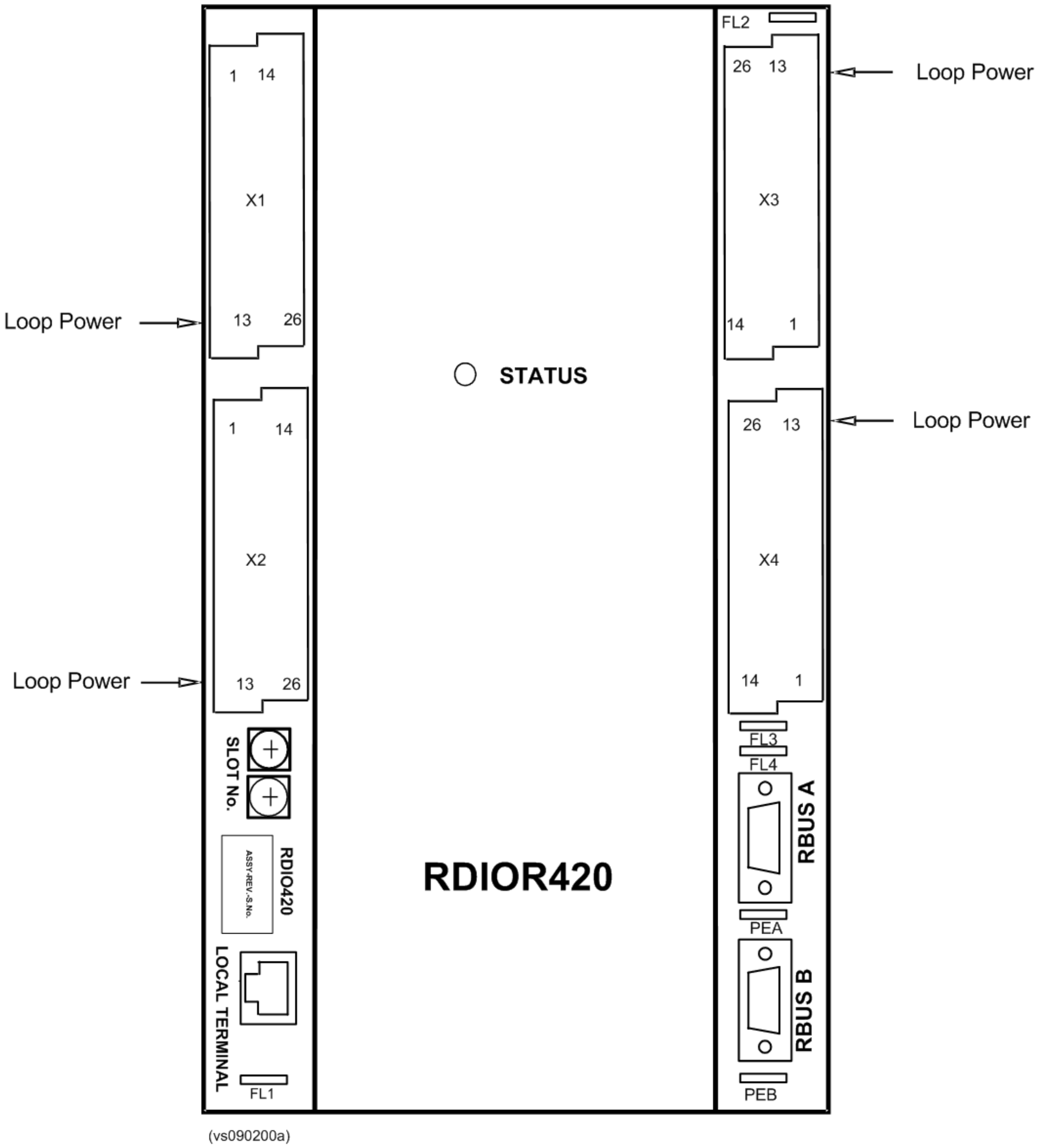


Note

Optimal switching reliability over time is obtained by operating the relay's contacts sett's on DC or purely resistive loads. Figure 8 illustrates operational de-ratings if exposing the contact set of AC operation with a high degree of cos φ (in particular inductive) loads. Thus, if AC load, always consider snubber protection of relay contact.

