MVR-T257

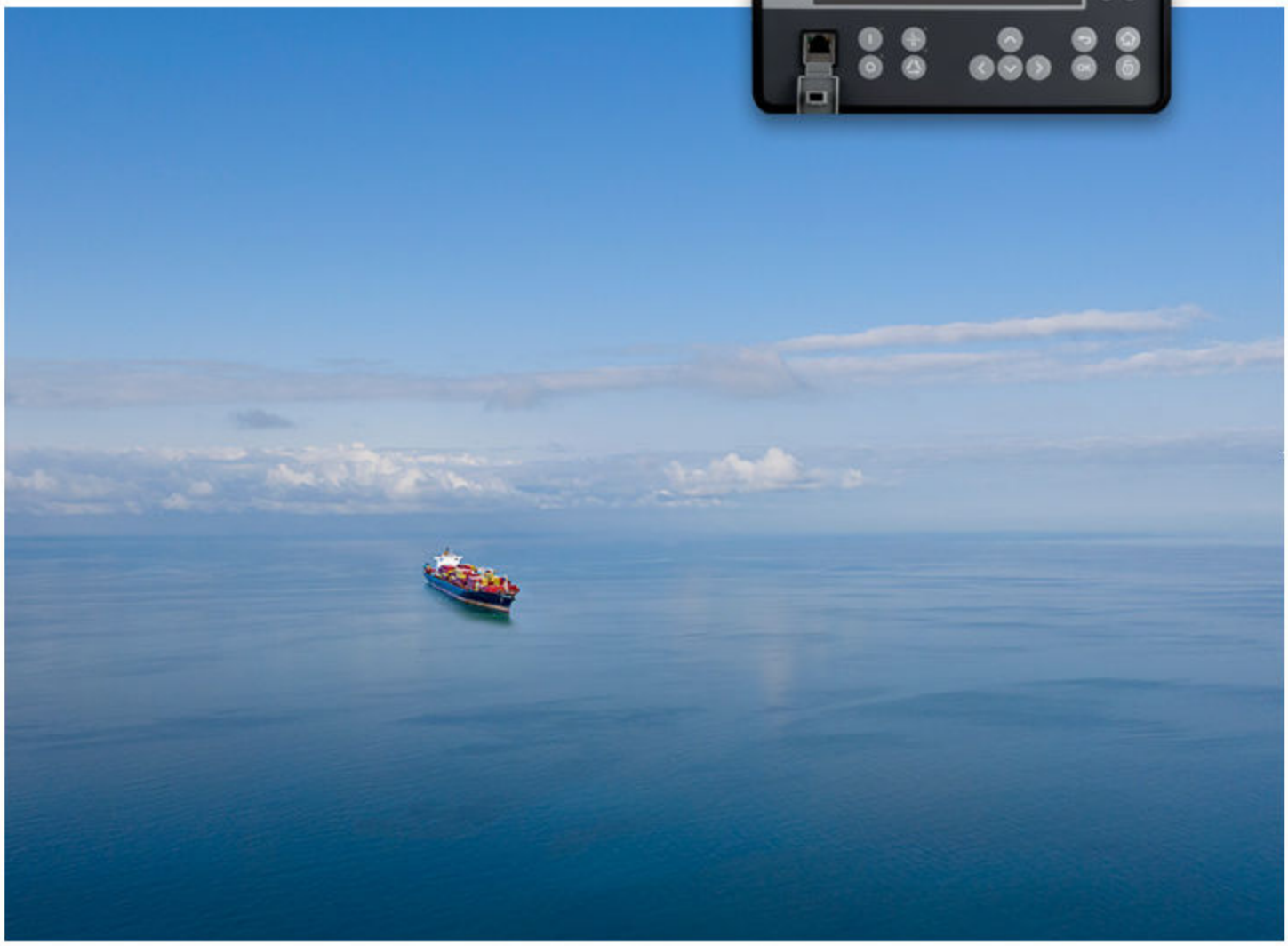
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Transformer protection

