Cost-effective industrial RIO with
8 relay output channels,
8 wide range digital inputs and
isolated RS-485 interface.

PIA-OKF Datasheet

Features

- Ethernet interface with Modbus TCP

- High immunity to electromagnetic disturbances

- ROS compatible Ethernet IO

- Analog and digital expansion modules available through backplane CAN connector

- Modbus RTU devices can be connected through the isolated RS-485 interface

- Advanced clock synchronization

- IO handling with microsecond timestamping

- Pattern generation and high-speed event handling

Applications

- Standalone industrial remote IO

- PLC replacement

- IEC 61131 Zone C programmable controller

- Process monitoring

General Description

The Prolan Industrial Automation **PIA-OKF** is a DIN rail mounted RTU. All external interfaces are designed with reinforced isolation per IEC 60664.

PIA-OKF integrates 8 miniature power relays capable of switching up to 400 VAC or 300 VDC, and up to 8 A. The digital input channels are organized into 2 isolated 4 bit groups, and are compliant with both IEC 61131-2 24 VDC and 48 VDC type 2 specifications simultaniously, through a very narrow 0-1 transition between 10 V and 11 V.

PIA-OKF can be used in the ROS compatible PIA RTU ecosystem with TCP or/and CAN connection, it can be the communication interface device in Prolan C-RTU systems.

PIA-OKF can also be ordered with various standalone firmware types with different communication protocol stacks (Modbus TCP, MQTT, etc.).
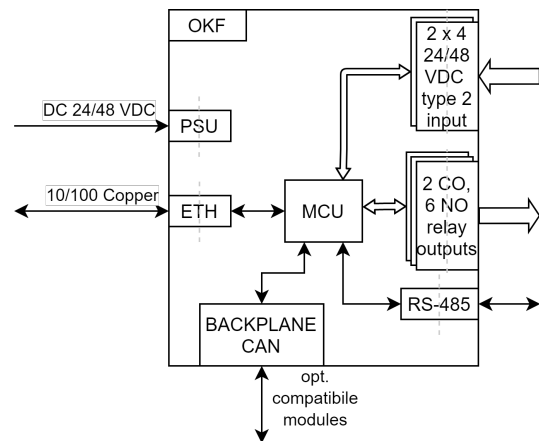

Figure 1: PIA-OKF device

Figure 2: PIA-OKF Functional Block Diagram

Absolute Maximum Ratings

Table 1: Absolute Maximum Ratings

Parameter	Rating
VIN+ to VIN-	0 V to +63 V
Ix.y to Ix.C	-0.3 V to +64 V
RS.A to RS.B	-7 V to +7 V
RS.A, RS.B to RS.SC	-1 V to +6 V
Storage Temperature	-40 °C to +105 °C
Operating Temperature	-40 °C to +85 °C
Relative Humidity	10 % to 95 %

Note: Stresses above those listed under Absolute Maximum Ratings can cause permanent damage to the device. This is a stress rating only. Functional operation of the device is not implied in any conditions above those indicated in the Electrical Specifications section.

General Information

Table 2: General information

Parameter	Rating/Comments
Standard compliances	IEC 61131-2, IEC 50121-4
IEC 61131-2 Environment	Zone C (encompasses Zone B and Zone A)
Repairability	Non user repairable
Response time	13 ms typical, dependent on parameters
Default state upon power loss	Outputs de-energised
Default state upon communication loss	Outputs de-energised

Electrical Specifications

All specifications are in $-40°C \leq T_A \leq 85°C$ unless otherwise noted.

Table 3: Supply Interface Specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions/Comments
Operational supply voltage[1]	VIN	18	24	60	VDC	
Rated supply voltage	VIN		24 / 48		VDC	12 / 24 VDC model available upon request
Supply input current @ 24 VDC	I_{VIN}		76	160	mA	Typical with all relay outputs de-energised, and maximum with all relay outputs energised
Supply input current @ 48 VDC	I_{VIN}		44	85	mA	Typical with all relay outputs de-energised, and maximum with all relay outputs energised
Peak inrush current @ 24 VDC	I_{INRUSH}		5		A	
Inrush I^2t product @ 24 VDC	I^2t		0.019		A^2s	
Peak inrush current @ 48 VDC	I_{INRUSH}		12		A	
Inrush I^2t product @ 48 VDC	I^2t		0.108		A^2s	
Supply input power	P_{VIN}		2	4	W	Typical with all relay outputs de-energised, and maximum with all relay outputs energised
Effect of reverse polarity			Fuse-blowing			
Insulation withstand voltage[2]	E_{MAX}		4.2		kVAC	Between supply inputs and internal circuitry (GND), between supply inputs and RS-485 interface

[1] Recommended operating voltage is 24 VDC
[2] Based on characterization data, not tested in production.

