Remote I/O
RIO600
Product Guide

Contents

1. Description

RIO600 is designed to expand the digital and analog I/O of ABB's Relion® protection and control relays and to provide I/O for the COM600 substation automation unit using the IEC 61850 and Modbus TCP communication. Both galvanic RJ-45 and optical LC connectors are supported for Ethernet station bus communication. RIO600 can also be used in secondary substations for fault passage indication and power measurements reporting values directly to a peer protection relay or to an upper level system. RIO600 accepts three-phase sensor signals (voltage and current) and provides fault detection and metering functions.

RIO600 allows flexible I/O assignment and provides seamless IEC 61850 connectivity between the substation's input and output signals and the protection relay or the COM600 substation gateway ensuring improved functionality and performance. RIO600 supports both Edition 1 and Edition 2 versions of the IEC 61850 standard. RIO600 can also be used as a standalone device in grid automation applications.

RIO600 helps in simplifying and decreasing the wiring inside the substation by digitizing the hardwired signals. The fully hardwired traditional medium-voltage switchgear/substation control and protection system results in extensive I/O wiring, connecting devices in switchgear signaling to the external systems, for example, to the remote terminal unit (RTU) or other higher-level automation systems.

RIO600 provides additional I/O within the switchgear using Ethernet communication. The I/O signals can be efficiently transmitted between the protection relay or COM600 with fast, high performance IEC 61850 GOOSE communication. Alternatively, RIO600 can communicate with an upper level automation system using the widely accepted Modbus TCP automation protocol.

The binary input module can be used for sending binary input values from primary equipment or secondary systems to peer protection relays or an upper-level system. The binary output modules can be used to control equipment based on the control signal received from communication.

The smart control module (SCM) can be used for different switchgear applications to drive primary switches. The module enables the control of a combined three-position switch (disconnector and earthing switch) used in gas insulated switchgears or standard two-position switches such as disconnector or earthing switches. Alternatively, the heavy-duty output contacts of the SCM can be used as power outputs for circuit breaker trip circuits to make, carry and break the belonging trip coil current. The module can also monitor the trip circuit supervision with external wiring and one binary input. Furthermore, the SCM can be used as a generic module with four binary inputs and four fast power outputs.

With the RTD/mA module, RIO600 can be used in different monitoring applications. RIO600 can receive temperatures (°C) via RTDs or analog input signals (mA) from various transducers or devices. The input current (mA) can be linearly scaled for various applications, for example, transformer tap changer position indication. The input value is forwarded to a peer protection relay or to an upper-level system. With the analog output module (AOM), RIO600 can control an external device having an mA input.

RIO600 also includes a measurement module with fault passage indication (FPI) functionality. This module is intended for grid automation applications where RIO600 enables accurate current and voltage measurements or only current measurement from a MV network using ABB's accurate and lightweight sensor technology. With this measurement module, RIO600 can be used as a stand-alone fault passage indicator unit. Based on the measured MV values, it can give voltage presence and directional FPI and report them to an upper-level system. This also enables power flow and power quality monitoring. The typical accuracy of line voltages, currents and active power is better than 0.5% and for other power measurements better than 1%.

The FPI functionality can be based on phase current measurements only. It provides a selective fault passage indicator for single phase earth faults in high-impedance earth networks, that is, in compensated, unearthed and high-resistance earthed systems. It can be applied as single-phase earth-fault FPI in case of overhead lines and underground cables, regardless of the earth-fault type (continuous, transient or intermittent) or the fault resistance value (low or high ohmic).

The FPI module incorporates the latest fault-detection algorithms used in the Relion family. With an easy-to-use multifrequency admittance-based (MFA) earth-fault detection algorithm, it accurately detects solid, resistive and intermittent earth faults. Practical sensitivity of up to 10 kΩ of the fault resistance can be achieved in symmetrical networks. This new functionality is suitable for high-impedance earthed networks, and especially for compensated and unearthed networks where accurate and selective earth-fault detection is more challenging due to low fault currents.

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2. Modular design

RIO600 is built on an industrial hardware platform which provides the same reliability, performance and real-time functionality as ABB protection relays withstanding extreme temperatures, electromagnetic interference and stringent industry standards.
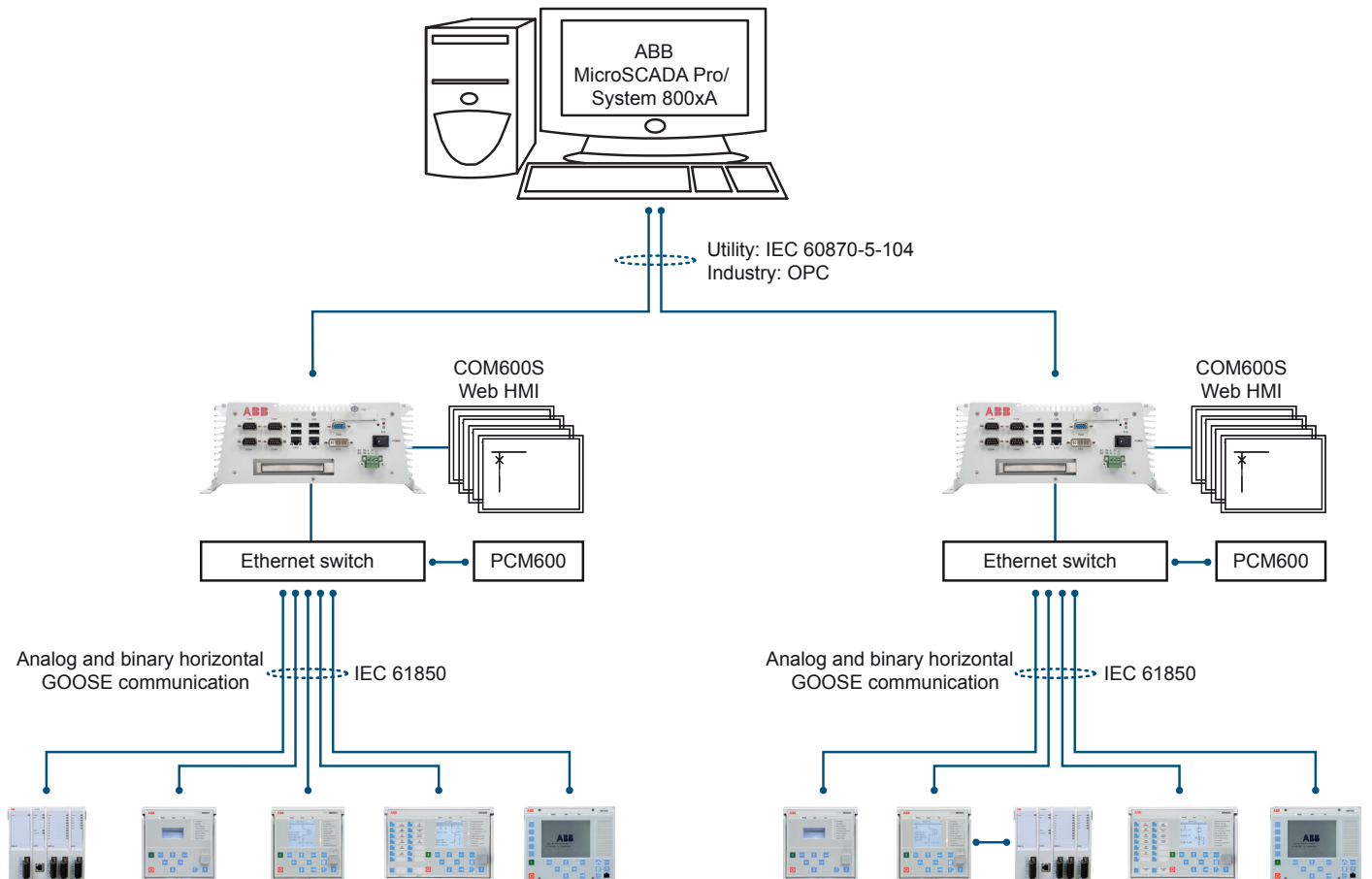

Figure 1.   Connection overview of RIO600

RIO600 uses a modular architecture where the I/O control functionality is built on modules. The modules can be stacked on a standard DIN rail to achieve the required configuration. The minimum configuration required for RIO600 contains a power supply module, a communication module and an I/O module.

Table 1. RIO600 module types

Module type			Description
Power supply modules		PSMH	High-voltage range power supply module
		PSML	Low-voltage range power supply module
Communication modules		LECM	Communication module with Ethernet port
		LECM	Communication module with optical Ethernet port
I/O modules	Digital input module	DIM8H	High-voltage range, eight optically isolated binary inputs with common return for two inputs
		DIM8L	Low-voltage range, eight optically isolated binary inputs with common return for two inputs
	Digital output module	DOM4	Four output contacts in each digital output module with two pairs of potential free contacts with common return
	RTD module	RTD4	Four optically isolated channels supporting RTD sensors (Pt100, Pt250, Ni100, Ni120 and Ni250) and an mA input (0...20 mA configurable). Individual channels are non-isolated from each other.
	Analog output module	AOM4	Four individually isolated channels of configurable mA outputs driving 0...20 mA signals
	Sensor input module	SIM8F	Sensor input module with combined three-phase current and voltage signals
	Sensor input module	SIM4F	Sensor input module with three-phase current signals
	Smart control module	SCM8H	High-voltage range, SCM with five application types • 4I4O – four input and four output channels • Three-position switch • Disconnector • Circuit breaker • Earthing switch
		SCM8L	Low-voltage range, SCM with five application types • 4I4O – four input and four output channels • Three-position switch • Disconnector • Circuit breaker • Earthing switch

The availability and combination of RIO600 modules and channels depend on the number of power supplies connected.

