DELOMATIC 400 HYDRO

4921240453E

Data sheet

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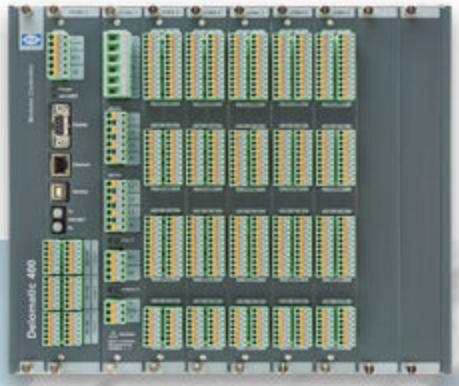

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-power in control

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DATA SHEET

DELOMATIC 400 HYDRO

- Integrated and flexible Hydro Turbine Control
- Dedicated speed governor for island and grid parallel operation
- Auxiliary and turbine control adapted to turbine type
- Local/remote PC monitoring via TCP/IP
- Turbine monitoring and protection
- Generator control and monitoring
- Auto synchronisation and load/reactive load control

DEIF A/S · Frisenborgvej 33 · DK-7800 Skive
Tel.: +45 9614 9614 · Fax: +45 9614 9615
info@deif.com · www.deif.com

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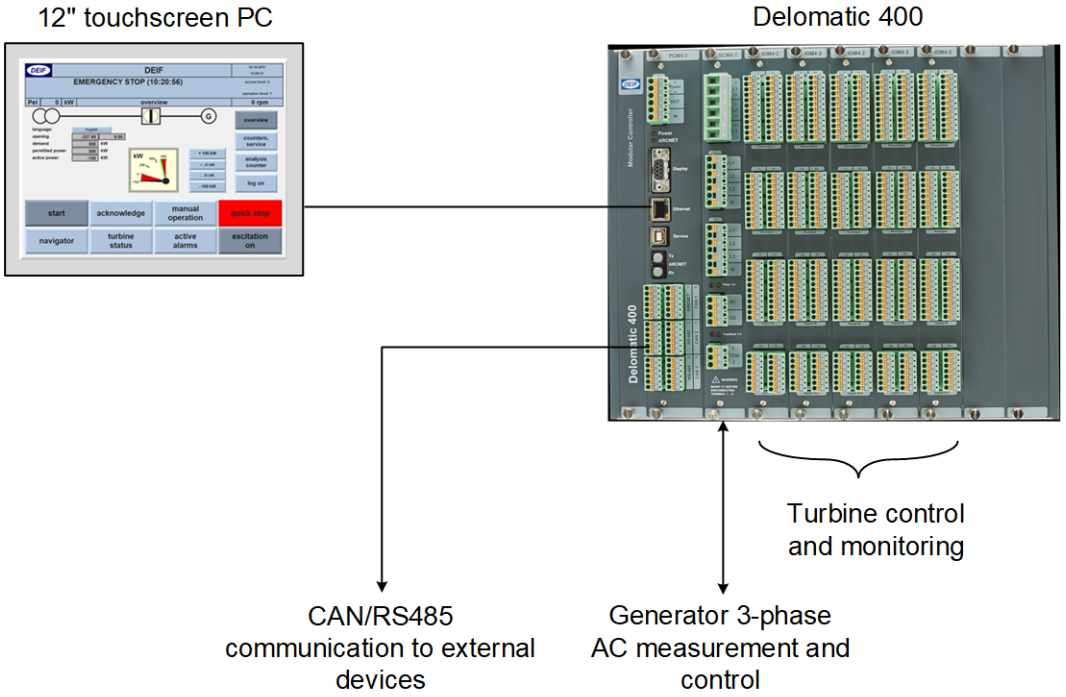
1. Application information

1.1 General information

1.1.1 Hardware

The Delomatic 400 delivery from DEIF consists of:



1.1.2 Application

The controller Delomatic 400 Hydro is designed primarily as a hydro turbine modular process controller. It covers the special demands of turbine energy plants regarding reliability, robustness, flexibility, and remote accessibility in an optimal way.