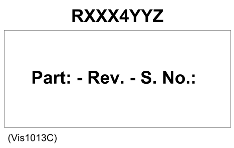
4 Module pin and connector description

Figure 9 Module layout



4.1 Module identification (when contacting KM)

For any written communication with KM regarding this module you should refer to the module name (RDIOR420) and the information in the rectangle (Assembly-Revision-Serial No.).



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

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

Figure 10 RBUS A and B connector pin layout

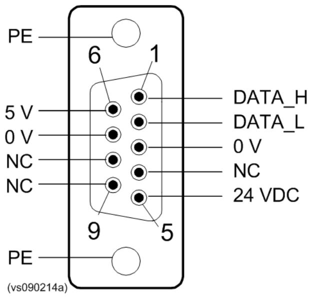


Table 3 RBUS A and RBUS B pin allocation

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	A_5V	B_5V	Isolated +5V for the RBUS line. Termination use only.
7	A_0V	B_0V	0 V, ground reference for isolated +5V
8			Not used (NC = Not Connected)
9			

4.3 Local terminal (P3)

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

4.4 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 Xn. One Xn handles eight I/O channels.

Figure 11 X1 to X4 with channel and terminal layout and names

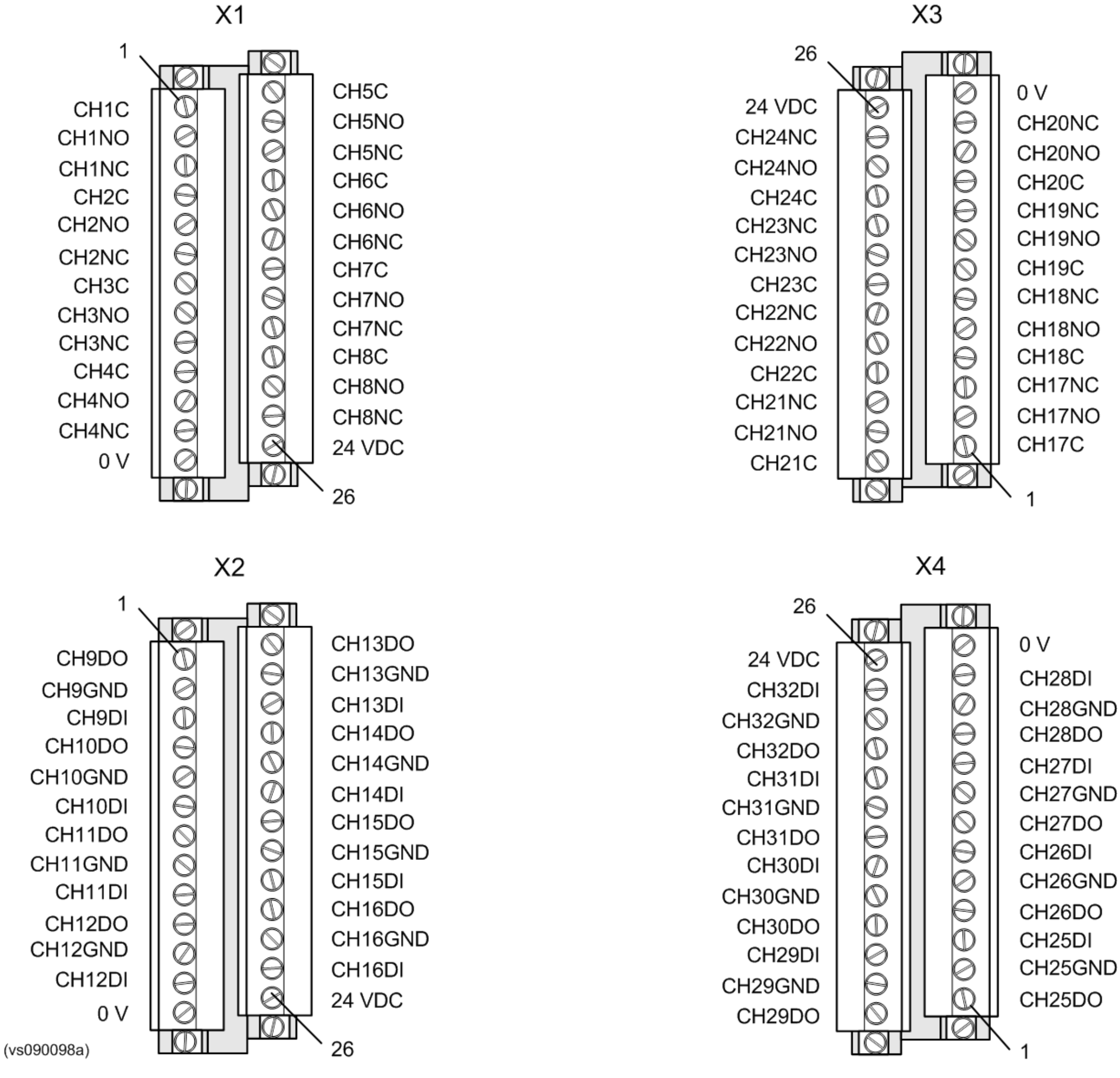


Table 4 X1, X2, X3, X4 terminal allocation

Pin no.	X1	X2	X3	X4
1	CH1C	CH9DO	CH17C	CH25DO
2	CH1NO	CH9GND	CH17NO	CH25GND
3	CH1NC	CH9DI	CH17NC	CH25DI
4	CH2C	CH10DO	CH18C	CH26DO
5	CH2NO	CH10GND	CH18NO	CH26GND
6	CH2NC	CH10DI	CH18NC	CH26DI
7	CH3C	CH11DO	CH19C	CH27DO
8	CH3NO	CH11GND	CH19NO	CH27GND
9	CH3NC	CH11DI	CH19NC	CH27DI
10	CH4C	CH12DO	CH20C	CH28DO
11	CH4NO	CH12GND	CH20NO	CH28GND
12	CH4NC	CH12DI	CH20NC	CH28DI
13	0 V	0 V	0 V	0 V
14	CH5C	CH13DO	CH21C	CH29DO
15	CH5NO	CH13GND	CH21NO	CH29GND
16	CH5NC	CH13DI	CH21NC	CH29DI
17	CH6C	CH14DO	CH22C	CH30DO
18	CH6NO	CH14GND	CH22NO	CH30GND
19	CH6NC	CH14DI	CH22NC	CH30DI
20	CH7C	CH15DO	CH23C	CH31DO
21	CH7NO	CH15GND	CH23NO	CH31GND
22	CH7NC	CH15DI	CH23NC	CH31DI
23	CH8C	CH16DO	CH24C	CH32DO
24	CH8NO	CH16GND	CH24NO	CH32GND
25	CH8NC	CH16DI	CH24NC	CH32DI
26	24 V	24 V	24 V	24 V