Table 2. Maximum number of modules and channels available when one power supply module is connected

Description	LECM with copper interface		LECM with fiber interface	
	Modules	Channels	Modules	Channels
Digital input modules (DIM8H/DIM8L)	5	40	5	40
Digital output modules	5	20	4	16
RTD4 modules	5	20	4	16
Analog output modules	2	8	1	4
SIM8F/SIM4F modules	5	-	4	-
Smart control module (SCM8H/SCM8L)	3	24	2	16

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Table 3. Maximum number of modules and channels available when two power supply modules are connected

Description	LECM with copper interface		LECM with fiber interface	
	Modules	Channels	Modules	Channels
Digital input modules (DIM8H/DIM8L)	5	40	5	40
Digital output modules	10	40	9	36
RTD4 modules	10	40	9	36
Analog output modules	4	16	3	12
SIM8F/SIM4F modules	5	-	5	-
Smart control module (SCM8H/SCM8L)	5	40	5	40

A combination of all the modules can be used in a single RIO600 stack. The number of modules supported by a number of power supply modules is automatically checked by PCM600. If the selected combination of modules exceeds the number of supported modules related to power consumption, the configuration tool gives an indication and does not configure the stack.

Indication LEDs

RIO600 has indication LEDs available on different modules.
- Ready LED on all modules
- Status-indication LED for each binary input and output
- LED for status indication of detected power flows and disturbances in the network
- IRF LED indicating a fault condition if it is steadily ON
- Communication diagnostic LED on the communication module

Configuration examples

The user-specific configuration can be adapted according to application requirements by combining different modules.

RIO600 can be configured with a combination of low-voltage and high-voltage modules, for example, PSMH-LECM-DIM8L, PSML-LECM-DIM8H or PSML-PSMH-LECM-DIM8H-DIM8L-DOM4.
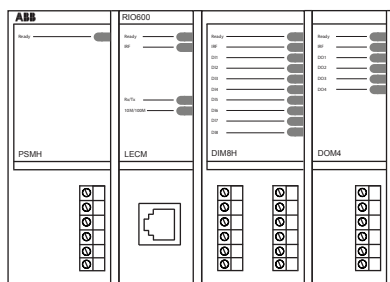

Figure 2.   RIO600 configuration with 12 channels with 8 DI and 4 DO (1 × DIM8H + 1 × DOM4)

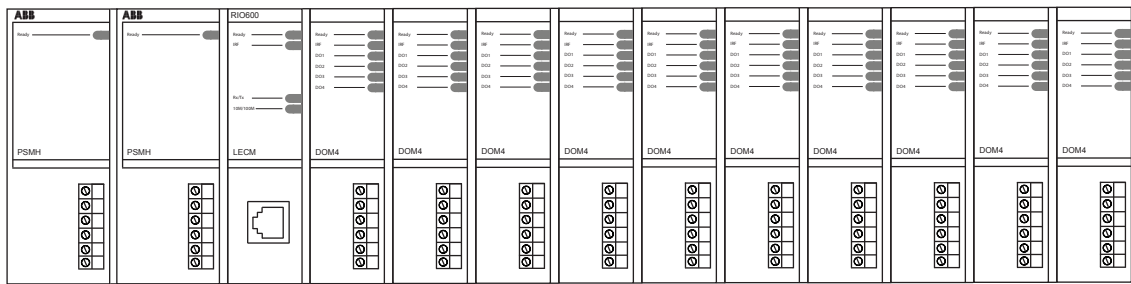Figure 3.   RIO600 configuration: 40 channels with 40 DO (10 × DOM4)
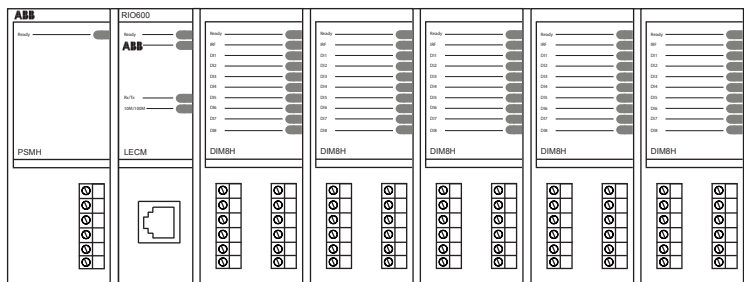
Figure 4.   RIO600 configuration: 40 channels with 40 DI (5 × DIM8H)
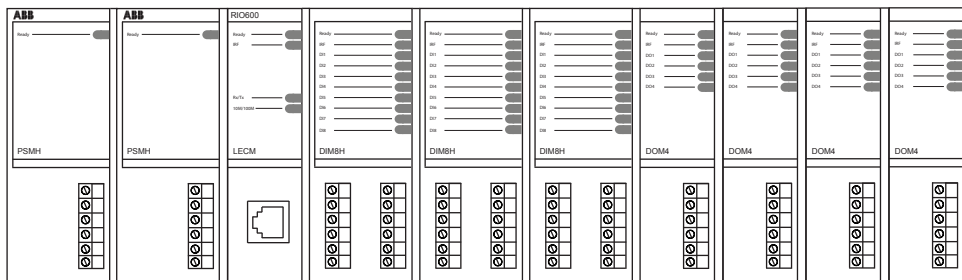
Figure 5.   RIO600 configuration: 40 channels with 24 DI and 16 DO (3 × DIM8H + 4 × DOM4)
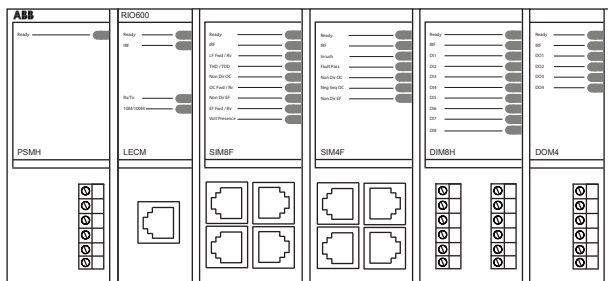
Figure 6.   RIO600 configuration: 1 × SIM8F + 1 × SIM4F + 1 × DIM8H + 1 × DOM4

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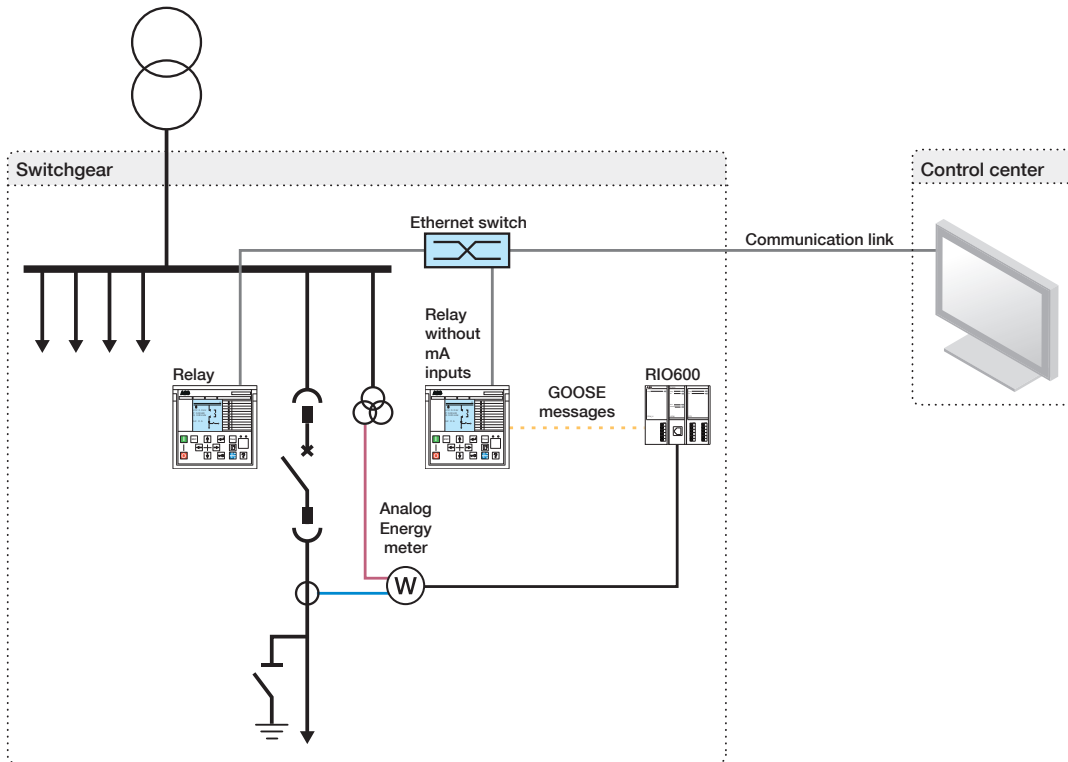
3. Applications

Figure 7.   RIO600 as an external metering input for the protection relay

Figure 7 illustrates an application example in which RIO600 acts as an external metering input for the protection relay.
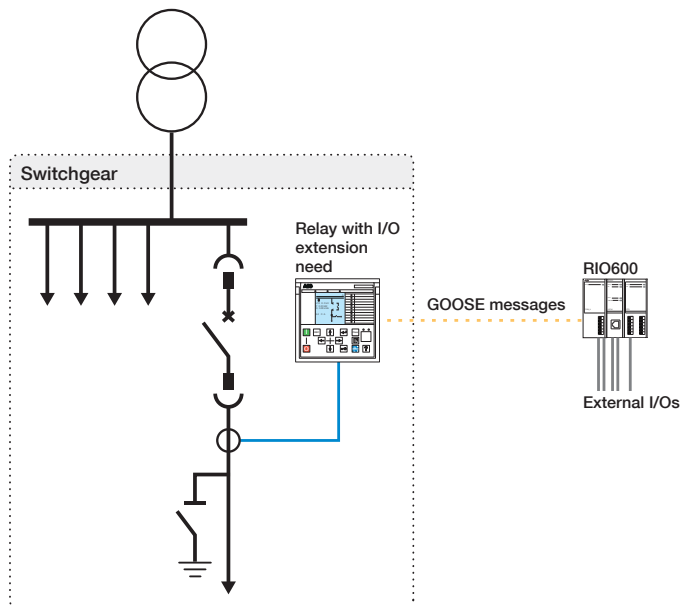
Figure 8.   RIO600 as an I/O extension