Based on an existing generator control system approved for marine applications and used in thousands of ships and land-based power stations over the last 25 years, Delomatic 400 Hydro matches the special demands of harsh environments and far-away-locations faced in decentralised energy generation.

The control system is designed for unmanned operation. The user interface provides full information to the user and allows an efficient diagnosis and a fast reestablishment of the operation locally as well as remotely.

1.1.3 Power flow speed governor

The integrated power flow speed governor in the Delomatic 400 is specifically designed for operation of high inertia machines such as hydro turbines.

Unlike a PID regulator, which typically operates on a speed error basis, the power flow regulator calculations are based on a power error basis.

The power flow regulator takes into account that the rotational energy is depending on the *square* of the rotational velocity. This means that the power flow regulator will react on an acceleration/deceleration only when this is too high or too low for a given situation. A PID regulator will react on any acceleration/deceleration even when this is desired in the given situation, for example accelerating to nominal speed. This difference is most significant during acceleration of the turbine, where the power flow regulator will use less time to get to nominal speed than a PID regulator will.

The power flow regulator offers excellent dynamics (fastest reaction to changes in speed set point) and aperiodic behaviour (no overshoots in speed). These are important features for controls of a high inertia machine when synchronising or running in islanded systems, be that alone or load sharing with other turbines.

1.1.4 Controller variants

Delomatic 400 Hydro speed governor

Delomatic 400 Hardware:
- 24TE rack
- 1 x PCM 4.3 processor and power supply module
- 2 x IOM 4.2 I/O module
    * 12 Pt100 temperature inputs
    * 8 analogue (4-20 mA or 0-10 V) inputs
    * 8 analogue (+/- 20 mA) outputs
    * 24 digital inputs
    * 6 high-speed digital inputs
    * 20 digital outputs

Functions:
- Control of Francis turbine wicket gate using proportional valve control (signal +/- 20 mA).
- Control of Kaplan turbine wicket gate and runner pitch using proportional valve control (signal 2 x +/- 20 mA).
- Control of Pelton turbine multiple nozzles (jets) using proportional valve control (signal 4 x +/- 20 mA).
- Speed governor control based on transistorised speed pickup (NPN, PNP or push-pull)
- Overspeed protection (multiple pickups possible)
- Speed bias input from external control system (4-20 mA or 0-10 V DC)

Governor control modes:
- Island operation, frequency control
- Grid parallel operation, fixed power (with external load control signal)
- Grid parallel operation, water level control

Delomatic 400 Hydro speed governor w/aux control

Delomatic 400 hardware:
- 42 TE rack
- 1 x PCM 4.3 processor and power supply module
- 3 x IOM 4.2 I/O module
    * 18 Pt100 temperature inputs
    * 12 analogue (4-20 mA or 0-10 V) inputs
    * 12 analogue (+/- 20 mA) outputs
    * 36 digital inputs
    * 12 high-speed digital inputs
    * 30 digital outputs

Up to 2 additional IOM 4.2 modules can be added

Functions:
Delomatic 400 Hydro speed governor functions plus:
- Automatic start/stop of turbine from zero to rated speed with ramp up/down control
- Single input for start
- Temperature monitoring and control – max 18 Pt 100 temperature sensors
- Jacking control for vertical turbines. Digital output ON/OFF
- Breaking control. Digital output ON/OFF
- Lube oil system control and monitoring
    * starting and stopping of one lube oil pressure pump
    * start/stop based on pressure measurement (4-20 mA) or pressure switches
    * monitoring of pressure
    * monitoring of temperature
- Hydraulic oil pressure control and monitoring
    * starting and stopping of one hydraulic oil pressure pump
    * start/stop based on pressure measurement (4-20 mA) or pressure switches
    * monitoring of oil tank level
    * monitoring of oil tank temperature

- Cooling water system control and monitoring
    * starting and stopping of one cooling water pump
    * start/stop based on turbine run/stop conditions
    * monitoring of water pressure

Note: The above functions are available on the condition that the necessary inputs/outputs are available.

