RUSIO-3224

Remote Universal Safe IO device (32 channels, 24 Vdc)

Description

The RUSIO-3224 module has 32 universal safe IO channels with configurable channel function; configuration is done in Safety Builder.
The RUSIO-3224 module can be used in applications up to SIL 3, in compliance with IEC 61508/61511.

It requires two RUSIO-3224 modules to achieve a redundant configuration.

All channels are powered out of the 24Vdc supply.

Each channel can be configured as:

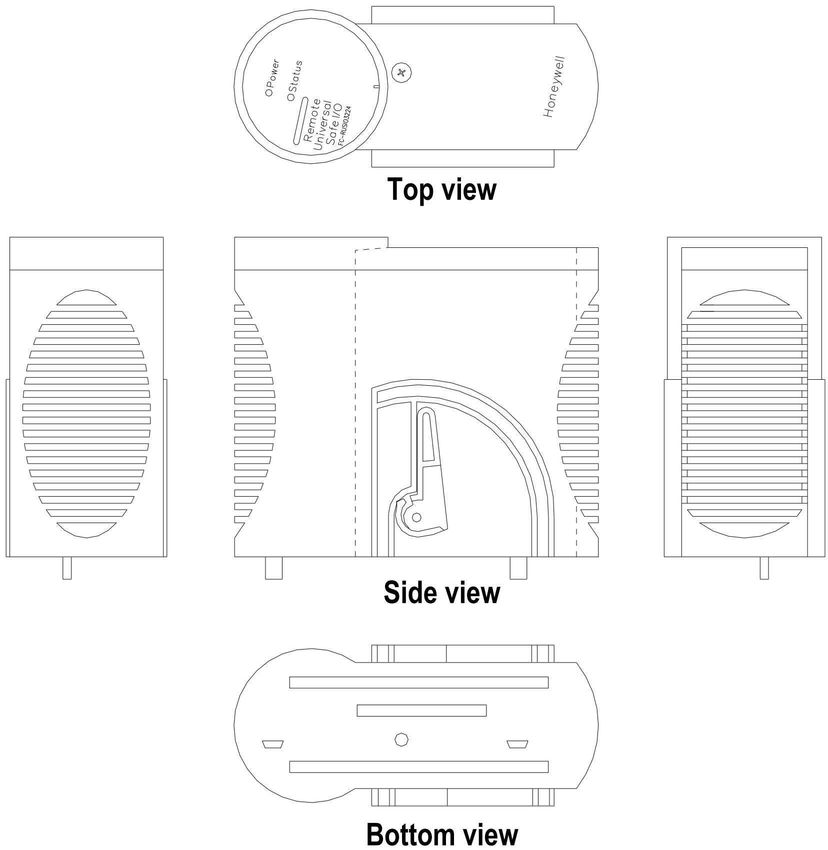
- Digital input (with or without loop monitoring)
- Digital output (with loop monitoring)
- Analog input (0-20mA or 4-20mA active)
- Analog output (0-20mA or 4-20mA active)

The RUSIO-3224 module supports two (100Mbaud) ethernet links to communicate with a SM Controller.

The RUSIO-3224 module has a housing that is in line with the patented Series C design of Honeywell. It needs to be placed on an IO Termination Assembly (IOTA).

Figure 249 on page 417 shows physical appearance of the RUSIO-3224 module.

Figure 249 RUSIO-3224 module - top, side and bottom view



The RUSIO-3224 module has the following features:

- 32 universal IO channels that can be configured to control DI, AI, DO, AO
- any type of IO field signal has only to be connected to the two connections of the applicable universal channel on the IOTA
- proven-in-use redundant processor concept that complies with the SIL 3 safety requirements in single channel operation
- a dedicated communication link between these processors
- a redundant communication link with the partner module (in redundant configuration)
- an Ethernet-based SM RIO link to the SM Controller in the network via dedicated switches; the SM RIO link uses a dedicated protocol

- monitoring the temperature of the electronics
- a configurable ESD function via channel 32 for dedicated safety related functions
- function-tested watchdogs that: monitor and/or handle:
  - monitor cycle time and supply voltage
  - handle the ESD function and memory errors
- LED indicators at the front of the module for power and health status indication
- real-time clock for Sequence Of Event (SOE) time stamping with a resolution of 1 msec

The RUSIO-3224 module functions as a universal IO module within the Safety Manager concept. It executes:

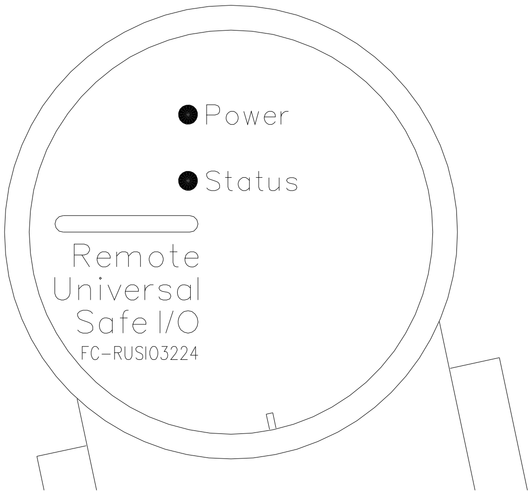
- the input scan of the process variables
- all functional tests of its hardware
- data exchange with its partner module
- data exchange via the SM RIO link with the SM Controller that executes the application logics
- update the outputs and thus the process

The FLASH nature of the memory allows for on line upgrading within the TUV-approved concept of both the system software as well as the channel configuration.