Table 4: Input Interface Specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions/Comments
Input type (61131-2)			Type 2, 24/48 VDC			
Input voltage threshold	V_{TH}	10.05	10.65	10.95	V	See figure 3 for typical V-I curve
Input current	I_{IN}			10	mA	Internally fused with PTC rated for 230 VAC. Tripping current is 190 mA
Input delay	t_d		5		μs	0-1 and 1-0 transition. Actual reaction time is dependent on parameters
Effect of reverse polarity			PTC activation			
Insulation withstand voltage[1]	E_{MAX}		3.75		kVAC	Between input banks and internal circuitry (GND), between input banks

[1] Based on characterization data, not tested in production.

Table 5: Output Interface Specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions/Comments
Output type			Non-latching			
Output protection			Non-protected			
Rated contact voltage			250		VAC	See figure 4 for DC ratings
Rated contact current			8		A	Over 300 V maximum 5 A
Maximum switching voltage				400	VAC	
Maximum breaking capacity				2000	VA	
Contact resistance			15		mΩ	
Operation time			6	9	ms	
Release time			3	5	ms	
Bounce time NO for contacts				6	ms	
Bounce time NC for contacts				10	ms	
Number of NO/NC outputs			2			
Number of NO outputs			6			
Insulation between channels[1]			3.5		kVAC	
Insulation between open contacts[1]			1		kVAC	
Insulation withstand voltage[1]	E_{MAX}		5		kVAC	Between output contacts and internal circuitry (GND)

[1] Based on characterization data, not tested in production.

Note: Total load for output shall not exceed 30 A at 51-150 V, 20 A at 151-300 V, 10 A at 301-400 V

Table 6: RS-485 Interface Specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions/Comments
Differential output voltage	V_{OD}	-5.0		5.0	V	
Baudrate	f_s	2400		230400	Bd	
Number of devices				32	Unit-Load	Up to 256 1/8th Unit-Load nodes on the bus.
Insulation withstand voltage[1]	E_{MAX}		3.75		kVAC	Between RS-485 interface and internal circuitry (GND)

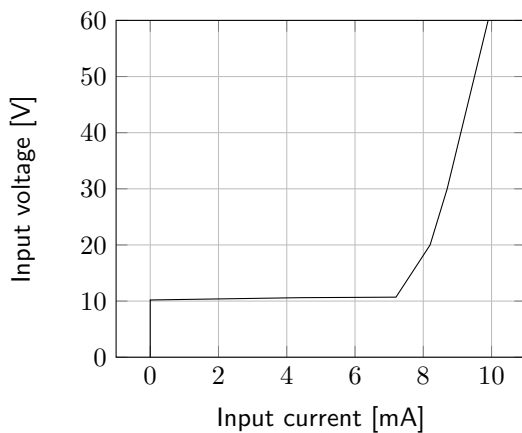[1] Based on characterization data, not tested in production.
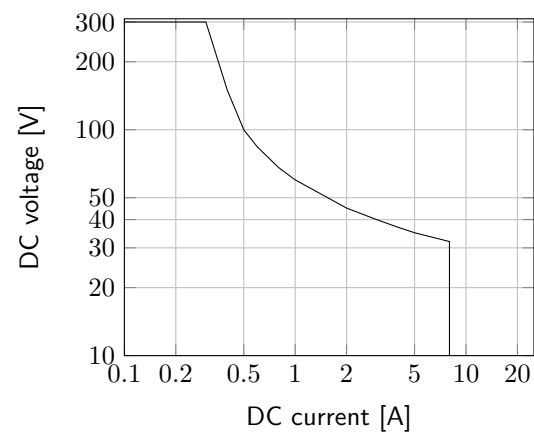