Data sheet

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1. Product description

1.1 About

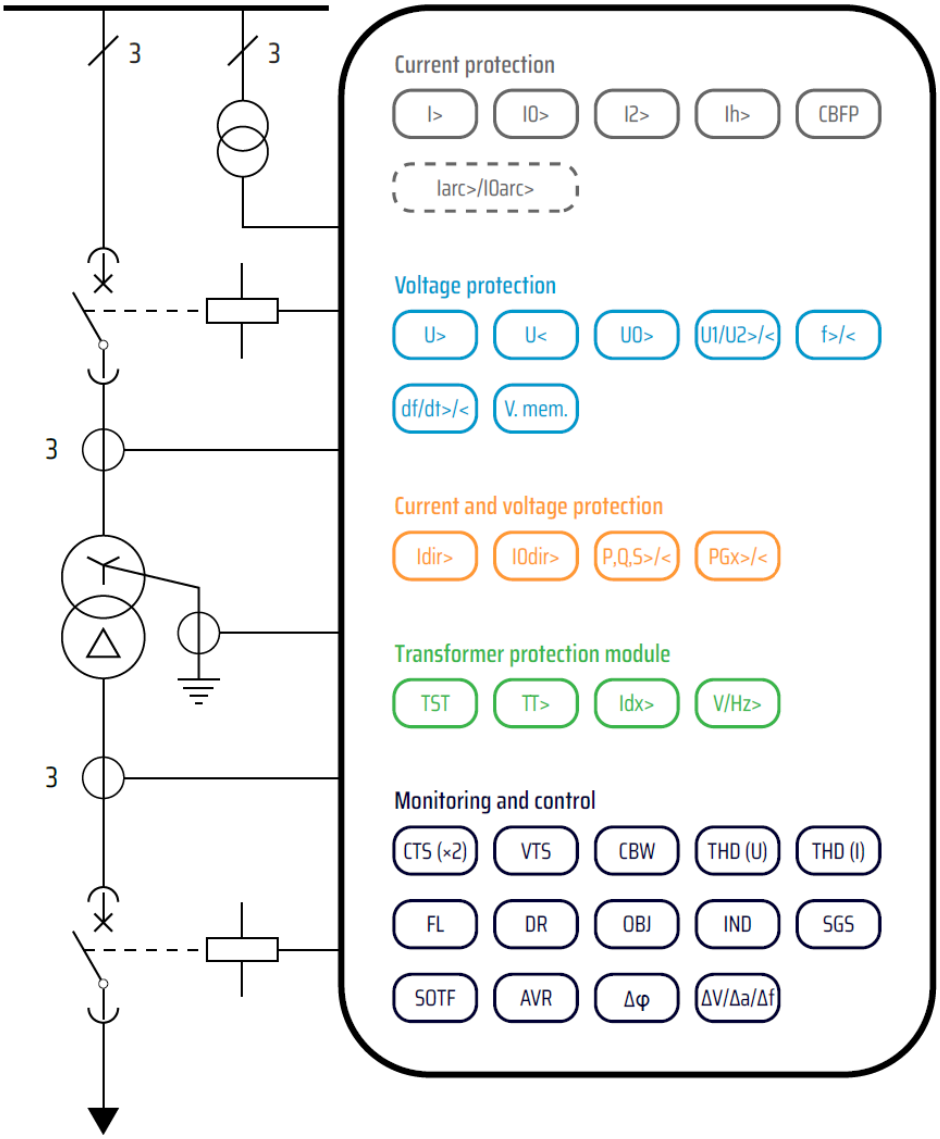
The MVR-T257 is a transformer protection device with a differential protection function and an integrated automatic voltage regulator function. The relay also provides complete current-based and voltage-based protection functions as well as full measurements. You can add up to total 9 option modules (I/O and other type of modules) into the device for extensive monitoring and control applications. MVR-T257 communicates using various protocols, including the IEC 61850.

1.2 Applications

A wiring example and key ANSI functions are shown below.

More information
See the **Protections** chapter for a full list of the protections.