Power and status indications

The RUSIO-3224 module has two LEDs; one for power indication and one for status indication (see Figure 250 on page 419).

Figure 250 RUSIO-3224 module - power and status indications



The table below specifies the applicable indications:

LED indication		Status
Power LED	Green, steady	Power to the module is switched on
	Off	Power to the module is switched off
Status LED	Green, steady	Running without hardware fault
	Red, steady	Running with hardware fault(s)
	Green, flashing, toggle 1 Hz	Idle without hardware fault
	Red, flashing, toggle 1 Hz	Idle with hardware fault(s)
	Red, flashing, toggle 4 Hz	Application / firmware loading
	Off	Module has stopped

ESD function

The RUSIO-3224 module has one channel that can be configured as Emergency ShutDown (ESD) input; this is channel 32. To configure channel 32 as ESD input in Safety Builder, the two pins fork on the **CN4** terminals on the IOTA must be in the **ENABLE** position (connecting pins 1 and 2).

Channel 32 must be configured for the ESD function in the software also, in order to execute the proper tests for the ESD channel.

When the (field) switch on the ESD input opens, the universal IO watchdogs switch off and all digital outputs of the connected RUSIO-3224 module(s) will go off and remain off. There is *no* software action required to do this; also there is *no* software action that can prevent this.

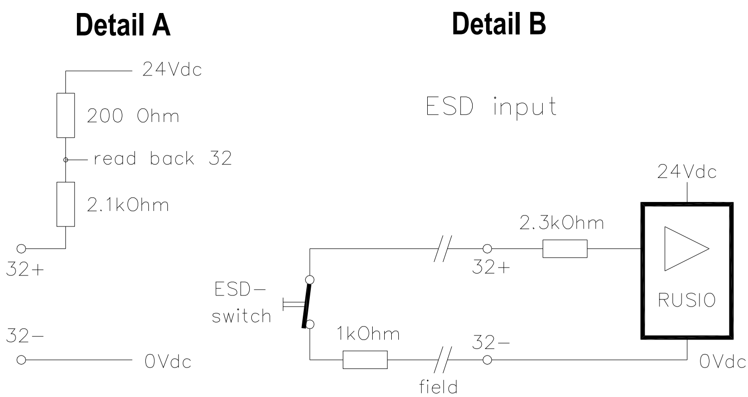
See detail A of Figure 251 on page 420 for a block diagram of this ESD input.

See detail B of Figure 251 on page 420 for the ESD input field connection.

The ESD input is line monitored (for short circuit in the field wires).

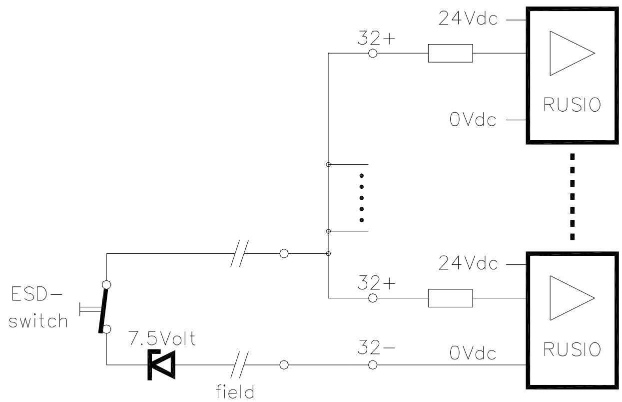
Place the (1kOhm) line termination resistor on (or near) the switch.

Figure 251 ESD input of a universal IO channel



Connecting multiple ESD-inputs of RUSIO-3224 modules with one switch requires a 7.5Volt zener, see Figure 252 on page 421.
All RUSIO-3224 modules involved must be supplied out of the same 24Vdc (power rail).
A 1 Watt zenerdiode - like the 1N4737A or the BZV85-C7V5 - can handle upto 10 ESD inputs of (redundant) RUSIO-3224 modules.
A 5 Watt zenerdiode - like the 1N5343B - can handle upto 50 ESD inputs of (redundant) RUSIO-3224 modules.

Figure 252 ESD switch to multiple universal IO modules



Technical Data for an ESD input

Open voltage:	24 Vdc -20% ... +30%
Closed contact current:	7 mA ± 5% (at 24Vdc)
Switch resistor (single):	1 kOhm ± 5% >0.25W
Switch zener (multiple):	7.5 Volt
Open contact current:	< 4 mA ± 5%
Short circuit detection:	field resistance < 500 Ohm ± 50%
ESD to outputs off delay:	10 ms ± 30%

IO channels

The RUSIO-3224 module has 32 remote universal safe IO channels.