Figure 3: Typical input V-I curve

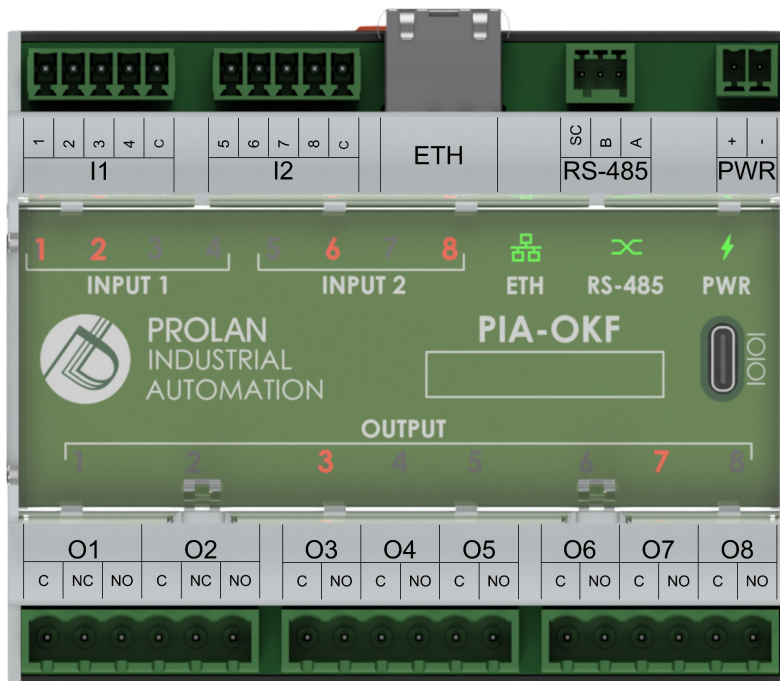**Figure 4: Maximum DC load breaking capacity**

Figure 5: PIA-OKF connections

Manual configuration

PIA-OKF is configurable through the front panel serial interface. Connect **PIA-OKF** to a PC with a USB-C cable, and set the serial port to 115200 Bd, 8N1.

Through the menu the Ethernet interface is configurable either to DHCP or manual IP.

Note: for proper operation CP210x VCP driver needs to be installed on the host system.

Installation

For the full installation guide please refer to Installation Manual.

The **PIA-OKF** should be mounted on TS35/7,5 DIN rail. In case the backplane CAN and further expansion modules are used, rivetting the DIN rail is recommended. In these applications the backplane connectors must be installed first.

After installation, at least 30mm distance should be kept around **PIA-OKF**, perpendicular to the DIN rail. Around the Ethernet port, 70 mm is recommended to account for stiffer cables.
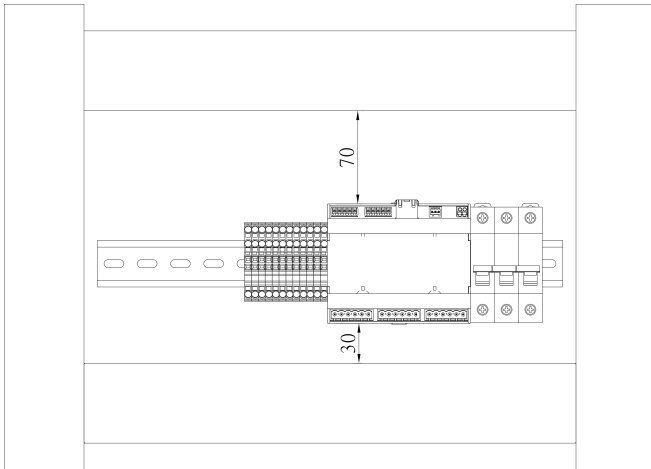

Figure 6: PIA-OKF wiring [mm]

Modbus TCP connection

TCP role	server
TCP port (standalone)	502
IP address	static IP or DHCP

- After the startup of the OKF device, the standalone Modbus port is opened, and the device awaits client side connection.

- The server-client connection is not closed and reopened during operation, to avoid undesirable operational effects.