Transformer protection wiring (T257)



1.3 Features

	Functions
Full product range, high performance, good usability	• Full protection for transformers • Bay control, alarm, measurement and monitoring • Large customisable HMI with configurable Mimic diagram • Freely configurable alarm LEDs and function buttons • Large flash memory for events, logs, recordings and documentation ◦ 15,000 events and 100 disturbance recordings • Easy-to-use and powerful MVR Utility Software for setting, configuration and analysing • Full set of communication protocols, including IEC 61850
Versatile protection design	• Fast, versatile and dependable protection functions over a wide frequency range (6 to 75 Hz) • Suitable for the most demanding protection applications
Modularity	• Fully modular hardware construction • Plug in more I/O or communication cards to meet the application requirements

Usability	• Sophisticated setting aids
	• Highly customisable HMI
	• Storage of PDF or other supportive documents
	• Extensive user log information
	  ◦ Setting changes
	  ◦ Other operational history

Performance	• Sub-cycle instantaneous trip times • Logics editor for ladder logic functionality • Logical device mode, and logical node mode • Up to 100 disturbance records, of up to 10 seconds each • 10,000 events stored in non-volatile memory
Savings in engineering time	• MVR Utility Software free-of-charge software suite with an intuitive and easy-to-use human-machine interface • Download all relay settings instantly using native 100 Mb/s Ethernet connection (front port or rear port)
Standardised hardware	• Standardised hardware design, for simpler logistics and stock management • Five CT inputs with configurable secondary currents • Configurable digital input voltage thresholds
Communication	• Native Ethernet communication • A variety of standard protocols including the IEC 61850 substation communication standard with fast GOOSE messaging • Modbus Gateway
IEC 61850 & IEEE 1588	• High-availability Seamless Redundancy (HSR) support • Parallel Redundancy Protocol (PRP) support • Precision Time Protocol (PTP) according to IEEE 1588

2. Protections

2.1 Current protections

2.1.1 Non-directional overcurrent protection (I>; 50/51)

Table 2.1 Technical data for the non-directional overcurrent function

Measurement inputs	
Current inputs	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C)
Current input magnitudes	RMS phase currents TRMS phase currents Peak-to-peak phase currents
Pick-up	
Pick-up current setting	0.10...50.00 × I_n, setting step 0.01 × I_n
Inrush 2nd harmonic blocking	0.10...50.00 %I_{fund}, setting step 0.01 %I_{fund}
Inaccuracy: - Current - 2nd harmonic blocking	 ±0.5 %I_{set} or ±15 mA (0.10...4.0 × I_{set}) ±1.0 %-unit of the 2nd harmonic setting
Operation time	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time: I_m/I_{set} ratio > 3 - Definite time: I_m/I_{set} ratio = 1.05...3	 ±1.0 % or ±20 ms ±1.0 % or ±30 ms
IDMT setting parameters: - k Time dial setting for IDMT - A IDMT constant - B IDMT constant - C IDMT constant	 0.01...25.00, step 0.01 0...250.0000, step 0.0001 0...5.0000, step 0.0001 0...250.0000, step 0.0001
Inaccuracy: - IDMT operating time - IDMT minimum operating time	 ±1.5 % or ±20 ms ±20 ms
Retardation time (overshoot)	<30 ms
Instant operation time	
Start time and instant operation time (trip): - I_m/I_{set} ratio > 3 - I_m/I_{set} ratio = 1.05...3	 <35 ms (typically 25 ms) <50 ms
Start time and instant operation time (trip): - I_m/I_{set} ratio = 2 - I_m/I_{set} ratio = 5 - I_m/I_{set} ratio = 10	 Typically 25 ms Typically 16 ms Typically 12 ms
Reset	
Reset ratio	97 % of the pick-up current setting
Reset time setting Inaccuracy: Reset time	0.010...10.000 s, step 0.005 s ±1.0 % or ±50 ms
Instant reset time and start-up reset	<50 ms

NOTE The release delay does **not** apply to phase-specific tripping!