One RUSIO-3224 module can be placed on a non-redundant IOTA to establish 32 non-redundant channels. Two RUSIO-3224 modules can be placed on one redundant IOTA to establish 32 redundant universal safe IO channels.

Each channel has two screw positions for the connection of field wires on the IOTA. No additional connections for field devices are required.

Positions 1+ thru 32+ are the signal connections; one for each of the channels.

Positions 1- thru 32- are (all) directly connected with the 0Volt supply connection.

All channels are 24Vdc sourcing ("active").

Each channel can be configured as (line monitored) input or output. Some channels have additional configuration features. In the next topics the features and specific technical data of the various configurations are described. The topic titles reflect the function that a channel will have once it is configured.

Line-monitored digital input

The line-monitored input of the RUSIO-3224 module consists of a 250 Ohm resistance and an electronic current limiter. See detail A of Figure 253 on page 423 for a block diagram of this universal IO channel configuration.

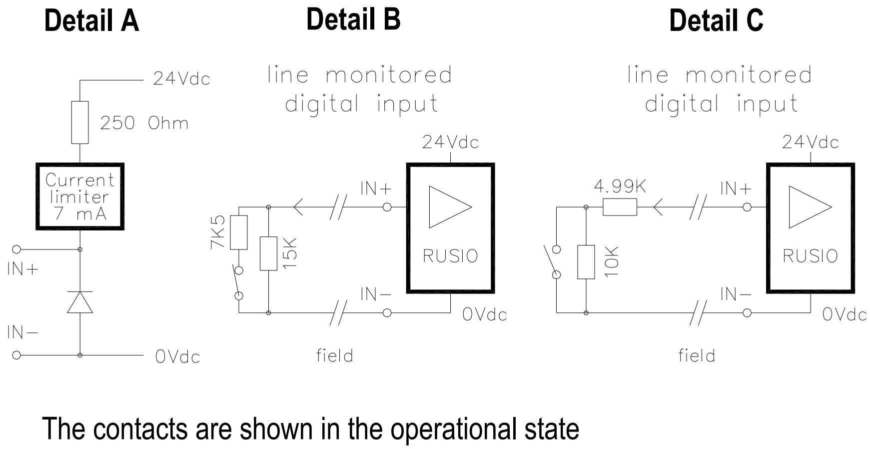
A line-monitored digital input requires two resistors in the field, near the switching element.

For Normally Closed (field-)contacts, these resistors must be connected in parallel, close to the switch. See detail B of Figure 253 on page 423.

For Normally Open (field-)contacts, these resistors must be connected in series, close to the switch. See detail C of Figure 253 on page 423.

Lead-breakage or short circuit in the wires to the switching element will be detected and result in a warning by the RUSIO-3224.

Figure 253 Line-monitored digital input of a universal IO channel



Technical Data for a line-monitored digital input

All channels	Open voltage:	24 Vdc -20% ... +30%
	Short circuit current:	7 mA ± 5%
	Current limiter voltage drop:	< 1.4 Volt (while NOT limiting)
	Open contact:	15 kOhm ± 5% >0.1W
	Closed contact:	5 kOhm ± 5% >0.25W
	Short circuit detection:	I > 6.3 mA ± 5%
	Closed contact detection:	2.8 mA < I < 6.3 mA ± 5%
	Open contact detection:	0.7 mA < I < 2.1 mA ± 5%
	Lead breakage detection:	I < 0.7 mA ± 5%
	Input filter:	first-order low-pass 100 Hz

Non line-monitored digital input

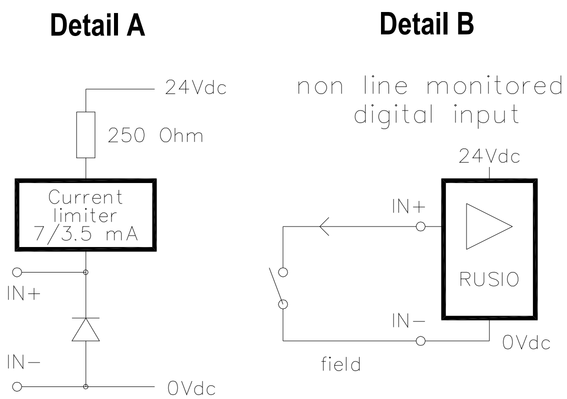
The non line-monitored input of the RUSIO-3224 module consists of a 250 Ohm resistance and an electronic current limiter. See detail A of Figure 254 on page 424 for a block diagram of this universal IO channel configuration.

A non line-monitored digital input has a switching element in the field; see detail B of Figure 254 on page 424.
This input has no short circuit or lead breakage detection.

Attention:

Channels configured as non line-monitored digital inputs may not be used as part of a safety loop.

Figure 254 Non line-monitored digital input of a universal IO channel



Technical Data for a non line-monitored digital input

All channels	Open voltage:	24 Vdc -20% ... +30%
	Closed contact current:	7 mA ± 5%, after open state detection
		3.5 mA ± 5%, after closed state detection
	Current limiter voltage drop:	< 1.4 Volt (while NOT limiting)
	Closed contact detection:	I > 2.8 mA ± 5%
	Open contact detection:	I < 2.1 mA ± 5%
	Input filter:	first-order low-pass 100 Hz

Analog input 0-20mA and 4-20mA

The analog input of the RUSIO-3224 module consists of a 250 Ohm resistance and an electronic current limiter. See detail A of Figure 255 on page 425 for a block diagram of this universal IO channel configuration.