In Figure 8 RIO600 is used as an input/output extension to a protection relay or a COM600 substation automation unit.
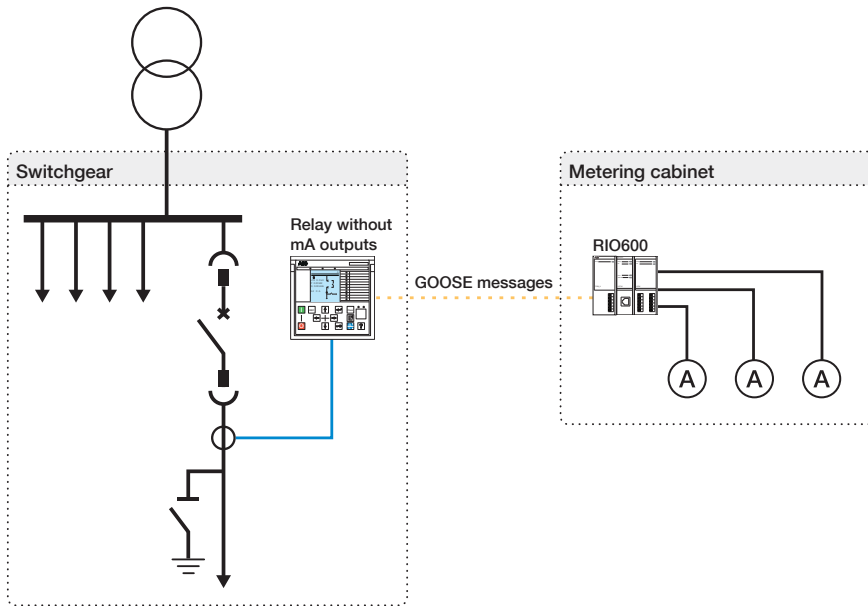
Figure 9.   RIO600 communicating analog signals for the external meters

In Figure 9, RIO600 communicates analog signals for the external meters.
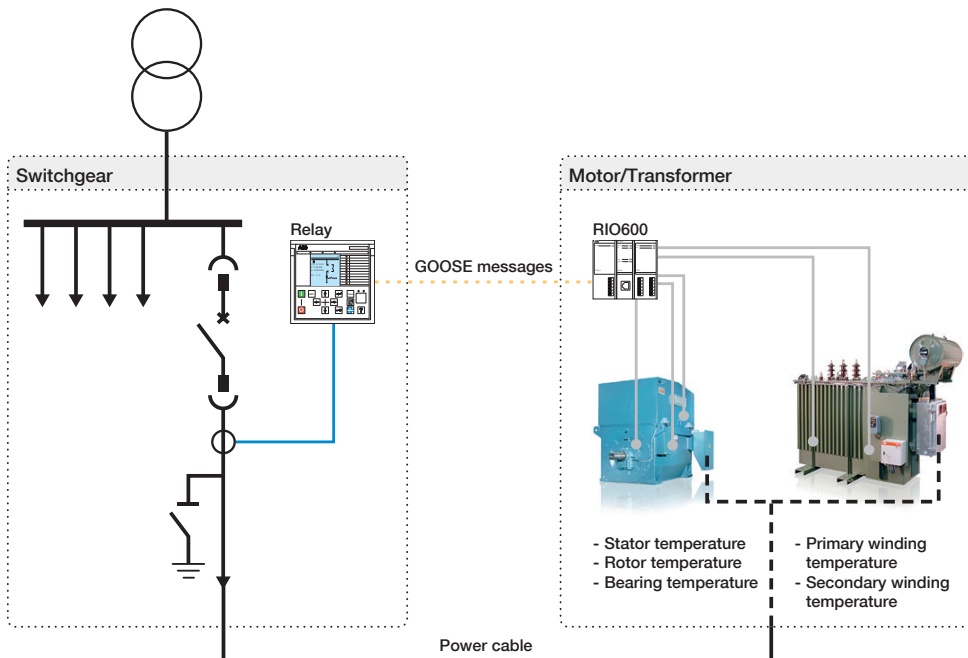
Figure 10.   Temperature measurement using RIO600

Figure 10 illustrates the use of RIO600 to measure temperature from motor or transformer devices. Fiber-optic Ethernet can be used to achieve communication over longer distances.

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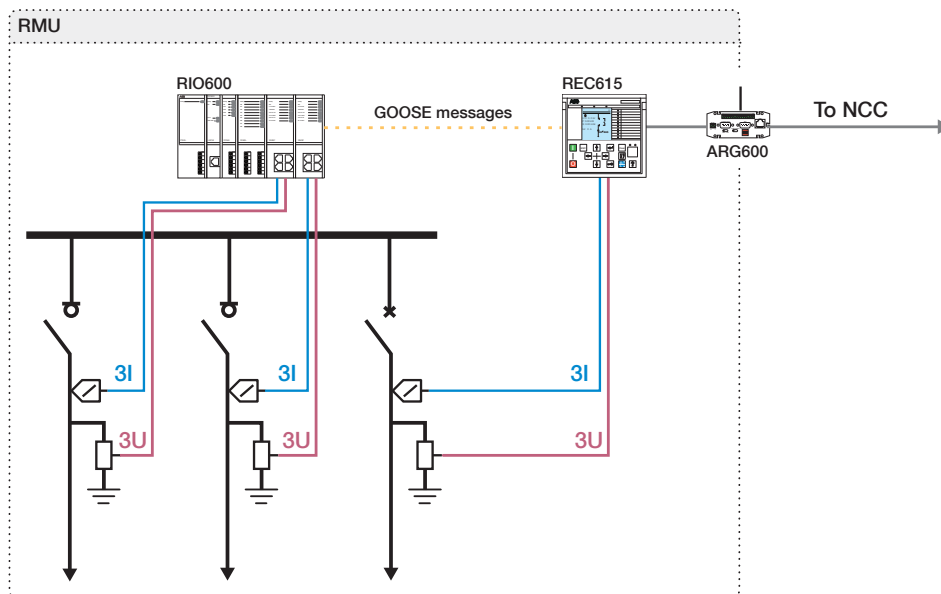
Figure 11. RMU fault passage indication using RIO600

Figure 11 shows RIO600 as a fault passage indicator in the RMU.

4. Self-supervision

RIO600 has a built-in self-supervision feature which continuously monitors the state of the RIO600 hardware and the operation of the software. Any detected fault or malfunction is used to alert the operator. A dedicated LED is provided to indicate the failure. The self-supervision status of RIO600 is also distributed to the IEC 61850 station bus as one data entry in the published GOOSE frame. One of the output contacts of the digital output module can be configured to indicate the status (life-contact) of RIO600.

Supervision information is available over Modbus TCP or via the Web HMI.

All module version information, RIO600 configuration version and firmware checksums are also available for fleet management purposes.

5. Communication

RIO600 supports horizontal Generic Object Oriented Substation Event (GOOSE) communication according to the IEC 61850 substation automation standard versions Edition 1 and Edition 2. It meets the horizontal communication performance criteria for protection and fault detection defined by IEC 61850-5, that is, peer-to-peer communication <10 ms. Currently, the IEC 61850 MMS profile for vertical TCP/IP communication is not supported.

Modbus TCP communication to one Modbus TCP client is also supported. IEC 61850 GOOSE and Modbus TCP can be used in parallel in the same Ethernet-based station bus.

RIO600 sends and receives binary and analog signals to or from the ABB Relion® series protection relays and the COM600 station automation unit/RTU using the IEC 61850-8-1 GOOSE profile or Modbus TCP. Any RTU supporting these protocols can be used. RIO600 subscribes to a GOOSE message from up to five peer protection relays and publishes to multiple protection relays as configured. Up to seven GOOSE data sets can be published. It is possible to send time-stamped events using the GOOSE service with a T0 class accuracy.

RIO600 also supports Modbus TCP communication used in Ethernet networks. The communication type is client-server where RIO600 acts as a Modbus TCP server. RIO600 Modbus TCP server supports connection to one Modbus TCP client.

RIO600 communication module includes a galvanic RJ-45 port with 10/100 Mbits/s or fiber-optic LC Ethernet for IEC 61850 GOOSE and Modbus TCP communication. The used cable must be a shielded twisted pair cable CAT5e at the minimum or a multimode fiber-optic cable with an LC connector.

Using the same Ethernet port, RIO600 can be connected in parallel to PCM600 and a Web browser over the same communication bus.