Delomatic 400 Hydro speed governor w/aux control and generator control

Delomatic 400 hardware:
- 42 TE rack
- 1 x PCM 4.3 processor and power supply module
- 1 x SCM 4.1 3-phase AC measurement module
- 3 x IOM 4.2 I/O module
    * 18 Pt100 temperature inputs
    * 12 analogue (4-20 mA or 0-10 V) inputs
    * 12 analogue (+/- 20 mA) outputs
    * 36 digital inputs
    * 12 high-speed digital inputs
    * 30 digital outputs

1 additional IOM 4.2 module can be added

Functions:
Delomatic 400 Hydro speed governor w/aux control functions plus:
- Generator breaker synchronisation
    * frequency control
    * phase angle matching
    * voltage matching
    * breaker close digital output command
- Island operation with frequency control
- Fixed load control in grid connected mode
- Water level control (water level-dependent power output)
- Analogue or relay increase/decrease output to AVR (AVR not included)

Delomatic 400 Hydro speed governor w/aux control and generator control and protection

Delomatic 400 hardware:
- 60 TE rack
- 1 x PCM 4.3 processor and power supply module
- 1 x SCM 4.1 3-phase AC measurement module
- 3 x IOM 4.2 I/O module
    * 18 Pt100 temperature inputs
    * 12 analogue (4-20 mA or 0-10 V) inputs
    * 12 analogue (+/- 20 mA) outputs
    * 36 digital inputs
    * 12 high-speed digital inputs
    * 30 digital outputs

Up to 4 additional IOM 4.2 modules can be added

Functions:
Delomatic 400 Hydro speed governor w/aux control functions and generator control plus:
- Generator protections:
    * Over-voltage (2 steps)
    * Under-voltage (2 steps)
    * Over-frequency (2 steps)
    * Under-frequency (2 steps)
    * Over-current (2 steps)
    * Thermal over-current curve (1 step)
    * Current asymmetry (1 step)
    * Overload (2 steps)
    * Reverse power (1 step)
    * Minimum load (1 step)
    * Over-excitation (1 step)
    * Under-excitation (1 step)

- Grid failure protection
    * Over-voltage (2 steps)
    * Under-voltage (2 steps)
    * Over-frequency (2 steps)
    * Under-frequency (2 steps)
    * Vector jump (1 step)
    * Df/Dt (ROCOF) (1 step)

Expandability

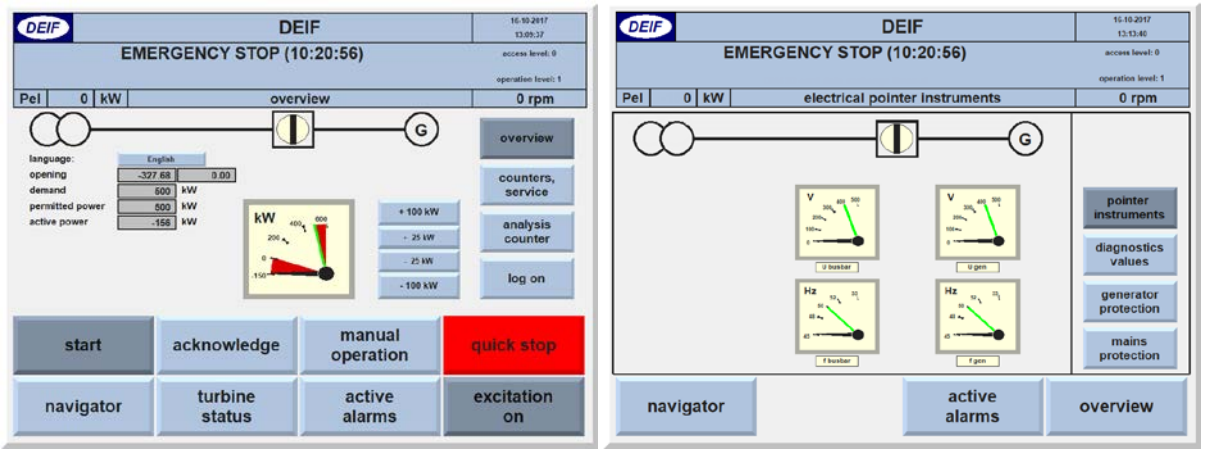
Both hardware and software can be expanded beyond the above. Contact DEIF for information.