An analog input is typically connected with a sensor in the field.
That sensor can also be a smoke or fire detector.
See details B and C of Figure 255 on page 425 for examples.

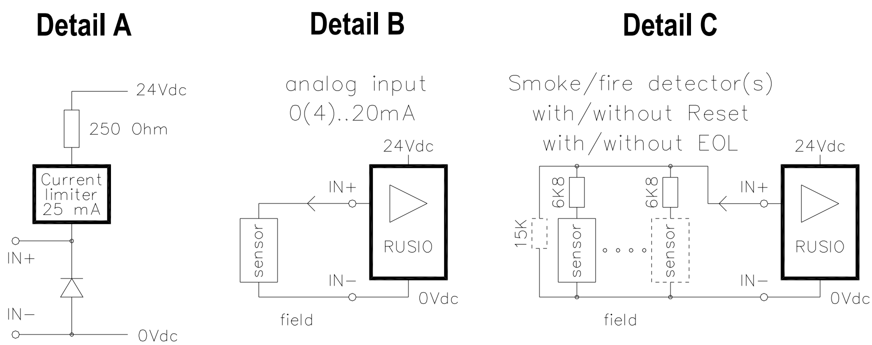
A latching smoke or fire detector can be reset by the RUSIO-3224 module without extra components or wires.
It is possible to connect multiple smoke or fire detectors (up to 6) on one channel.
Line monitoring and sensor state must be handled in the function block.
For a wiring example see detail C of Figure 255 on page 425.

An analog input can be configured for 0-20mA or 4-20mA and is always active (internally sourced out of the 24Vdc supply).

Short circuit in the wires to the sensor will be detected and result in a warning by the RUSIO-3224.

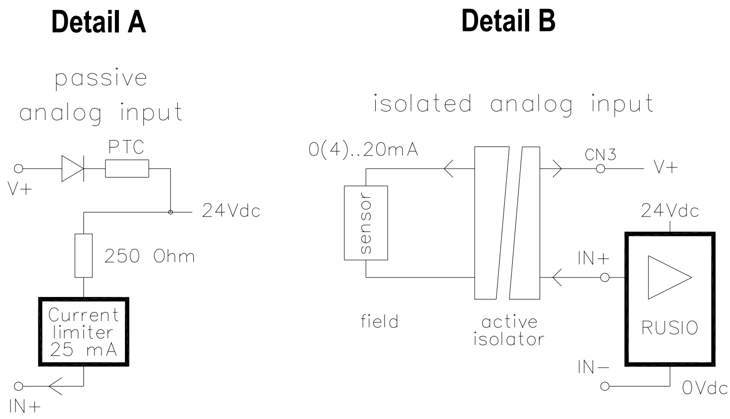
If the input is configured for 4-20mA, than lead breakage of the wires will also be detected and result in a warning by the RUSIO-3224 module.

Figure 255 Analog input of a universal IO channel



A passive analog universal IO input 0-20mA or 4-20mA can only be created if the current source is isolated. See detail A of Figure 256 on page 426 for a block diagram of this universal IO input.
Passive analog universal IO inputs use a V+ pin of **CN3** on the IOTA. See detail B of Figure 256 on page 426 for an example.

Figure 256 Passive analog input of a universal IO channel



Technical Data for an analog input

Open voltage:	24 Vdc -20% ... +30%
Field voltage:	> 15 Vdc (at 0 ... 24 mA)
Short circuit current:	24.5 mA ± 0.5 mA
Input range:	0-20mA or 4-20mA
Input impedance:	typically 250 Ohm
A-D conversion:	16 bit
Accuracy:	0.15% of full scale
Safety-related inaccuracy:	< 1% of full scale
Input filter:	first-order low-pass 100 Hz

Warning:

1. All active field devices shall be galvanically separated (isolated) from live voltages. Live voltages are voltages higher than 30Vac or 40Vdc.
2. Drawing more than 24 mA will cause extra heat dissipation in the housing of the RUSIO-3224 module. For more information refer to "Temperature derating" on page 430.

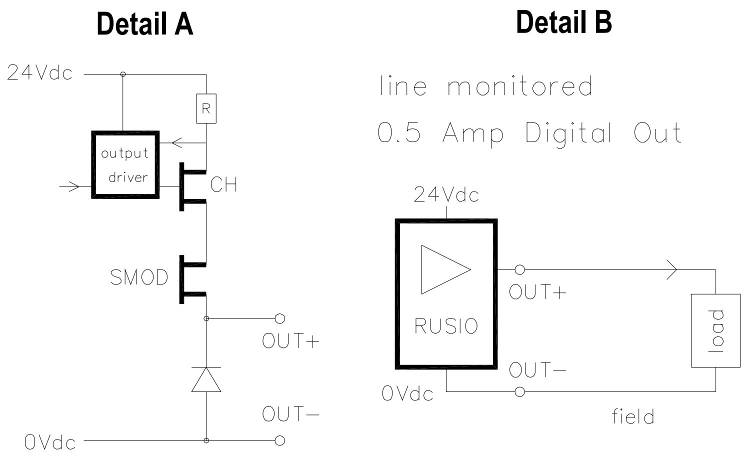
Digital output

The digital output of the RUSIO-3224 module consists of a (0.5 Amp current limited) output with a Secondary Means Of De-energisation (SMOD) FET output.
Each output has a SMOD to enable switching off the channel, even if the channel FET fails. See detail A of Figure 257 on page 427 for an example.