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6. Technical data

Table 4. Module weights

Description	Value
PSMH/PSML	235 g
LECM	123 g
DIM8H/DIM8L	206 g
DOM4	163 g
RTD4	206 g
AOM4	206 g
SIM8F/SIM4F	180 g
SCM8H/SCM8L	215 g

Table 5. Dimensions of the end clamp (EW 35, Weidmuller)

Description	Value
Width	8.5 mm (to be fixed at the ends of assembled modules)

Table 6. Power supply

Description	PSMH	PSML
U_{aux} nominal	100, 110, 120, 220, 240 V AC, 50 and 60 Hz	24, 30, 48, 60 V DC
	110, 125, 220, 250 V DC	
U_{aux} variation	85…110% of U_{aux} nominal (85...264 V AC)	50...120% of U_{aux} nominal (12...72 V DC)
	80…120% of U_{aux} nominal (88…300 V DC)	
Start-up threshold		19.2 V DC (24 V DC × 80%)
Maximum interruption time in the auxiliary DC without resetting the RIO600 modules	100 ms at U_{aux} nominal	50 ms at U_{aux} nominal
Ripple in the DC auxiliary voltage	Max. 15% of the DC value (at frequency of 100 Hz)	
Reversal of DC power supply polarity	1 minute for each polarity	
Burden of auxiliary voltage supply		
• Quiescent (Pq) condition (none of the 20 I/O channels are activated)	<4.0 W nominal	
• Operating condition (20 binary output channels in DOM4 modules are activated)	<12.0 W (maximum)	
Module configuration	Condition	Max. consumption for PSMH and PSML
PSM + LECM + DIM8H	All DIs activated	2 W
PSM + LECM + DIM8L		
PSM + LECM + DOM4	All DOs activated	4 W
PSM + LECM + DOM4 (5)	All DOs activated	12 W
PSM (2) + LECM + DIM8H (5)	All DIs activated	11 W
PSM (2) + LECM + DIM8L (5)		
PSM (2) + LECM + DOM4 (10)	All DOs activated	22 W

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Table 7. Binary inputs

Description	DIM8H	DIM8L
Rated voltage	110…250 V DC	24, 30, 48, 60 V DC
Operating voltage range	±20% of rated voltage	±20% of rated voltage
Current drain	3…3.7 mA	2 mA
Power consumption/input channel	330…925 mW	30…130 mW
Threshold voltage	78 V DC	13 V DC
Reaction time	5 ms...4.0 s filtering time	5 ms...4.0 s filtering time

Table 8. Signal outputs (digital output module DOM4)

Description	Value
Operating time	<5 ms
Nominal coil power	<500 mW
Rated voltage	250 V AC/DC
Continuous contact carry	5 A
Make and carry for 3.0 s	10 A
Make and carry for 0.5 s	15 A
Breaking capacity when the control circuit time constant L/R <40 ms, at 48/110/220 V DC	1 A/0.25 A/0.15 A

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Table 9. mA/RTD input (RTD4 module)

Description		Value	
RTD inputs	Supported RTD sensors	100 Ω platinum	TCR 0.00385 (DIN 43760)
		250 Ω platinum	TCR 0.00385
		100 Ω nickel	TCR 0.00618 (DIN 43760)
		120 Ω nickel	TCR 0.00618
		250 Ω nickel	TCR 0.00618
	Maximum lead resistance (three-wire measurement)	100 Ω platinum	200 Ω per lead
		250 Ω platinum	200 Ω per lead
		100 Ω nickel	200 Ω per lead
		120 Ω nickel	200 Ω per lead
		250 Ω nickel	200 Ω per lead
	Isolation	4 kV	Inputs to all other channel outputs and protective earth
	RTD/resistance sensing maximum	0.275 mA rms current	
	Operation accuracy	±1°C	
	Response time	< Filter time + 350 ms	
mA inputs	Supported current range	0…20 mA	
	Current input impedance	44 Ω ± 0.1%	
	Operation accuracy	±0.5% or ±0.1 mA	
	Isolation	4 kV	Inputs to all outputs and protective earth

Table 10. Analog output module (AOM4)

Description		Value
mA output	Supported current range	0.0…20.0 mA
	Operation accuracy	±0.1% or ±0.2 mA
	Isolation	4 kV between each output and protective earth

Table 11. Sensor input module (SIM8F)

Description		Value
Preferred ABB sensors		• Combined sensors KEVCY 24 RE1, KEVCY36 RE1, KEVCY 40.5 RE1, KEVCD A • Combination of current sensor KECA 80 C85 or KECA D85 and voltage sensor KEVA 24 C10, 24 C21, 24 C22, 24 C23, 17.5 B20, 17.5 B21, 24 B20, or 24 B21
Current measurement	Range	4...8000 A
	Accuracy	±5% or ±1 A in the range of 4...80 A ±1% in the range of 80...4800 A ±10% in the range of 4800...8000 A
Line voltage measurement	Range	480 V...48 kV
	Accuracy	±5% in the range of 480...9600 V ±0.5% in the range of 9.6...48 kV
Power measurements: P, Q, S and PF	Range	9.6...28.8 kV 80...630 A
	Accuracy	±1.0% for active power P (±0.5% at +25ºC) ±3.0% for reactive Q and apparent power S (±1% at +25ºC) ±0.03 for power factor ±3.0% for energy
Line frequency measurement	Range	50 or 60 Hz
	Accuracy	For 50 Hz, ±50 mHz For 60 Hz, ±60 mHz
Average operating current, voltage and power		Average operating current, voltage, power according to selection: 3 min/10 min/15 min/1 hour/2 hours/24 hours
Peak current, voltage and power values		Peak values for 1 day, 1 week, 1 month, 1 year
General detection of the harmonics disturbances		• Current TDD (Total demand distortion) up to the 8th harmonics • Voltage THD (Total harmonic distortion) up to the 8th harmonics
Load flow direction		Forward/reverse
Non-directional overcurrent fault detection	Operating range	50...2000 A
	Accuracy	Depending on the nominal frequency of the current measured: f_n ±1.5% of the set value Operate time: ±1.0% of the set value or ±20 ms
Directional overcurrent fault detection	Operating range	50...2000 A
	Accuracy	Depending on the nominal frequency of the current measured: f_n Current: ±1.5% of the set value Voltage: ±1.5% of the set value Phase angle: ±2º Operate time: ±1.0% of the set value or ±20 ms
Non-directional earth-fault detection	Operating range	4...200 A (isolated/compensated network) 200...1000 A (solidly grounded/low-impedance network)
	Accuracy	Depending on the nominal frequency of the current measured: f_n ±10% of the set value in the range of 4...25 A ±1.5% of the set value in the range of >25...1000 A Operate time: ±1.0% of the set value or ±20 ms (Current measurement based on internal calculation)

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Table 11. Sensor input module (SIM8F), continued

Description		Value
Directional earth-fault detection	Operating range	4...200 A (isolated/compensated network) 200...1000 A (solidly grounded/low-impedance network)
	Accuracy	Depending on the nominal frequency of the current measured: f_n Current: • ±10% of the set value in the range of 4...25 A • ±1.5% of the set value in the range of >25...1000 A Voltage: ±1.5% of the set value Phase angle: ±3º Operate time: ±1.0% of the set value or ±20 ms (Current measurement based on internal calculation)
Fuse failure protection	Operating range	4...1000 A (Negative-sequence current level) 300...10000 V (Negative-sequence voltage level)
	Accuracy	Depending on the nominal frequency of the current measured: f_n NPS function: <36 ms for U_{Fault} = 1.1 × set value <22 ms for U_{Fault} = 5 × set value Delta function: <34 ms for ΔU = 1.1 × set value <28 ms for ΔU = 5 × set value
Three-phase inrush detector	Operating range	5…100% Ratio I2f/I1f measurement
	Accuracy	Depending on the nominal frequency of the current measured: f_n Current: ±1.5% of the set value or ±0.02 A Ratio I2f/I1f measurement: ±5.0% of the set value Operate time: ±35 ms
Negative-sequence overcurrent protection	Operating range	4...200 A (isolated/compensated network) 200...1000 A (solidly grounded/low-impedance network)
	Accuracy	Depending on the nominal frequency of the current measured: $f = f_n$ Current: ±1.5% of the set value or ±0.02 A I_{Fault} = 2 × set value = <36 ms I_{Fault} = 10 × set value = <30 ms Operate time: ±1.0% of the set value or ±20 ms
Multifrequency admittance-based earth-fault indication	Operating range	480 V...28.8 kV
	Accuracy	Depending on the nominal frequency of the current measured: f_n Voltage: ±5% in the range of 480 V...9.6 kV ±0.5% in the range of 9.6...28.8 kV Operate time: ±1.0% of the set value or ±20 ms

Table 12. Current sensor module (SIM4F)

Description		Value
Preferred ABB sensors		Current sensors KECA 80 C85 or KECA 80 D85
Current measurement	Range	4...8000 A
	Accuracy	±5% or ±1 A in the range of 4...80 A ±1% in the range of 80...4800 A ±10% in the range of 4800...8000 A
Line frequency measurement	Range	50 or 60 Hz
	Accuracy	For 50 Hz, ±50 mHz For 60 Hz, ±60 mHz
Average operating current		Average operating current according to selection: 3 min/10 min/15 min/1 hour/2 hours/24 hours
Peak current		Peak values for 1 day, 1 week, 1 month, 1 year
Non-directional overcurrent fault detection	Operating range	50...2000 A
	Accuracy	Depending on the nominal frequency of the current measured: f_n ±1.5% of the set value Operate time: ±1.0% of the set value or ±20 ms
Non-directional earth-fault detection	Operating range	4...200 A (isolated/compensated network) 200...1000 A (solidly grounded/low-impedance network)
	Accuracy	Depending on the nominal frequency of the current measured: f_n ±10% of the set value in the range of 4...25 A ±1.5% of the set value in the range of >25...1000 A Operate time: ±1.0% of the set value or ±20 ms (Current measurement based on internal calculation)
Fault pass indicator	Operating range	1...100 A (earth-fault and residual current) 10…100 A (instantaneous current)
	Accuracy	Depending on the nominal frequency of the current measured: f_n Current: ±1.5% of the set value Start time :±1.0% of the set value or ±70 ms Operate time: ±1.0% of the set value or ±30 ms
Three-phase inrush detector	Operating range	5…100% Ratio I2f/I1f measurement
	Accuracy	Depending on the nominal frequency of the current measured: f_n Current: ±1.5% of the set value or ±0.02 A Ratio I2f/I1f measurement: ±5.0% of the set value Operate time: ±35 ms
Negative-sequence overcurrent protection	Operating range	4...200 A (isolated/compensated network) 200...1000 A (solidly grounded/low-impedance network)
	Accuracy	Depending on the nominal frequency of the current measured: $f = f_n$ Current: ±1.5% of the set value or ±0.02 A I_{Fault} = 2 × set value = <36 ms I_{Fault} = 10 × set value = <30 ms Operate time: ±1.0% of the set value or ±20 ms