1.2 User interface

1.2.1 General description

- Display of all measurements as graphics and in numbers
- Visualisation of the states of the protections
- Trending function
- Logbooks with more than 200 entries with time stamps each
- Adjustment of parameters
- Multi-user function with standard hardware as touch screens, laptop computers for direct access (TCP/IP)
- Remote access (TCP/IP)
- “Living” P&I diagrams on the screen show changes and states of components in graphics
- Operation of the plant
- Maintenance calls after operating hours, adjustable

1.2.2 Examples



1.3 System components with specifications

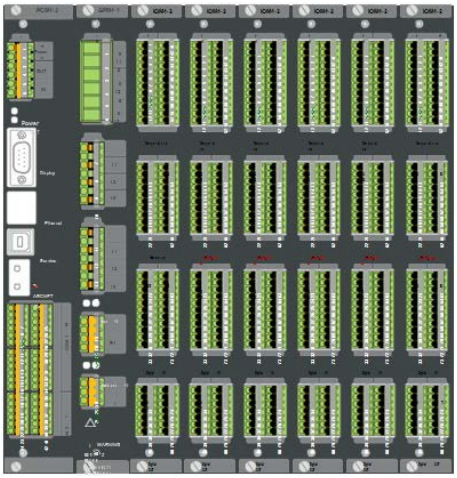
1.3.1 General description

The whole Delomatic 400 Hydro system consists of only three hardware modules. Each module contains its own processor and therefore it works independently of the other modules. Communication between the modules is carried out via the rack backplane.

All three modules will be delivered in a standard industry rack. Available standard sizes:

- 24 TE for 2 modules + power supply/processor module.
- 42 TE for up to 4 modules + power supply/processor module.
- 60 TE for up to 8 modules + power supply/processor module.

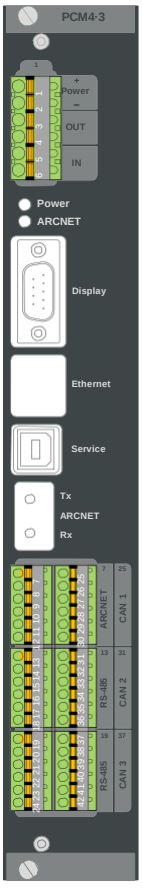
1.3.2 Rack

Technical specifications	
	
Operating temperature	-25 to 70 °C to IEC 60068-2-1, IEC 60068-2-2 & IEC 60255-1
Storage temperature	-40 to 85 °C to IEC 60255-1
Reference temperature	15 to 30 °C
Climate	55 °C 97 % RH condensing to IEC 60068-2-30 Db
Vibration	DNV class A+C & IEC 60068-2-6 Fc 3.0 to 13.2 Hz 2.0 mmpp 13.2 to 100 Hz 0.7 g 3.0 to 13.2 Hz 6.0 mmpp 13.2 to 50 Hz 2.1 g Vibration response test. To IEC 60255-21-1 Class2 10 to 58.1 Hz 0.15 mmpp 58.1 to 150 Hz 1 g Vibration endurance test. To IEC 60255-21-1 Class2 10 to 150 Hz 2 g Vibration seismic test. To IEC 60255-21-3 Class2 3 to 8.15 Hz 15 mmpp 8.15 to 35 Hz 2 g
Repetitive shock (bump)	20 g 16 ms. To IEC 60255-21-2 Class2
Shock	Shock test. To IEC 60068-2-27Ea 50 g 11 ms. Half sine Shock response test. To IEC 60255-21-2 Class2 10 g 11 ms. Half sine Shock withstand test. To IEC 60255-21-2 Class2 30 g 11 ms. Half sine