The output driver limits the output (short circuit) current and switches off the output if an overload condition lasts too long.

All digital outputs are off when the universal IO watchdogs are tripped.

Figure 257 (Single) digital output of a universal IO channel



Lead breakage detection in the (field-) wiring is achieved by sourcing a small current (1 mA) into the field. Failure to conduct this current indicates lead breakage.

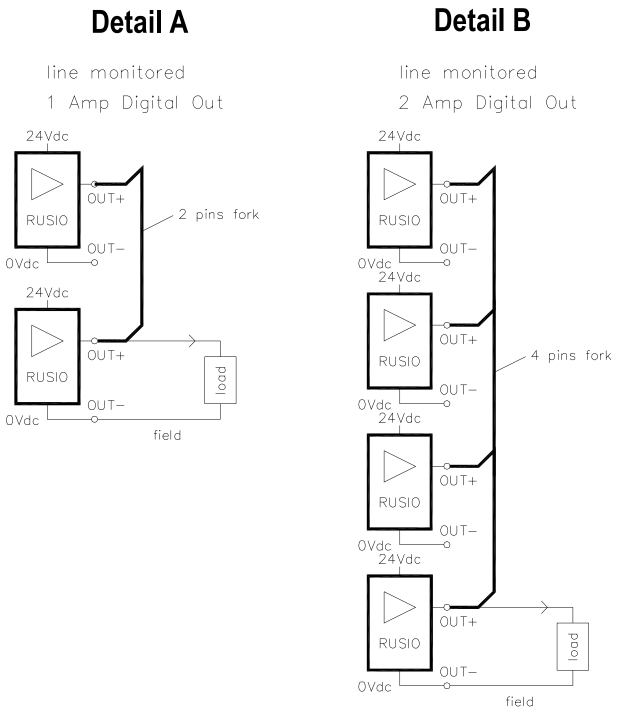
Loads of more than 0.5Amp are supported with the multiple output option.

Sets of two or four outputs can be configured as a multiple output, respectively capable of sourcing up to 1 Amp or 2 Amp.

A 2 pins fork with a pitch of 5.08mm (or a 4 pins fork with a pitch of 5.08mm) can be used to interconnect the multiple outputs. See details A and B of Figure 258 on page 428 for examples.

The field + wire must be connected with one of the OUT+ pins (together with the fork). Any one of the OUT- pins can be used to connect the field return wire.

Figure 258 Multiple digital output connection of a universal IO channel



Technical Data for a digital output

Output:	24 Vdc solid-state source
	short circuit proof
Maximum (resistive) load:	500 mA
	for more details see “General information about output modules” on page 344
Maximum tungsten-lamp load:	125mA (3 W)
Minimum load:	1 mA
Maximum load capacitance:	1 uF
Voltage drop:	< 1.5 V (at 500 mA)
Off current:	< 0.1 mA
Lead breakage test current:	approx. 5 mA
Two pins fork:	Weidmuller, LPA QB 2
Four pins fork:	Weidmuller, LPA QB 4

Analog output 0-20mA and 4-20mA

The analog output of the RUSIO-3224 module consists of a 250 Ohm readback resistor, a current control circuit with output FET (AO) and a SMOD FET. See detail A of Figure 259 on page 429 for a block diagram of this universal IO output.

An analog output is typically connected with an 0-20mA or 4-20mA analog actuator in the field. See detail B of Figure 259 on page 429 for an example.

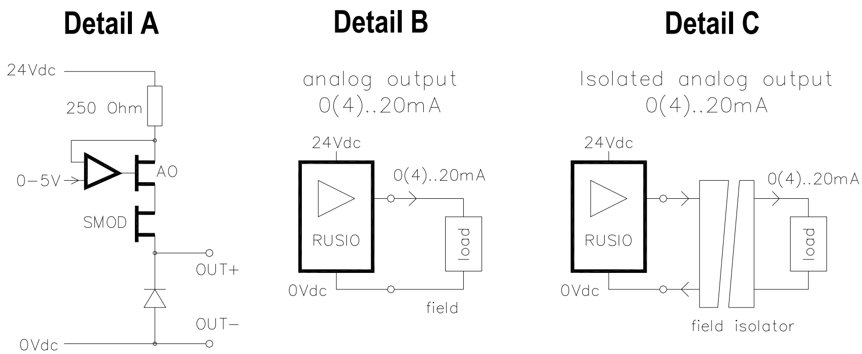
An analog output can be configured for 0-20mA or 4-20mA and is always active. This means that the RUSIO-3224 module provides the required power.