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Table 13. Binary inputs (SCM)

Description	SCM8H	SCM8L
Rated voltage	110...250 V DC	24, 30, 48, 60 V DC
Operating voltage range	±20% of rated voltage	±20% of rated voltage
Current drain	3…3.7 mA	2 mA
Power consumption/input channel	330…925 mW	30…130 mW
Threshold voltage	78 V DC	13 V DC
Reaction time	5 ms...4.0 s filtering time	5 ms...4.0 s filtering time

Table 14. High-speed outputs (SCM)

Description	SCM8H	SCM8L
Operating time	<1 ms	<1 ms
Rated voltage	110..250 V DC	24, 30, 48, 60 V DC
Continuous current carry	20 A	20 A
Short time current carry	100 A for 10 ms	200 A for 10 ms

Table 15. Communication interface (communication module LECM)

Connector	Cable	Data transfer	Maximum distance	Wave length	Permitted path attenuation[1]
RJ-45	Shielded twisted pair cable, at minimum CAT5e	10/100 Mbits/s	30 m	-	-
LC	Multimode 62.5/125 µm or 50/125 µm glass-fiber core	100 Mbits/s	2 km	1310 nm	<8 dB

1) Maximum allowed attenuation caused by connectors and cable together

Table 16. Degree of protection by enclosure

Description	Value
Degree of protection	IP20[1]

1) If a higher IP class is required, the cabinet where the device is installed should provide proper protection.

Table 17. Environmental conditions

Description	Value
Operating temperature range	-25...+70°C
Relative humidity	<93%
Atmospheric pressure	86...106 kPa
Altitude	up to 2000 m
Transport and storage temperature range	-40...+85°C

Table 18. Inspection of mechanical structure

Description	Reference	Result
Markings and mechanical structure	IEC 60255-1 and IEC 60255-27	OK
Enclosure class of the flush-mounted device	IEC 60529	IP 20
Clearances and creepage distances	IEC 60255-27	OK

Table 19. Overload test

Description	Reference	Result
Thermal withstand capability test	IEC 60255-1 and IEC 60255-27	OK

Table 20. Power supply module tests

Test	Type test value	Result
Operating range of auxiliary supply voltage test	80% and 120% of rated value for DC 85% and 110% of rated value for AC, frequency is between 50 Hz for -5% and 60 Hz for +5%	IEC 60255-1 and IEEE C37.90-2005
Power consumption of auxiliary supply • Quiescent load • Maximum load	 <4 W <12 W	IEC 60255-1 and IEEE C37.90-2005
Reversal of DC power supply polarity	1 min for each polarity	IEC60255-27
Start-up time test	<30 s	

Table 21. Contact tests

Description	Type test value	Reference
Make and carry	Signaling contacts • 5 A, continuous • 10 A for 3 s • 15 A for 0.5 s	IEC 60255-1, IEC 61810-1 and IEEE C37.90-2005
Breaking capacity for DC, L/R ≤40 ms	Signaling contacts • 48 V, 1.00 A • 110 V, 0.25 A • 220 V, 0.15 A	IEC 60255-1, IEC 61810-1 and IEEE C37.90-2005
Mechanical durability	10000 operations	IEC 60255-1, IEC 61810-1 and IEEE C37.90-2005

Table 22. Insulation tests

Description[1]	Type test value	Reference
Dielectric tests	2 kV, 50 Hz, 1 min 500 V, 50 Hz, 1 min for communication 2.8 kV DC, 1 min 700 V DC, 1 min for communication	IEC 60255-27 and IEEE C37.90-2005
Impulse voltage tests	5 kV, 1.2/50 µs, 0.5 J	IEC 60255-27 and IEEE C37.90-2005
Insulation resistance measurements	>100 MΩ, 500 V DC	IEC 60255-27

1)   Insulation tests are not applicable to SIM8F/SIM4F

Table 23. Electromagnetic compatibility and immunity tests

Description	Type test value	Reference
Electrostatic discharge		IEC 60255-26 and IEC 61000-4-2, Level 3
• Air discharge	8 kV	
Radio frequency electromagnetic field (amplitude modulated)	10 V/m (RMS) f = 80...1000 MHz and 1.4...2.7 GHz	IEC 60255-26 and IEC 61000-4-3, Level 3
Radio frequency electromagnetic field from digital radio telephones (pulse modulated)	10 V/m (RMS) f = 900 MHz, 1890 MHz	IEC 61000-4-3, Level 3
Power frequency (50 Hz) magnetic field		IEC 60255-26 and IEC 61000-4-8
• Continuous	100 A (RMS)/m	
• 3 s	300 A (RMS)/m	
Pulsed magnetic field	1000 A/m; 6.4/16 µs Tr/Td; 5 pulses positive/negative; 10 s (time interval)	IEC 61000-4-9, Level 5
Conducted disturbance induced by radio frequency fields, Amplitude modulated	0.15...80 MHz - 10 V (unmod, RMS); 80% AM (1 kHz); 150 Ω source impedance 27 and 68 MHz (spot frequencies); 10 V (unmod, RMS); 80% AM (1 kHz); 150 Ω source impedance	IEC 60255-26 and IEC 61000-4-6, Level 3
Fast low-energy transient (EFT) (including functional earth port)	5/50 ns Tr/Td; 5 kHz repetition frequency 4 kV (peak) for power supply input/output ports and 2 kV (peak) for communication port	IEC 60255-26 and IEC 61000-4-4
Damped oscillatory waves (HFD) 100 kHz and 1 MHz burst	100 kHz and 1 MHz frequency; 75 ns Tr; 40 Hz and 400 Hz repetition frequency; 200 Ω source impedance	IEC 60255-26 and IEC 61000-4-18
• Power supply and input/output ports	Differential mode: 1 kV (peak) Common mode: 2.5 kV (peak)	
• Communication port	Differential mode: not applicable Common mode: 1 kV (peak)	
Slow high-energy transient (surge1.2/50 µs voltage pulse)	1.2/50 µs Tr/Th (open circuit) 8/20 µs Tr/Th (short circuit)	IEC 60255-26 and IEC 61000-4-5
• Auxiliary power supply and input/output ports[1]	±4 kVp (L-Gnd) ±2 kVp (L-L)	
• Communication port	±2 kVp (L-Gnd) while no L-L test is applicable	
Voltage dips, short interruptions and voltage variation immunity tests (AC 50 Hz and 60 Hz)	30% reduction for 25/30 cycles 60% reduction for 10/12 cycles 100% reduction for 0.5, 1.0, 2.5 and 5.0 cycles 100% reduction for 250/300 cycles	IEC 60255-26 and IEC 61000-4-11
Voltage dips, supply interruption and voltage variations on DC input power port (immunity tests)	30% reduction for 500 ms 60% reduction for 200 ms 100% reduction for 10, 20, 30 and 50 ms 100% reduction for 5 s	IEC 60255-26 and IEC 61000-4-29
Ripple voltage	15% U_n frequencies of ripple 100/120 Hz (for 50/60 Hz)	IEC 60255-26, IEC 61000-4-17 and IEEE C37.90-2005
Gradual shut-down/start-up test (for DC power supply)		IEC 60255-26
• Ramp towards shut-down	60 s	
• Wait at power of condition	5 min	
• Ramp towards start-up	60 s	

Table 23. Electromagnetic compatibility and immunity tests, continued

Description	Type test value	Reference
Power frequency voltage 50 Hz and 60 Hz Input/output port		IEC 60255-26 and IEC 61000-4-16
• Differential mode	150 V (RMS) 100 Ω coupling resistor 0.1 µF coupling capacitor	
• Common mode	300 V (RMS) 220 Ω coupling resistor 0.47 µF coupling capacitor	
Emission tests		IEC 60255-26
• Radiated		
30...230 MHz	<40 dB (µV/m) quasi-peak, measured at 10 m distance	
230...1000 MHz	<47 dB (µV/m) quasi-peak, measured at 10 m distance	
• Conducted		
0.15...0.50 MHz	<79 dB (µV) quasi-peak <66 dB (µV) average	
0.5...30 MHz	<73 dB (µV) quasi-peak <60 dB (µV) average	

1)   When SCM is configured as a generic I/O, the level supported is ±2 kVp (L-Gnd) ±1 kVp (L-L)

Table 24. Electromagnetic compatibility and immunity tests according to ANSI standards

Description	Type test value	Reference
1 MHz oscillatory SWC test	All ports: ±2.5 kV common mode/differential mode	IEEE C37.90.1-2002
Fast transient SWC test	All ports: ±4 kV common mode/differential mode	IEEE C37.90.1-2002
Radio frequency interference tests	20 V/m (prior to modulation) f = 80...1000 MHz (AM) f = 900 MHz (PM)	IEEE C37.90.2-2004
Electrostatic discharge test	±15 kV air discharge	IEEE C37.90.3-2001