EMC/CE	To EN 61000-6-2, EN 61000-6-4 & IEC 60255-26
Protection class	IP 20 To IEC/EN 60529
Material	Plastic headers acc. UL94-V0, Alu-case, steel cover plates
Safety	To EN 61010-1 over-voltage category III, 690 V AC, pollution degree 2

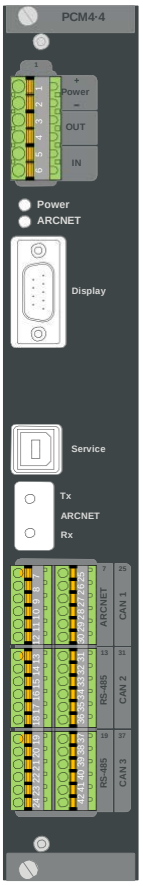
1.3.3 PCM 4·3 module specifications

The PCM 4.3 is the power supply and main control module of the Delomatic 400 system with a module width of 8TE. It is mounted leftmost in the rack. It supplies all other modules in the rack and controls the data exchange on the backplane. Furthermore, it contains the control unit with the application software and communication interfaces.

Power and control module		
	Power supply	Power IN 18 to 36 V DC, max 6 A
	Output	Digital relay output (NO)/24 V DC 8 A
	Input	Digital input designed for potential-free contacts. Open/Close 5 V/7.5 mA
	Interface	**3 x CAN:** Independent CAN bus lines 125/250 kbps **1 x RS-422/485 port**: 4,800 – 57,600 Baud **1 x ARCNET port either electrical or optical connection:** 2.5 Mbit **1 x Ethernet port:** 10/100 Mbit **1 x display port (TTL):** 4,800 – 57,600 Baud
	Service	**USB service interface** 256,000 Baud
	Processor	180 MHz
	Operative system	Linux 2.6
	Storage	64 MB SD RAM 32 Kb non-volatile RAM 16 MB FLASH shared for programme memory and data storage
	Size	8TE (40.64 mm)

1.3.4 PCM 4·4 module specifications

The PCM 4·4 module is typically used as a controller for an extension rack, should one rack be insufficient. The main and extension PCM modules communicate via ARC-Net.

Distributed I/O and field bus controller		
	Power supply	Power IN 18 to 36 V DC, max 6 A
	Output	Digital relay output (NO) 250 V AC/24 V DC 8 A
	Input	Digital input designed for potential-free contacts. Open/Close 5 V/7.5 mA
	Interface	**3 x CAN**: Independent CAN bus lines 125/250 kbps **1 x RS-422/485 port**: 9,600 – 57,600 Baud **1 x ARCNET port either electrical or optical connection:** 4,800 – 57,600 Baud **1 x display port (TTL)**: 4,800 – 57,600 baud
	Service	USB service interface 256,000 Baud
	Storage	2 MB RAM 32 Kb non-volatile RAM 1 MB FLASH
	Size	8TE (40.64 mm)

1.3.5 IOM 4·2 module specifications

IOM 4·2 is a highly flexible IO module which holds the most commonly used IO signals. IOM 4·2 is designed for rough environment and all inputs and outputs are protected by optical insulation from other potentials.

40 channel multi-function I/O module with analogue inputs, temperature inputs, digital inputs, frequency counter inputs, analogue outputs and digital outputs			
	12 digital inputs	Input	9 to 36 V DC or -9 to -36 V DC with reference to common.
		Impedance	App. 2.4 kΩ
		Insulation	Optically insulated from other potentials 550 V AC
	4 frequency/digital inputs	Input	9 to 36 V DC
		Impedance	App. 2.4 kΩ
		Insulation	Each input is optically insulated from other potentials with 550 V AC
		Frequency	0 to 20 kHz. (Internal frequency divider for frequency >1 kHz)
		Duty cycle	>40 % at 1 to 20 kHz; >20 % at 500 Hz
		Resolution	0.8 µsec. (1.25 MHz sampling rate.)
	10 digital outputs	Supply	External supply 9 to 36 V ~~DC~~.
		Voltage	Voltage drop <1 V according to external supply
		Current	0 to 200 mA source or sink for each output
		Insulation	Optically insulated from other potentials 550 V AC
		Protection	Current limited for short-circuit protection or thermal overload. In case of a short circuit or a thermal overload of the output stages, a signal is gene rated to the PCM main controller, so the application can take a controlled action.