Short circuit in the wires to the load will not be detected.

If the output is configured for 4-20mA, than lead breakage of the wires will be detected and result in a warning by the RUSIO-3224 module.

Isolated analog output signals require an (Ex-)analog isolator module. See detail C of Figure 259 on page 429 for an example of how to connected such an output.

Figure 259 Analog output of a universal IO channel



Technical Data for an analog output

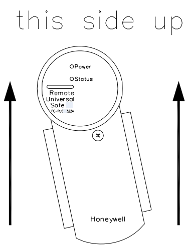
Open voltage:	24 Vdc -20% ... +30%
Output current:	0 - 23 mA
Field (loop) resistance:	max. 500 Ohm
D-A conversion:	12 bit
Accuracy:	0.15% of full scale
Safety-related inaccuracy	< 1% of full scale

Temperature derating

This sub section addresses ‘outside module temperature’. The maximum outside module temperature must be limited depending on the internal dissipation.

Attention:

1. Airflow in / through the module is assumed to be natural convection.
2. Make sure that RUSIO-3224 modules are installed in the correct position. A RUSIO-3224 module must be mounted in upright position (refer to the figure at the right).



To determine the maximum acceptable outside module temperature for a typical configuration do the steps below. Relevant details are given in separate topics.

Outline of the procedure	For details see
1 Perform the Internal dissipation calculation. **a.** Determine which supply voltage applies to your configuration: - 25V or less, - more than 25V or unknown. **b.** Select the applicable reference table. **c.** Determine and record the actual configuration data. **d.** Calculate the totals per dissipation contributor. **e.** Add the totals of the previous step to determine the internal dissipation.	page 431
2 Determine the maximum acceptable outside module temperature. Use the applicable derating curve, based on the supply voltage: • 25V or less: use the derating curve in Figure 260. • more than 25V or unknown: use the derating curve in Figure 261.	 page 433 page 435

Tip:

You can make a print of the applicable calculation table to make annotations of your specific configuration(s). Make sure to fill in the table for the applicable supply voltage.

Internal dissipation calculation

To calculate the maximum outside module temperature, you need the configuration. The maximum dissipation caused by the logic of the RUSIO-3224 module is a fixed value. Other dissipation contributions depend on the channel configuration. The maximum dissipation per channel type depends on the applicable supply voltage.

Select the appropriate table to carry out the calculation, based on the supply voltage:

- 25V or less: 25V (default) - Table 58 on page 431,
- more than 25V or unknown: 31.2V (maximum) - Table 59 on page 432.

Table 58 Dissipation calculation - supply voltage 25V

Dissipation contributor (P)	Max. dissipation per channel [W]	Number of configured channels	Dissipation [W]
Logic			5.5
DI-LM; field impedance ≥ 5 KOhm	0.01		
DI; closed contact; 3.5 mA	0.085		
AI; < 24 mA; Current limited by field	0.05		
AI; > 24 mA; Current limited by RUSIO [1]	0.49		
DO; <0.3 A	0.115		
DO; <0.5 A	0.305		
AO; 500 Ohm field impedance; < 23 mA	0.225		
AO; 250 Ohm field impedance; < 23 mA	0.335		
AO; < 250 Ohm; < 23 mA	0.47		
AO; < 250 Ohm; < 20 mA	0.42		
Total Power Dissipation (TPD) [W]			
Max. outside module temperature [°C]			

1 Analogue input currents above 24mA should be avoided. Field devices for the analogue input should be configured to drive currents below 24mA, e.g. 3.5mA for sensor fault conditions to minimize the universal IO internal power dissipation. The thin-line derating curve needs to be taken when using currents above 24 mA.

Good practice for the high dissipating channels is:

1. To distribute them over the two IO boards in the module between CH1-16 and CH17-32.
2. To select the channels at the bottom of the IO boards (near CH16 and CH32).

Table 59 Dissipation calculation - supply voltage 31.2V

Dissipation contributor (P)	Max. dissipation per channel [W]	Number of configured channels	Dissipation [W]
Logic			5.5
DI-LM; field impedance ≥ 5 KOhm	0.01		
DI; closed contact; 3.5 mA	0.085		
AI; < 24 mA; Current limited by field	0.05		
AI; > 24 mA; Current limited by RUSIO [1]	0.64		
DO; <0.3 A	0.115		
DO; <0.5 A	0.305		
AO; 500 Ohm field impedance; < 23 mA	0.345		
AO; 250 Ohm field impedance; < 23 mA	0.48		
AO; < 250 Ohm; < 23 mA	0.61		
AO; < 250 Ohm; < 20 mA	0.545		
Total Power Dissipation (TPD) [W]			
Max. outside module temperature [°C]			

1 Analogue input currents above 24mA should be avoided. Field devices for the analogue input should be configured to drive currents below 24mA, e.g. 3.5mA for sensor fault conditions to minimize the universal IO internal power dissipation. The thin-line derating curve needs to be taken when using currents above 24 mA.