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Table 25. Mechanical tests

Description	Type test value	Reference
Vibration tests (sinusoidal)	Class 1	IEC 60255-21-1
• Vibration response test	f = 10…150 Hz Peak acceleration: 0.5 g 1 sweep cycle in each axis	
• Vibration endurance test	f = 10…150 Hz Peak acceleration: 1.0 g 20 sweep cycles in each axis	
Shock and bump test	Class 1	IEC 60255-21-2
• Shock response test	Peak acceleration: 5 g Duration of the pulse: 11 ms Number of pulses in each direction: 3	
• Shock withstanding test	Peak acceleration: 15 g Duration of the pulse: 11 ms Number of pulses in each direction: 3	
• Bump test	Peak acceleration: 10 g Duration of the pulse: 16 ms Number of pulses in each direction: 1000	
Seismic test	Class 2	IEC 60255-21-3
• Nominal frequency range	1...35 Hz	
• Zero period acceleration	Horizontal direction: 2.0 gn Vertical direction: 1.0 gn	
• Number of time histories in each axis	Single axis sine sweep	

Table 26. Environmental tests

Description	Type test value	Reference
Dry heat test	• 96 h at +70°C	IEC 60068-2-2 and IEEE C37.90-2005
Dry cold test	• 96 h at -25°C • 16 h at -40°C	IEC 60068-2-1 and IEEE C37.90-2005
Damp heat cyclic test	• 6 cycles (12 h + 12 h) at +25...+55°C, humidity >93%	IEC 60068-2-30
Damp heat steady state test	• Temperature 40°C • Humidity 93% • Duration 96 h	IEC 60068-2-78 and IEEE C37.90-2005
Change of temperature test	• 5 cycles (3 h + 3 h) at -25...+55°C	IEC60068-2-14
Storage test	• 96 h at -40°C • 96 h at +85°C	IEC 60068-2-1, IEC 60068-2-2 and IEEE C37.90-2005

Table 27. EMC compliance

Description	Reference
EMC directive	2004/108/IEC
Standard	EN 50263 (2000) EN 60255-26 (2007)

Table 28. RoHS compliance

Description
Complies with RoHS directive 2002/95/EC

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Available functions

Table 29. Functions available in SIM8F

Function	IEC 61850		IEC 60617	IEC-ANSI
	Edition 1	Edition 2		
Measurement functions				
Three-phase current measurement	CMMXU	CMMXU	3I	3I
Three-phase voltage measurement	VMMXU	VMMXU	3U	3U
Residual current measurement	RESCMMXU	RESCMMXU	Io	Io
Residual voltage measurement	RESVMMXU	RESVMMXU	Uo	Uo
Three-phase power and energy measurement	PEMMXU	PEMMXU	P	P
Three-phase power direction	PWRRDIR	PWRRDIR	-	-
Energy monitoring	EMMTR	EMMTR	E	E
Current, voltage and power average and peak measurement	CMSTA	CAVMMXU CMAMMXU RCAVMMXU	-	-
	VMSTA	VAVMMXU VMAMMXU		
	PEMSTA	PEAVMMXU PEMAMMXU		
Power quality measurement functions (harmonics)				
Current total demand distortion monitoring	CMHAI	CMHAI	PQM3I	PQM3I
Voltage total demand distortion monitoring	VMHAI	VMHAI	PQM3U	PQM3V
Detection and indication functions				
Three-phase non-directional overcurrent fault detection	PHPTOC	PHPTOC	3I>	51P
Three-phase directional overcurrent fault detection	DPHPTOC	DPHPTOC	3I>->	67P
Non-directional earth-fault fault detection	EFPTOC	EFPTOC	I0>	51N
Directional earth-fault fault detection	DEFPTOC	DEFPTOC	I0>->	67N
Multifrequency admittance-based earth-fault indication	MFAPSDE	MFAPSDE	I0>->Y	67YN
Voltage presence indication	PHSVPR	PHSVPR	PHSVPR	PHSVPR
Negative-sequence overcurrent protection	NSPTOC	NSPTOC	I2>	46
Three-phase inrush detector	INRPHAR	INRPHAR	3I2f>	68
Fuse failure protection	SEQSPVC	SEQSPVC	FUSEF	60

Table 30. Functions available in SIM4F

Function	IEC 61850		IEC 60617	IEC-ANSI
	Edition 1	Edition 2		
Measurement functions				
Three-phase current measurement	CMMXU	CMMXU	3I	3I
Residual current measurement	RESCMMXU	RESCMMXU	Io	Io
Current average and peak measurement	CMSTA	CAVMMXU CMAMMXU RCAVMMXU	-	-
Detection and indication functions				
Three-phase non-directional overcurrent fault detection	PHPTOC	PHPTOC	3I>	51P
Non-directional earth-fault detection	EFPTOC	EFPTOC	I0>	51N
Negative-sequence overcurrent protection	NSPTOC	NSPTOC	I2>	46
Three-phase inrush detector	INRPHAR	INRPHAR	3I2f>	68
Fault passage indicator	FPIPTOC	FPIPTOC	-	-

Table 31. CMMXU Technical data

Characteristic	Value
Operation accuracy	At frequency $f = f_n$
	±5% or ±1 A in the range of 4...80 A ±1% in the range of 80...4800 A ±10% in the range of 4800...8000 A
Suppression of harmonics	RMS: No suppression

Table 32. VMMXU Technical data

Characteristic	Value
Operation accuracy	At frequency $f = f_n$
	±5% in the range of 480 V...9.6 kV ±0.5% in the range of 9.6...28.8 kV ±1% in the range of 28.8...48 kV
Suppression of harmonics	RMS: No suppression

Table 33. RESCMMXU Technical data

Characteristic	Value
Operation accuracy	At frequency $f = f_n$ ±5.0% (when all three phase currents are in the range of 80...630 A)
Suppression of harmonics	RMS: No suppression

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Table 34. RESVMMXU Technical data

Characteristic	Value
Operation accuracy	At frequency f = f_n ±5.0% (when all three voltages are in the range of 9.6...14.4 kV or 19.2...28.8 kV)
Suppression of harmonics	RMS: No suppression

Table 35. PEMMXU Technical data

Characteristic	Value
Operation accuracy	At frequency f = f_n All three voltages are in the range of 9.6...14.4 kV or 19.2...28.8 kV. All three currents are in the range of 80...630 A. Active power and energy are in the range |PF| > 0.71. Reactive power and energy are in the range |PF| < 0.71.
	±1.0% for active power P (±0.5% at +25ºC) ±3.0% for reactive Q and apparent power S (±1% at +25ºC) ±0.03 for power factor
Suppression of harmonics	RMS: No suppression

Table 36. EMMTR Technical data

Characteristic	Value
Operation accuracy	At frequency f = fn All three voltages are in the range of 9.6...14.4 kV or 19.2...28.8 kV. All three currents are in the range of 80...630 A. Active power and energy are in the range |PF| > 0.71. Reactive power and energy are in the range |PF| < 0.71.
	±3.0% for energy
Suppression of harmonics	RMS: No suppression

Table 37. PHPTOC Technical data

Charateristic	Value
Operation accuracy	Depending on the frequency of the current measured: f = f_n ±1.5% of the set value
Operate time accuracy (DMT)	±1.0% of the set value or ±20 ms

Table 38. DPHPTOC Technical data

Characteristic	Value
Operation accuracy	Depending on the nominal frequency of the current measured: f = f_n Current: ±1.5% of the set value Voltage: ±1.5% of the set value Phase angle: ±2º
Operate time accuracy (DMT)	±1.0% of the set value or ±20 ms

Table 39. EFPTOC Technical data

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: f = f_n ±10% of the set value in the range of 4...25 A ±1.5% of the set value in the range of 26...1000 A (Current measurement based on internal calculation)
Operate time accuracy (DMT)	±1.0% of the set value or ±20 ms

Table 40. DEFPTOC Technical data

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: f = f_n Current: ±10% of the set value in the range of 4...25 A ±1.5% of the set value in the range of 26...1000 A Voltage: ±1.5% of the set value Phase angle: ±3° (Current measurement based on internal calculation)
Operate time accuracy (DMT)	±1.0% of the set value or ±20 ms

Table 41. MFAPSDE Technical data

Characteristic	Value
Operation accuracy	At frequency f = f_n ±5% in the range of 480 V...9.6 kV ±0.5% in the range of 9.6...28.8 kV
Operate time accuracy	±1.0% of the set value or ±20 mS

Table 42. PHSVPR Technical data

Characteristic	Value
Operation accuracy	At frequency f = f_n ±5% in the range of 480 V...9.6 kV ±0.5% in the range of 9.6...28.8 kV

Table 43. NSPTOC Technical data

Characteristic	Value
Operation accuracy	Depending on the nominal frequency of the current measured: f = f_n Current: ±1.5% of the set value or ±0.02 A I_{Fault} = 2 × set value = <36 ms I_{Fault} = 10 × set value = <30 ms
Operate time accuracy	±1.0% of the set value or ±20 ms

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Table 44. FPIPTOC Technical data

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: $f = f_n$ ±1.5% of the set value
Start time accuracy	±1.0% of the set value or ±70 ms
Operate time accuracy[1]	±1.0% of the set value or ±30 ms

1) f_n = 50 Hz, results based on statistical distribution of 1000 measurements

Table 45. INRPHAR Technical data

Characteristic	Value
Operation accuracy	Depending on the nominal frequency of the current measured: f_n Current: ±1.5% of the set value or ±0.02 A Ratio I2f/I1f measurement: ±5.0% of the set value
Operate time accuracy	±35 ms

Table 46. SEQSPVC Technical data

Characteristic	Value
Operate time accuracy	Depending on the nominal frequency of the current measured: f_n NPS function: <36 ms for U_{Fault} = 1.1 × set value <22 ms for U_{Fault} = 5 × set value Delta function: <34 ms for ΔU = 1.1 × set value <28 ms for ΔU = 5 × set value