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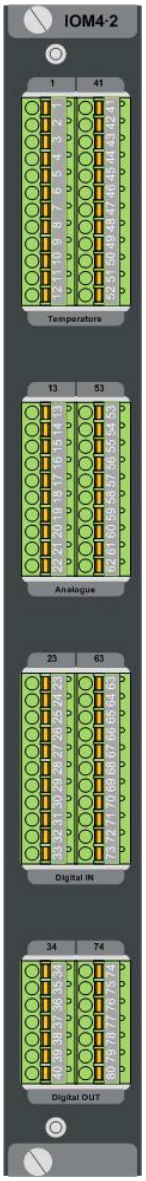
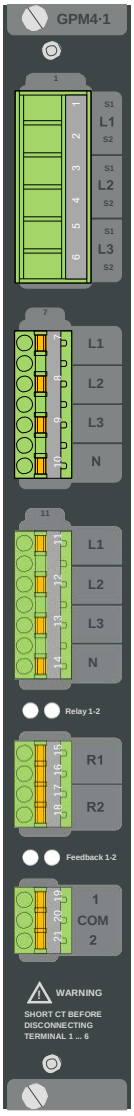
40 channel multi-function I/O module with analogue inputs, temperature inputs, digital inputs, frequency counter inputs, analogue outputs and digital outputs



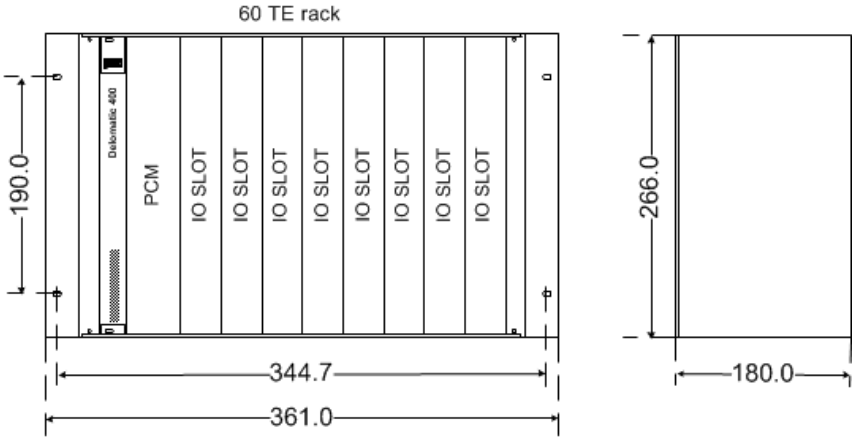
6 temperature inputs	Sensor type	Pt100, Pt1000 or NiCr-Ni thermocouple sensor
	Range	-50 to 200 °C for Pt sensors; -50 to 1000 °C for NiCr-Ni sensors
	Wire	2-, 3- or 4-wire connection for Pt sensors
	Cable error	Open input and short circuit is detected. (Only open for NiCr-Ni sensors)
	Resolution	0.1 °K
	Accuracy (4-wire)	0.5 °K at reference temperature. 2.0 °K at operational temperature.
	Accuracy (2- or 3-wire)	1.0 °K at reference temperature. 2.5 °K at operational temperature (2-wire only when cables are shorter than 1 m).
	Accuracy (NiCr-Ni sensor)	5.0 °K at reference temperature. 20.0 °K at operational temperature.
	Insulation	Same potential as analogue inputs and analogue outputs. Optically insulated from other potentials 550 V AC.
4 analogue inputs	Input type	-20 mA to 20 mA or -10 V to 10 V
	Impedance	App. 50 Ω (mA-input)/10 kΩ (V-input)
	Resolution	16 bit
	Accuracy	0.5 % of full range input (40 mA/20 V) at reference temperature. 1.0 % of full range input (40 mA/20 V) at operational temperature.
	Insulation	Same potential as analogue outputs and temperature inputs. Optically insulated from other potentials 550 V AC
4 analogue outputs	Output	-20 mA to 20 mA
	Load	0 to 500 Ω
	Resolution	12 bit
	Accuracy	0.5 % of full range output (40 mA) at reference temperature. 1.0 % of full range output (40 mA) at operational temperature.
	Insulation	Same potential as analogue inputs and temperature inputs. Optically insulated from other potentials 550 V AC.
	Size	6TE (30.48 mm)