Good practice for the high dissipating channels is:

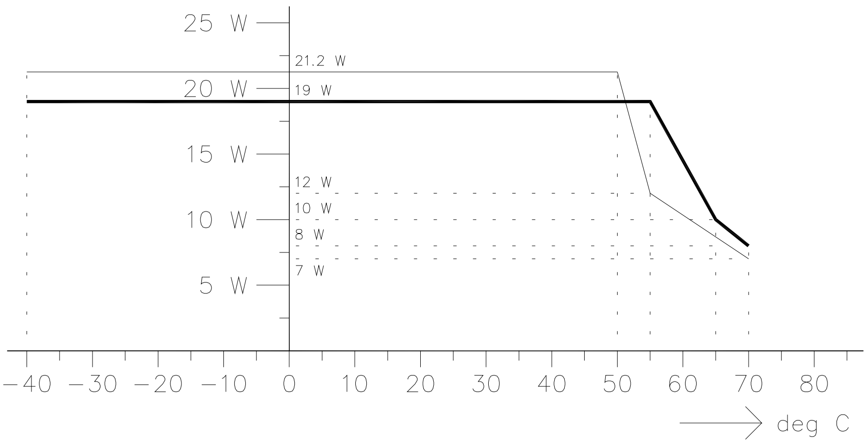
1. To distribute them over the two IO boards in the module between CH1-16 and CH17-32.
2. To select the channels at the bottom of the IO boards (near CH16 and CH32).

Temperature derating curves (25V supply voltage)

Figure 260 shows the maximum outside module temperature versus the internal power dissipation. It shows the derating curves for 25V supply voltage.

An example calculation for this supply voltage is given in Table 60 on page 434.

Figure 260 Module derating with a supply voltage of 25V default



Thick line: applicable for most applications having AO<=20mA and AI<=24mA

Thin line: applicable if one or more channels have AO>20mA or AI>24mA

Table 60 shows a calculation example using the table for a 25 V supply voltage. The column “Number of configured channels” is filled in for the actual situation. Totals per channel type are calculated in the column “Dissipation contribution”.

The “Total internal power dissipation” is calculated at the bottom. Using the applicable line in Figure 260 on page 433 the maximum outside module temperature is deduced.

In this example the maximum outside module temperature allowed is 70°C, with the **High temperature shutdown** of the module set at 90°C.

Note:

The maximum outside temperature limit can be improved with forced airflow.

Table 60 Example: dissipation calculation - supply voltage 25V

Dissipation contributor (P)	Max. dissipation per channel [W]	Number of configured channels	Dissipation [W]
Logic			5.5
DI-LM; field impedance ≥ 5 KOhm	0.01	10	0.1
DI; closed contact; 3.5 mA	0.085		
AI; < 24 mA; Current limited by field	0.05	10	0.5
AI; > 24 mA; Current limited by RUSIO [1]	0.49		
DO; <0.3 A	0.115	10	1.15
DO; <0.5 A	0.305		
AO; 500 Ohm field impedance; < 23 mA	0.225		
AO; 250 Ohm field impedance; < 23 mA	0.335	2	0.67
AO; < 250 Ohm; < 23 mA	0.47		
AO; < 250 Ohm; < 20 mA	0.42		
Total Power Dissipation (TPD) [W]			**7.92**
Max. outside module temperature [°C]			**+ 70**

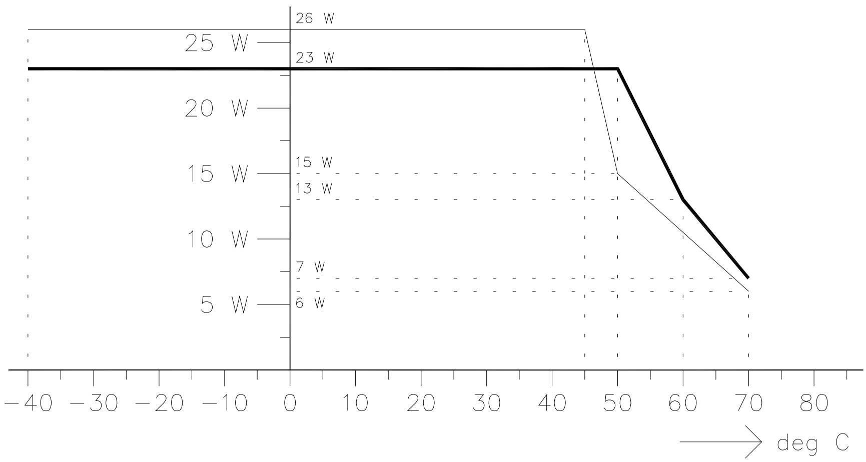
1 Analogue input currents above 24mA should be avoided. Field devices for the analogue input should be configured to drive currents below 24mA, e.g. 3.5mA for sensor fault conditions to minimize the universal IO internal power dissipation. The thin-line derating curve needs to be taken when using currents above 24 mA.

Temperature derating curves (31.2V supply voltage)

Figure 261 shows the maximum outside module temperature versus the internal power dissipation. It shows the derating curves for 31.2V supply voltage.

An example calculation for this supply voltage is given in Table 61 on page 436.