Table 47. Functions available in SCM

Function	IEC 61850		IEC 60617	IEC-ANSI
	Edition 1	Edition 2		
Supervision function				
Trip circuit supervision	TCSHSCBR/ TCSLSCBR	TCSHSCBR/ TCSLSCBR	TCS	TCM

Table 48. TCSHSCBR/TCSLSCBR Technical data

Characteristic	Value
Operate time accuracy	±1.0% of the set value or ±20 ms

7. Module dimensions
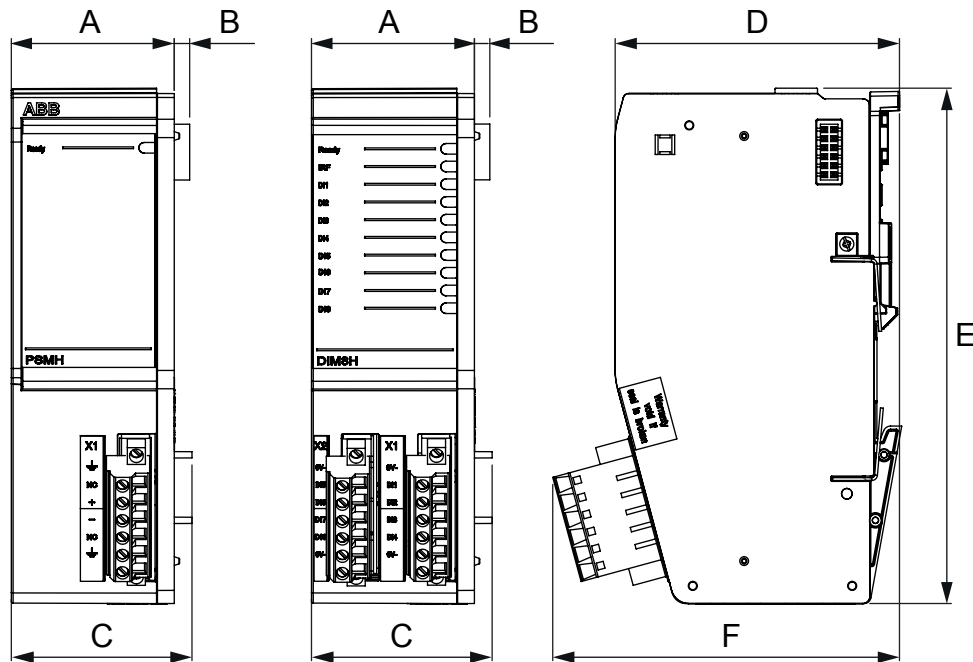

Figure 12.   Dimension and mounting details of the PSMH/PSMLDIM8H/DIM8L/RTD4/AOM4/SCM8H/SCM8L modules

A   46 mm

B   4.5 mm

C   51 mm

D   81 mm

E   146 mm

F   99 mm

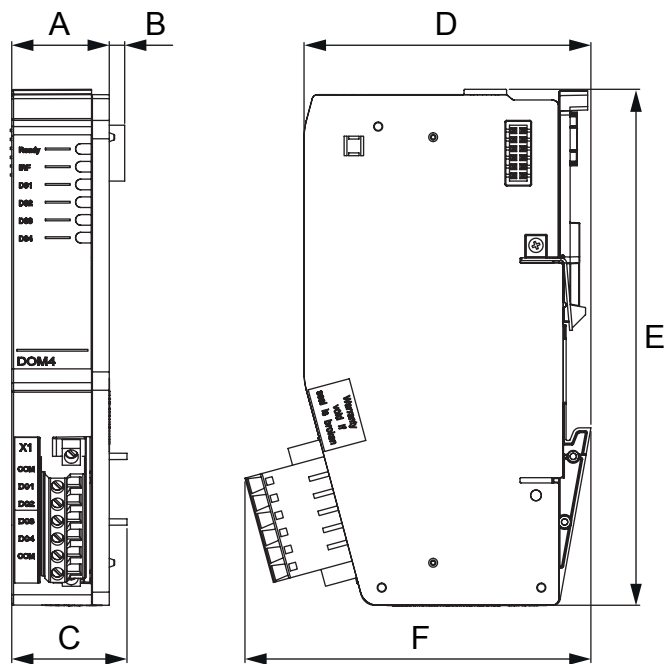ABB   29

Figure 13.   Dimension and mounting details of the digital output module DOM4
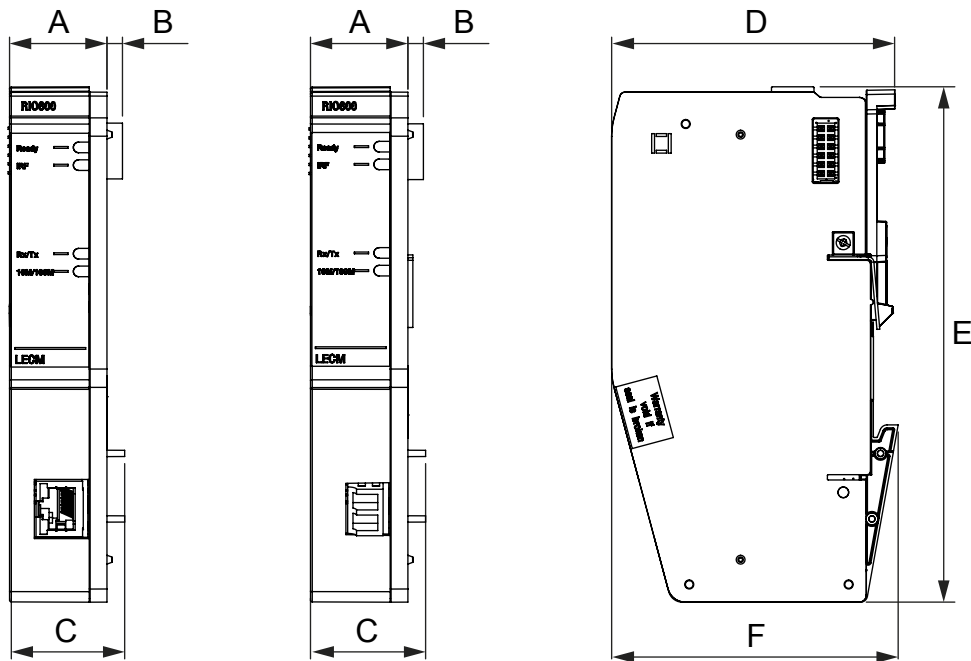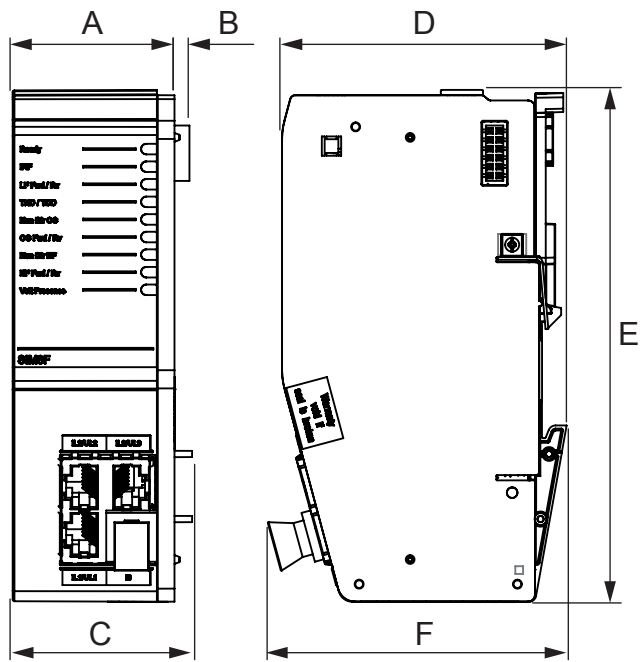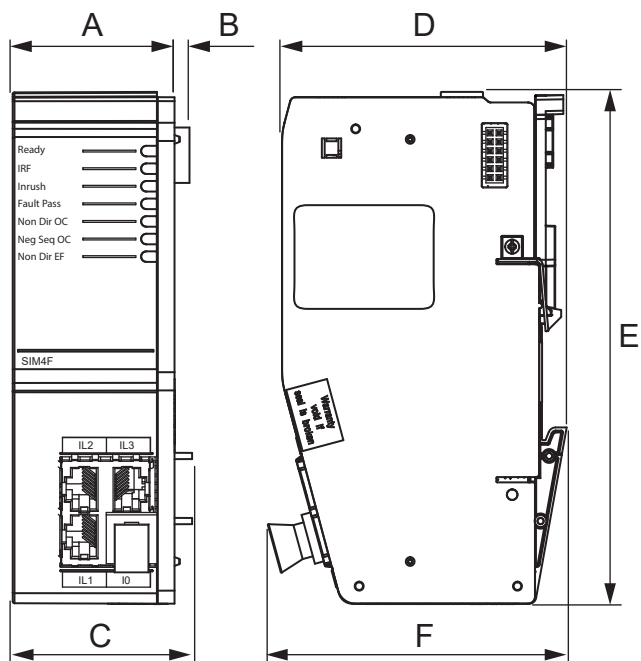
A   27.5 mm

B   4.5 mm

C   33 mm

D   81 mm

E   146 mm

F   99 mm

Figure 14.   Dimension and mounting details of the communication module LECM

A   27.5 mm

B   4.5 mm

C   33 mm

D   81 mm

E   146 mm

F   81 mm

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Figure 15.   Dimension and mounting details of the SIM8F module