Modbus operational fundamentals

- Register addresses follow standard Modbus allocation: 40001 specifies the '0' address holding register.

- If a nonexistent input register is queried on the Modbus interface, the response is 0x0000. Such a read query will not result in an Illegal Data Address error.

- If a nonexistent output register is set on the Modbus interface, no physical output channel is set, and the response is an Illegal Data Address error. This is true for both function codes 06 (nonexistent register is addressed) and 16 (nonexistent register is written).

Reading field inputs

- Register type: HOLDING

- Function code: 03

- Structure:

  ○ 1 holding register per 1 input bank.

  ○ In the response, inputs are set as bits from LSB to MSB, in order of channel number.

  ○ LOW inputs are represented as 0, HIGH as 1.

Address	Channel	Description
40001	IN1	Input Bank 1
40002	IN2	Input Bank 2

Reading and setting field outputs

Notes

- Register type: HOLDING

- Function code: 03, 06, 16

- Structure:

  ○ 1 holding register per 1 output channel.

  ○ Output control supports both holding and impulse functions.

  ○ The output impulse control duration can be set as an Uint8 on the upper 8 bits, with 100ms resolution.

  ○ In case of 0 value for output impulse control duration, the output acts as "holding".

  ○ The expected state of the output channel as a result of the action is set in the LSB bit of the request.

  ○ All field outputs fall back to '0' (LOW) state when the TCP connection is dropped.

  ○ The output last set by the OKF can be queried, no hardware feedback is used for reading back field outputs.

Address	Channel	Description
41001	CH1	Output Channel 1
41002	CH2	Output Channel 2
41003	CH3	Output Channel 3
41004	CH4	Output Channel 4
41005	CH5	Output Channel 5
41006	CH6	Output Channel 6
41007	CH7	Output Channel 7
41008	CH8	Output Channel 8

Internal webserver

A self-hosted webserver is available at the **PIA-OKF**'s IP address, that provides basic information such as hardware and software manuals, network configuration, and firmware update.

LED feedback

The meaning of different front panel indicators are explained in table 7.

Table 7: LED feedback explanation

LED state	Meaning
Bootmanager	
Logo 5 Hz green blink	Bootmanager running
Logo 10 Hz green blink	Flash operation
Logo 10 Hz red	Fatal error
Bootchanger	
Logo 10 Hz red blink	Boot region operation[1]
Logo 2.5 Hz red blink	Bootchanger uninstalling
FBUS firmware	
Logo red	No connection to master or startup forbidden
Logo 2.5 Hz green breath	Startup state
Logo 0.5 Hz green breath	Status OK
Logo 0.5 Hz red-green breath	Application startup failure
Logo 0.5 Hz red breath	Application runtime failure
Logo 0.5 Hz red-yellow breath	Application startup and runtime failure
Logo 10 Hz red-green blink	Identification mode
Standalone modbus firmware	
Logo green	Status OK
Logo red	No Modbus TCP connection
Logo 10 Hz red-green blink	Identification mode
Communication	
”RS-485” green	RS-485 interface enabled
”RS-485” blinking green	RS-485 activity
”ETH” green	Ethernet link up
”ETH” blinking green	Ethernet activity
Hardware controlled	
”PWR” green	Internal supply OK
Input ”x” orange	Input ”x” is logic high[2]
Output ”x” orange	Output ”x” is operated

[1] Interruption of power in this mode can result in lock up reversible only by manual firmware update.
[2] In a narrow region (<100 mV) around the threshold the LED can become dimly lit without a logic high.

EMC Immunity Levels

Table 8: Enclosure Immunity

Environmental phenomenon	Performance criteria	Test level	Conditions/Comments
Radio-frequency electromagnetic field. Amplitude modulated. 80% AM, 1 kHz	A	20 V/m (rms)	80 MHz to 800 MHz
		20 V/m (rms)	800 MHz to 1000 MHz
		20 V/m (rms)	1400 MHz to 2000 MHz
		10 V/m (rms)	2000 MHz to 2700 MHz
		3 V/m (rms)	5100 MHz to 6000 MHz
Power-frequency magnetic field	A	300 A/m	50 Hz
Electrostatic discharge	B	± 6 kV	Contact discharge
		± 8 kV	Air discharge