Figure 261 Module derating with a supply voltage of 31.2V



Thick line: applicable for most applications having AO<=20mA and AI<=24mA

Thin line: applicable if one or more channels have AO>20mA or AI>24mA

Table 61 shows a calculation example using the table for a 31.2 V supply voltage. The column “Number of configured channels” is filled in for the actual situation. Totals per channel type are calculated in the column “Dissipation contribution”.

The “Total internal power dissipation” is calculated at the bottom. Using the applicable line in Figure 261 on page 435 the maximum outside module temperature is deduced.

In this example the maximum outside module temperature allowed is 65°C, with the **High temperature shutdown** of the module set at 90°C.

Note:

The maximum outside temperature limit can be improved with forced airflow.

Table 61 Example: dissipation calculation - supply voltage 31.2V

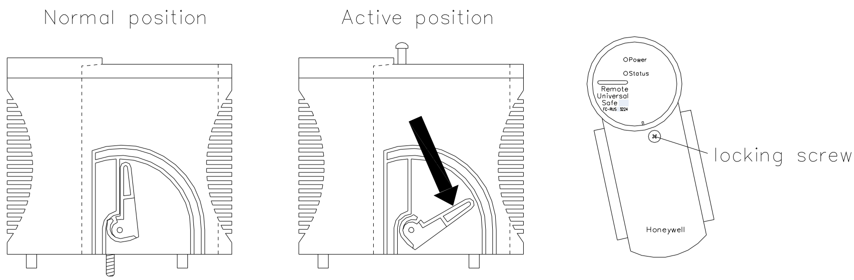
Dissipation contributor (P)	Max. dissipation per channel [W]	Number of configured channels	Dissipation [W]
Logic			5.5
DI-LM; field impedance ≥ 5 KOhm	0.01	2	0.02
DI; closed contact; 3.5 mA	0.085		
AI; < 24 mA; Current limited by field	0.05	21	1.05
AI; > 24 mA; Current limited by RUSIO [1]	0.64		
DO; <0.3 A	0.115		
DO; <0.5 A	0.305	9	2.75
AO; 500 Ohm field impedance; < 23 mA	0.345		
AO; 250 Ohm field impedance; < 23 mA	0.48		
AO; < 250 Ohm; < 23 mA	0.61		
AO; < 250 Ohm; < 20 mA	0.545		
Total Power Dissipation (TPD) [W]			**9.32**
Max. outside module temperature [°C]			**+ 65**

1 Analogue input currents above 24mA should be avoided. Field devices for the analogue input should be configured to drive currents below 24mA, e.g. 3.5mA for sensor fault conditions to minimize the universal IO internal power dissipation. The thin-line derating curve needs to be taken when using currents above 24 mA.

Module handling - replacement

This sub section describes the procedures for removal and installation of a RUSIO-3224 module. See Figure 262 on page 437 for relevant details.

Figure 262 Module handling - removal lever



Removal of a RUSIO-3224 module

Do these steps in the order given to remove the subject RUSIO-3224 module:

1. On the IOTA, set the applicable switch (**POWER 1** or **POWER 2**) to **OFF**. The **Power** LED (green) must go off.
2. Completely loosen the locking screw.
3. Press both (removal) levers at the sides of the module down *at the same time*. See **Active Position** in Figure 262.
4. Remove the module from the IOTA.
5. Put the (removal) levers back in the upright (normal) position.

Installation of a RUSIO-3224 module

Do these steps in the order given to install the subject RUSIO-3224 module:

1. On the IOTA, make sure that the applicable switch (**POWER 1** or **POWER 2**) is set to **OFF**.
2. On the module to be installed, make sure that the (removal) levers are in the upright (normal) position.
3. Hold the module in the correct position on the IOTA and carefully push it down on the corresponding connectors.
4. Tighten the locking screw.
5. On the IOTA, set the applicable switch (**POWER 1** or **POWER 2**) to **ON**. The **Power** LED (green) must go on.

Technical data

The RUSIO-3224 module has the following specifications:

General	Type number:	FC-RUSIO-3224
	Operating temperature:	
	• outside module temperature:	–40°C ... +70°C (–40°F ... +158°F)
	• inside module temperature:	–40°C ... +90°C (–40°F ... +194°F)
	Storage temperature:	–40°C ... +85°C (–40°F ... +185°F)
	Relative humidity:	10 ... 95% (non condensing)
	Pollution:	Pollution degree 2 or better
	Approvals:	CE; UL, TUV pending
Power	Supply voltage:	24 Vdc -15% ... +30%
	Supply current:	max 300mA (without field load)
IO	Number of channels:	32
	Channel type:	Universal safe (software configurable)
	• Digital in	max. 32 (with or without line-monitoring)
	• ESD in	max. 1 (with line-monitoring)
	• Analog in	max. 32 (with or without line-monitoring)
	• Digital out	max. 32 (with or without line-monitoring) max. combined load: 9 Amp
	• Analog out	max. 16 (with or without open loop detection)
Physical Data	Dimensions (H x W x D):	145 x 165.1 x 72.4 mm 5.7 x 6.5 x 2.85 in
	Weight:	0.66 kg 1.45 lbs