Table 5 X1, X2, X3, X4 terminal description

Name	Function
CHnC	X1 and X3 only. Channel n common relay contact
CHnNO	X1 and X3 only. Channel n normally open relay contact
CHnNC	X1 and X3 only. Channel n normally closed relay contact
CHnGND	X2 and X4 only. Channel n Ground reference or Loop Power ground
CHnDO	X2 and X4 only. Channel n Digital Output or channel Loop Power
CHnDI	X2 and X4 only. Channel n Digital Input
0 V	Module power 0 V – loop power reference
+24 V	Module power +24 VDC – loop power

4.5 FL1 and FL2

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

4.6 FL3

Note

Not in use.

4.7 FL4

Note

Not in use.

4.8 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.

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1 Label the module.

2 Set correct module address by rotating the two decimal switches to correct values (see 2.4 on page 8).

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

4 Connect wires to the fast-on terminals FL1, FL2, PEA, and PAB 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 screws.

7 Turn on the power supply to the module.

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

6 Module 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 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, FL2, PEA, and PAB 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 address to the module by rotating the two decimal switches to correct values.

9 Fix the module to the rail by fasten the screws on top and bottom.

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

11 Reconnect all field wires and power wires to the appropriate connector X1 to X4 by snapping on the connector headers and fastening the end bolts.

12 Plug the RBUS cable plugs to the RBUS A and RBUS B connectors and fasten them by using the screws.

13 Turn on the power suply to the module.

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