Table 9: Supply Interface Immunity

Environmental phenomenon	Performance criteria	Test level	Conditions/Comments
Radio-frequency common mode. 80% AM, 1 kHz	A	10 V (rms)	0.15 MHz to 80 MHz
Fast transients	A	± 2 kV	5/50 ns, 5 kHz
Surges	B	± 2 kV	1.2 / 50 μs, CM (12 Ω, 9 μF)
		± 1 kV	1.2 / 50 μs, DM (2 Ω, 18 μF)
Damped oscillatory wave	B	2.5 kV	CM, 100 kHz, 1 MHz, (200 Ω)
		1 kV	DM, 100 kHz, 1 MHz, (200 Ω)

Table 10: Input Interface Immunity

Environmental phenomenon	Performance criteria	Test level	Conditions/Comments
Radio-frequency common mode. 80% AM, 1 kHz	A	10 V (rms)	0.15 MHz to 80 MHz
Fast transients	A	± 2 kV	5/50 ns, 5 kHz, capacitive coupling
Surges	B	± 2 kV	1.2 / 50 μs, CM, (42 Ω, 0.5 μF)
		± 1 kV	1.2 / 50 μs, DM, (42 Ω, 0.5 μF)
Damped oscillatory wave	B	2.5 kV	CM, 100 kHz, 1 MHz, (200 Ω)
		1 kV	DM, 100 kHz, 1 MHz, (200 Ω)

Table 11: Output Interface Immunity

Environmental phenomenon	Performance criteria	Test level	Conditions/Comments
Radio-frequency common mode. 80% AM, 1 kHz	A	10 V (rms)	0.15 MHz to 80 MHz
Fast transients	A	± 2 kV	5/50 ns, 5 kHz, capacitive coupling
Surges	B	± 2 kV	1.2 / 50 μs, CM, (2 Ω, 18 μF)
		± 1 kV	1.2 / 50 μs, DM, (2 Ω, 18 μF)
Damped oscillatory wave	B	2.5 kV	CM, 100 kHz, 1 MHz, (200 Ω)
		1 kV	DM, 100 kHz, 1 MHz, (200 Ω)

Table 12: RS-485 Interface Immunity

Environmental phenomenon	Performance criteria	Test level	Conditions/Comments
Radio-frequency common mode. 80% AM, 1 kHz	A	10 V (rms)	0.15 MHz to 80 MHz
Fast transients	A	± 2 kV	5/50 ns, 5 kHz, capacitive coupling
Surges	B	± 2 kV	1.2 / 50 μs, CM, (42 Ω, 0.5 μF)
Damped oscillatory wave	B	2.5 kV	CM, 100 kHz, 1 MHz, (200 Ω)
		1 kV	DM, 100 kHz, 1 MHz, (200 Ω)

Table 13: Ethernet Interface Immunity

Environmental phenomenon	Performance criteria	Test level	Conditions/Comments
Radio-frequency common mode. 80% AM, 1 kHz	A	10 V (rms)	0.15 MHz to 80 MHz
Fast transients	A	± 2 kV	5/50 ns, 5 kHz, capacitive coupling
Surges	B	± 2 kV	1.2 / 50 μs, CM, (42 Ω, 0.5 μF)
		± 1 kV	1.2 / 50 μs, DM, (42 Ω, 0.5 μF)
Damped oscillatory wave	B	2.5 kV	CM, 100 kHz, 1 MHz, (200 Ω)
		1 kV	DM, 100 kHz, 1 MHz, (200 Ω)

EMC Emission Levels

Table 14: Emission limits

Port	Frequency range	Value	Conditions/Comments
Supply interface	150 kHz to 500 kHz	<79 dBμV	Quasi-peak
		<66 dBμV	Average
	500 kHz to 30 MHz	<73 dBμV	Quasi-peak
		<60 dBμV	Average
Enclosure	30 MHz to 230 MHz	<40 dB(μV/m)	Quasi-peak
	230 MHz to 1000 MHz	<47 dB(μV/m)	Quasi-peak