A   46 mm

B   4.25 mm

C   51 mm

D   81 mm

E   145.5 mm

F   85 mm

Figure 16.   Dimension and mounting details of the SIM4F module

A   46 mm

B   4.25 mm

C   51 mm

D   81 mm

E   145.5 mm

F   85 mm

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8. Assembly diagram
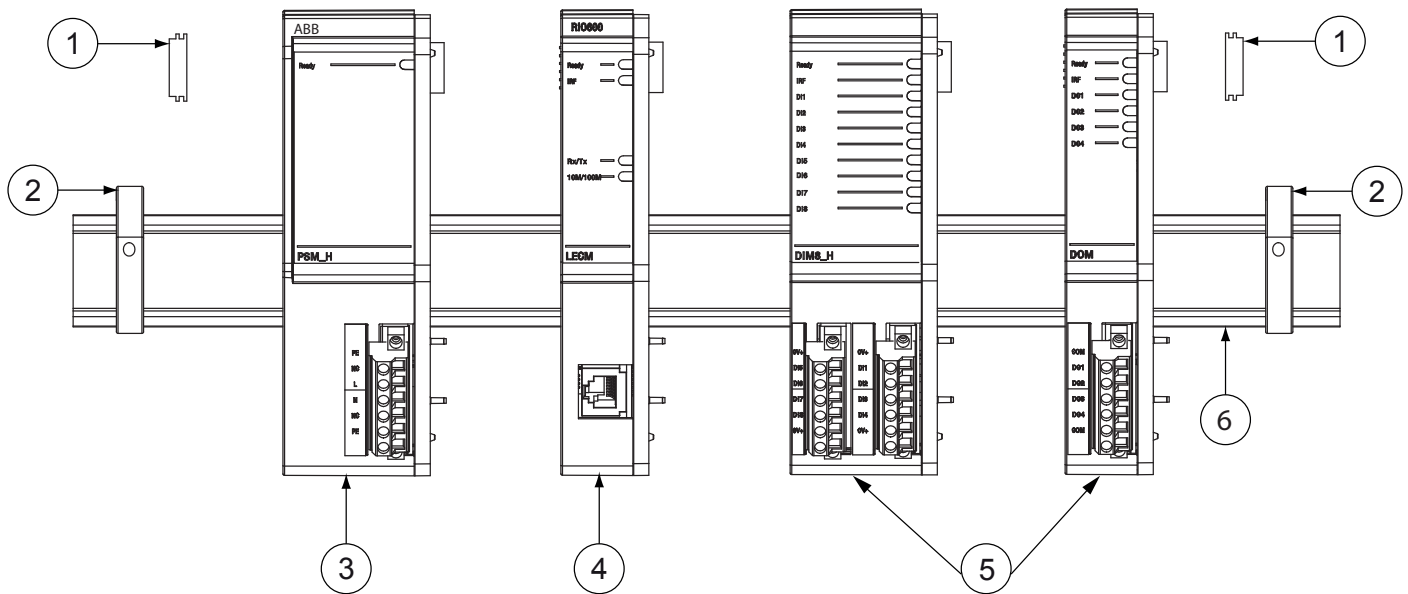
Figure 17.   Assembly drawings of RIO600 modules

1   Rubber cap

2   End clamp

3   PSM module

4   LECM module

5   Modules (DIM/DOM4/RTD4/AOM4/SIM8F/SIM4F/SCM8H/SCM8L)

6   DIN rail

The total width of the assembly can be calculated by adding together the length of all modules.

The width of the end clamp depends on the selected part. This mounting uses the Weidmuller part EW 35, which is 8.5 mm wide.

9. Ordering data

Table 49. Ordering details for RIO600 modules

Item	Order number
Digital input module with 8 inputs, high-voltage power supply	MOD600ADIM8H
Digital input module with 8 inputs, low-voltage power supply	MOD600ADIM8L
Digital output module with 4 outputs	MOD600ADOM4R
RTD/mA input module with 4 inputs	MOD600ARTD4
Analog output module with 4 outputs	MOD600AAOM4
Sensor input module with 4 currents and 3 voltages	MOD600ASIM8F
Sensor input module with 4 currents	MOD600ASIM4F
Smart control module with 4 inputs and 4 high-speed outputs, high-voltage power supply	MOD600ASCM8H
Smart control module with 4 inputs and 4 high-speed outputs, low-voltage power supply	MOD600ASCM8L
High-power supply module	MOD600APSMH07
Low-power supply module	MOD600APSML07
Communication module with RJ-45 port	MOD600GLECMIR
Communication module with multimode fiber-optic LC port	MOD600CLECMFO

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10. Tools

The status information of RIO600 can be viewed from the Web browser-based user interface (Web HMI) and the parameter setting values can be viewed or changed in PCM600 in combination with the RIO600-specific connectivity package.

The Protection and Control IED Manager PCM600 with the RIO600 connectivity package is used for configuring RIO600 in the offline or online mode to connect to the other protection relays or substation gateways in the IEC 61850 station bus. When the Web browser-based user interface is used, RIO600 can be accessed remotely with a Web browser.

The RIO600 connectivity package is a collection of software tools with specific device information which enables system products and tools to connect and interact with RIO600. The connectivity packages support system integration and engineering and thus minimize device configuration and setup time.

RIO600 parameters can be configured with Parameter Setting in PCM600. Internal and station communication based logics are engineered in graphical Application Configuration and in Signal Matrix. IEC 61850 peer-to-peer communication can be configured in PCM600 as well.

Table 50. Tools

Description	Version
PCM600	2.9 Hotfix 2 or later
Web browser	IE 9.0 or later
RIO600 connectivity package	1.8 or later

Figure 18.   RIO600 Web HMI

11. Connection and terminal diagrams
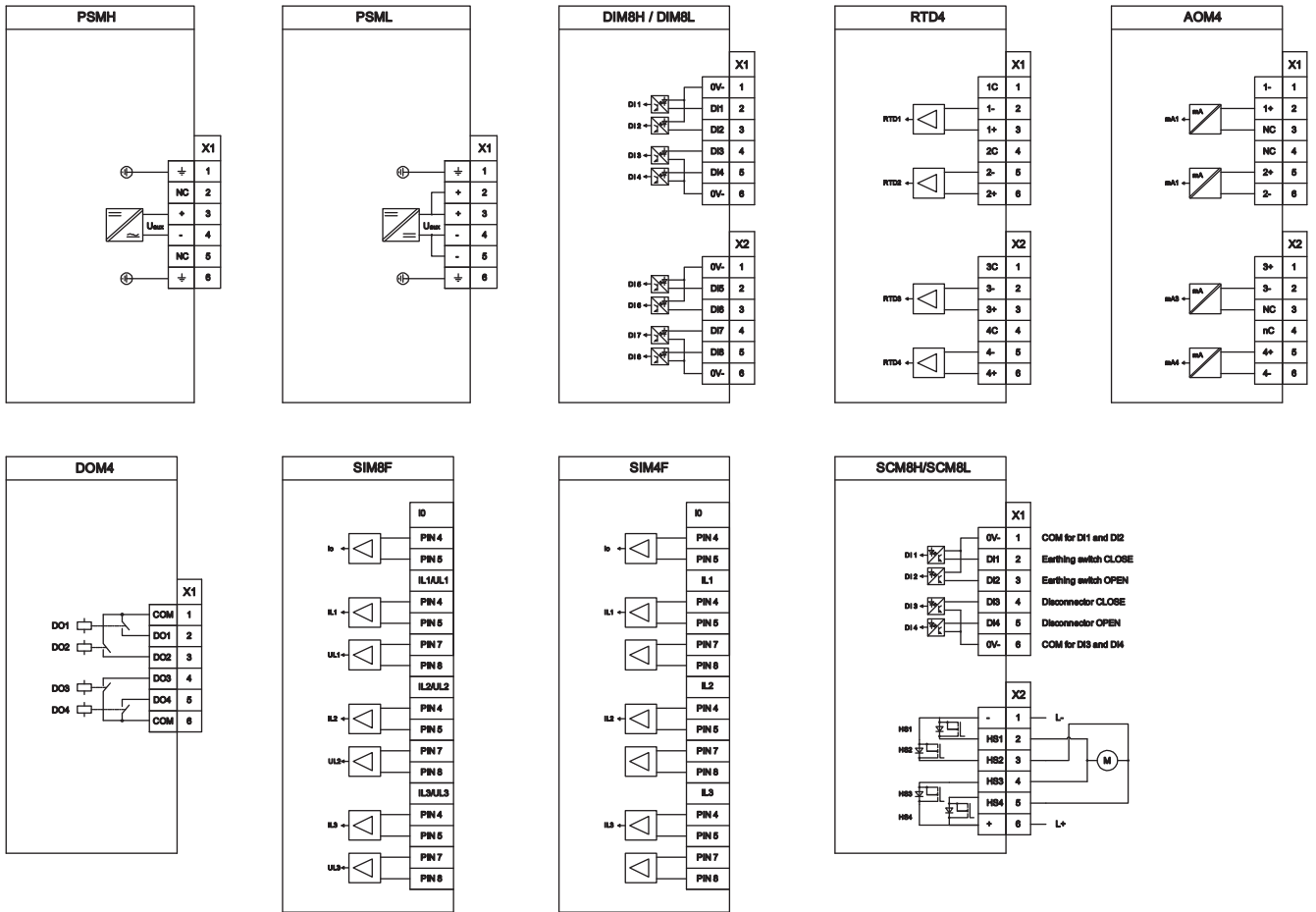
Figure 19.   Connection and terminal diagram of RIO600 modules

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12. Document revision history

Document revision/date	Product version	History
A/2011-12-23	1.0	First release
B/2012-12-18	1.1	Content updated to correspond to the product version
C/2013-09-30	1.2	Content updated to correspond to the product version
D/2014-09-29	1.5	Content updated to correspond to the product version
E/2015-08-31	1.6	Content updated to correspond to the product version
F/2016-06-09	1.7	Content updated to correspond to the product version
G/2019-05-17	1.7	Content updated
H/2019-12-16	1.8	Content updated to correspond to the product version

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