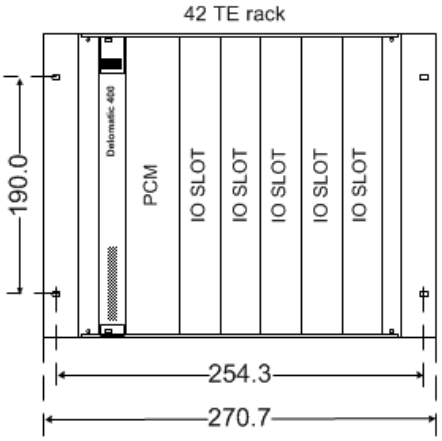
1.3.6 SCM 4·1 module specifications

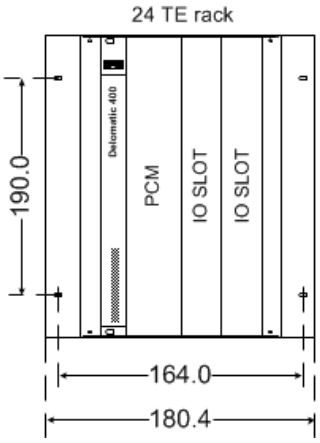
The SCM 4·1 module is a class 0.5 AC measurement and protection module which can be fully configured from the main application. All measurements are available for the main application each period. Two relay outputs are controlled, one is a sync check relay, the other a trip relay controlled by the protection functions to secure a fast and reliable disconnection of a generator in case of electrical failures.

3-phase grid and generator voltage and current measurement (Class 0.5) with configurable grid protection features like vector jump (Δφ) detection		
	Inputs	**2 x direct three-phase voltage inputs (L1, L2, L3, N)** 40 to 70 Hz Max 690 Vrms direct. Other range by use of voltage transformer ../100 or ../110 V AC. Load max 0.5 mA or 0.3 VA per phase. Overload: <130 % of Un continuously <200 % of Un for 10 s. External fuse max 2 A slow-blow **1 x three-phase current input (L1, L2, L3)** 40 to 70 Hz current transformer secondary 1 Arms or 5 Arms. Load max 0.4 VA per phase. Overload: 20 Arms continuously, <75 A for 10 s, <300 A for 1 s
	Outputs	**2 x digital relay outputs (normally open (NO) for sync check, normally closed (NC) for protections)** 230 V AC, max. 8 A
	Certification class	0.5 measurement of voltage, frequency, current, power, reactive power, phase angle Configurable grid protection functions
	Harmonics	Up to 500 Hz measured
	Galvanic separation	3.25 kV isolation between voltage measurement inputs individually and between voltage measurement inputs and all other potentials. 2.2 kV isolation between relay outputs and all other potentials 550 V isolation between digital inputs (feedback supervision) and all other potentials
	Safety	To EN 61010-1 over-voltage category III, 690 V AC, pollution degree 2
	Accuracy	Acc. to IEC 60688 0.5 % at reference temperatures 1.0 % at operational temperatures
	Size	6TE (30.48 mm)

2. Base mounting racks







3. General information

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