Insulation Levels

Table 15: AC/DC Voltage Test Levels

	Input Interface	Output Interface	Supply Interface	RS-485 Interface	Ethernet Interface	Internal Ground
Input Interface	2.5 kVAC	5 kVAC	4.2 kVAC	2.5 kVAC	2.5 kVAC	2.5 kVAC
Output Interface	-	3.5 kVAC	5 kVAC	5 kVAC	5 kVAC	5 kVAC
Supply Interface	-	-	-	4.2 kVAC	4.2 kVAC	4.2 kVAC
RS-485 Interface	-	-	-	-	2.5 kVAC	2.5 kVAC
Ethernet Interface	-	-	-	-	-	2.25 kVDC
Internal Ground	-	-	-	-	-	-

Climatic tests

Table 16: Climatic tests

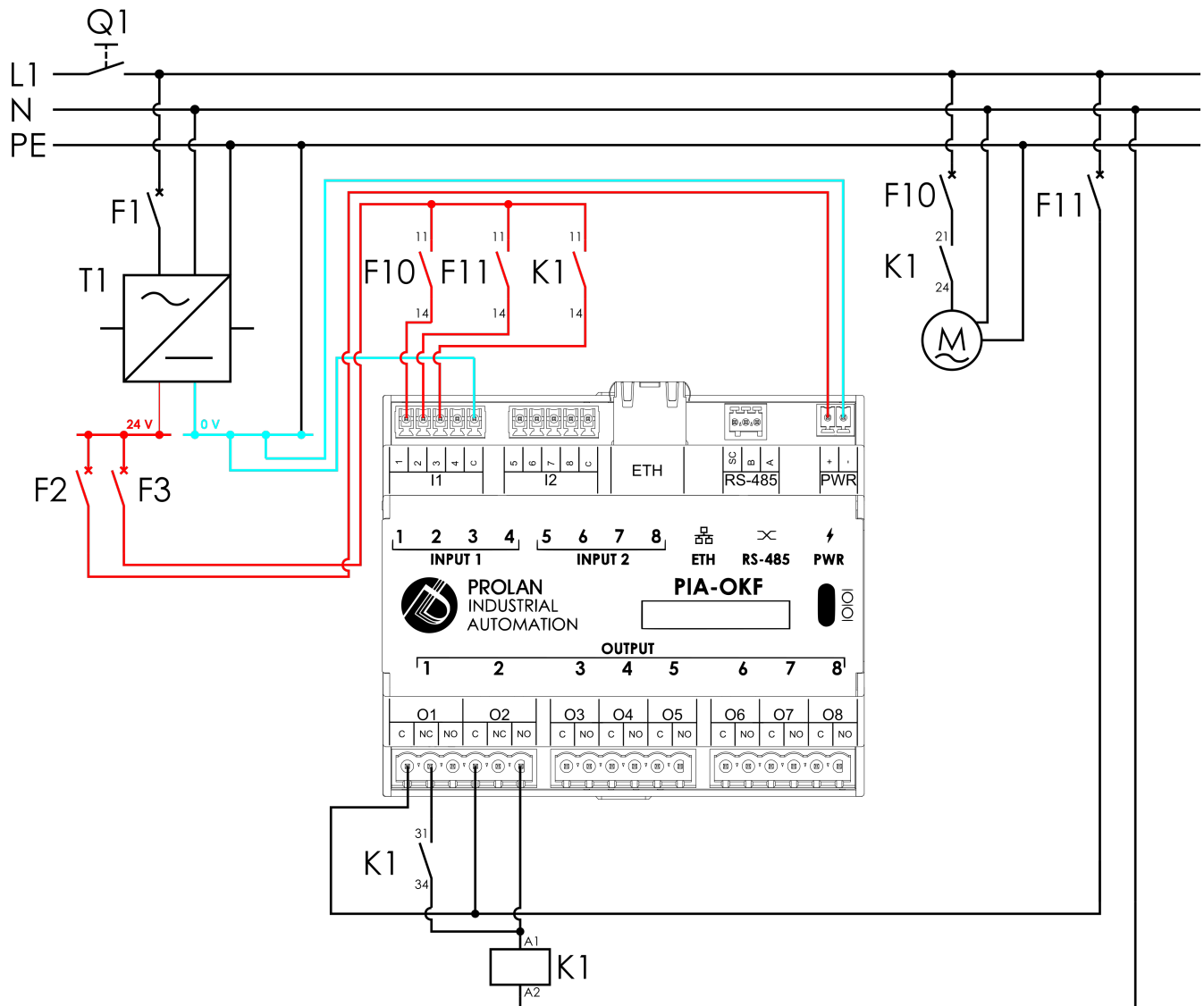| Test	Severity/Comments
60068-2-2 (Bb)	70 °C, 16+1 hours
60068-2-1 (Ab)	-40 °C, 16 hours
60068-2-14 (Nb)	+5 °C, +55 °C
60068-2-30 (Db)	+55 °C

Example system schematic

Figure 7: Motor control example

- External "T1" AC/DC power supply provides the 24 VDC to PIA-OKF supply and digital input interface.

- "F10" and "F11" circuit breakers are monitored through their auxiliary contacts.

- "K1" contactor can be set through an output pulse on O2 channel. "K1" contactor can be reset through an output pulse on O1 channel.

- The state of "K1" contactor is read back through contacts 11 and 14.

Mechanical Specifications

Table 17: Mechanical Specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions/Comments
Bounding dimensions			107.79 x 89.7 x 60.7		mm	L x W x H
Weight	m		313		g	With terminal plugs
Ingress Protection rating			IP20			
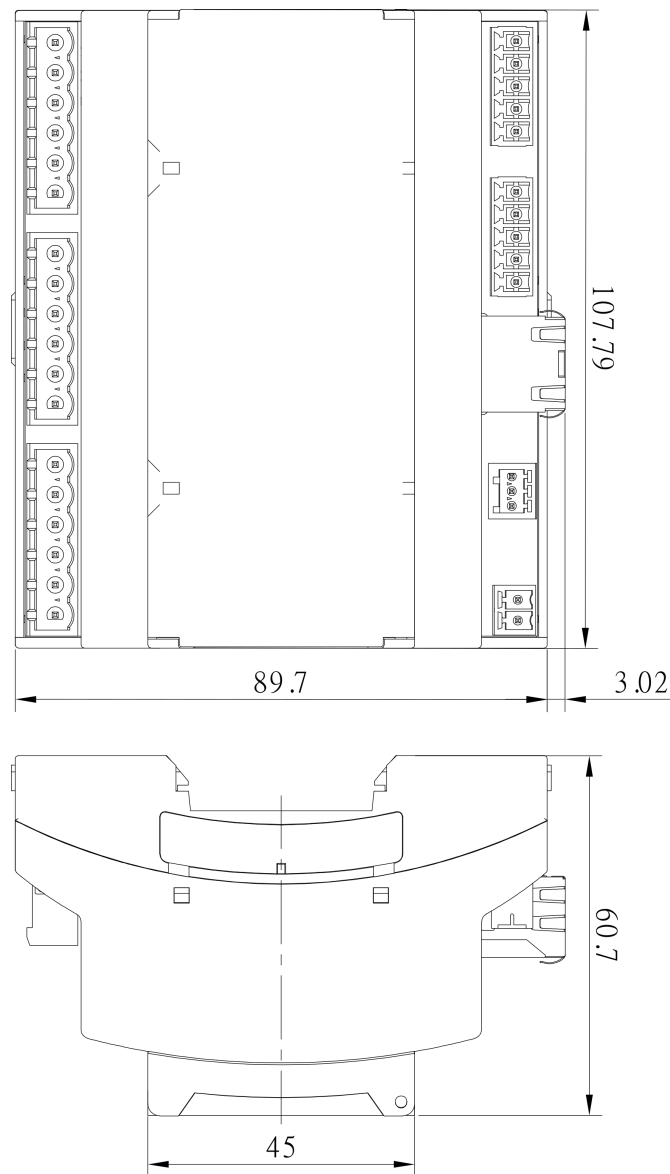
Figure 8: PIA-OKF dimensions [mm]

Revision history

Table 18: Revision history

Revision	Date	Change
1.0	2022.04.14.	Initial release
1.1	2022.05.17.	Updated EMC immunity and insulation sections according to test results, added climatic tests and EMC emission sections, expanded RS-485 specification.