2.1.2 Non-directional earth fault protection (I0>; 50N/51N)

Table 2.2 Technical data for the non-directional earth fault function

Measurement inputs	
Current input (selectable)	Residual current channel I_{01} (Coarse) Residual current channel I_{02} (Fine) Calculated residual current: I_{L1} (A), I_{L2} (B), I_{L3} (C)
Current input magnitudes	RMS residual current (I_{01}, I_{02} or calculated I_0) TRMS residual current (I_{01} or I_{02}) Peak-to-peak residual current (I_{01} or I_{02})
Pick-up	
Used magnitude	Measured residual current I01 (1 A) Measured residual current I02 (0.2 A) Calculated residual current I0Calc (5 A)
Pick-up current setting	0.0001...40.00 × I_n, setting step 0.0001 × I_n
Inaccuracy: - Starting I01 (1 A) - Starting I02 (0.2 A) - Starting I0Calc (5 A)	 ±0.5 %$I0_{set}$ or ±3 mA (0.005...10.0 × I_{set}) ±1.5 %$I0_{set}$ or ±1.0 mA (0.005...25.0 × I_{set}) ±1.0 %$I0_{set}$ or ±15 mA (0.005...4.0 × I_{set})
Operating time	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time: I_m/I_{set} ratio > 3 - Definite time: I_m/I_{set} ratio = 1.05...3	 ±1.0 % or ±20 ms ±1.0 % or ±30 ms
IDMT setting parameters: - k Time dial setting for IDMT - A IDMT constant - B IDMT constant - C IDMT constant	 0.01...25.00, step 0.01 0...250.0000, step 0.0001 0...5.0000, step 0.0001 0...250.0000, step 0.0001
Inaccuracy: - IDMT operating time - IDMT minimum operating time	 ±1.5 % or ±20 ms ±20 ms
Retardation time (overshoot)	<30 ms
Instant operation time	
Start time and instant operation time (trip): - I_m/I_{set} ratio > 3.5 - I_m/I_{set} ratio = 1.05...3.5	 <50 ms (typically 35 ms) <55 ms
Reset	
Reset ratio	97 % of the pick-up current setting
Reset time setting Inaccuracy: Reset time	0.010...10.000 s, step 0.005 s ±1.0 % or ±50 ms
Instant reset time and start-up reset	<50 ms

NOTE The operation and reset time accuracy does **not** apply when the measured secondary current in I02 is 1...20 mA. The pick-up is tuned to be more sensitive and the operation times vary because of this.

2.1.3 Directional overcurrent protection (Idir>; 67)

Table 2.3 Technical data for the directional overcurrent function

Input signals	
Current inputs	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C)
Current input magnitudes	RMS phase currents TRMS phase currents Peak-to-peak phase currents
Current input calculations	Positive sequence current angle
Voltage inputs	U_{L1}, U_{L2}, U_{L3} U_{L12}, U_{L23}, U_{L31} + U0
Voltage input calculations	Positive sequence voltage angle
Pick-up	
Characteristic direction	Directional, non-directional
Operating sector center	-180.0...180.0 deg, setting step 0.1 deg
Operating sector size (+/-)	1.00...170.00 deg, setting step 0.10 deg
Pick-up current setting	0.10...40.00 × I_n, setting step 0.01 × I_n
Inaccuracy: - Current - U1/I1 angle (U > 15 V) - U1/I1 angle (U = 1...15 V)	 ±0.5 %I_{set} or ±15 mA (0.10...4.0 × I_{set}) ±0.20° ±1.5°
Operation time	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time: I_m/I_{set} ratio > 3 - Definite time: I_m/I_{set} ratio = 1.05...3	 ±1.0 % or ±20 ms ±1.0 % or ±35 ms
IDMT setting parameters: - k Time dial setting for IDMT - A IDMT constant - B IDMT constant - C IDMT constant	 0.01...25.00, step 0.01 0...250.0000, step 0.0001 0...5.0000, step 0.0001 0...250.0000, step 0.0001
Inaccuracy: - IDMT operating time - IDMT minimum operating time	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): - I_m/I_{set} ratio > 3 - I_m/I_{set} ratio = 1.05...3	 <40 ms (typically 30 ms) <50 ms
Reset	
Reset ratio: - Current - U1/I1 angle	 97 % of the pick-up current setting 2.0°
Reset time setting Inaccuracy: Reset time	0.010...10.000 s, step 0.005 s ±1.0 % or ±50 ms
Instant reset time and start-up reset	<50 ms

NOTE The minimum voltage for direction solving is 1.0 V secondary. During three-phase short-circuits the angle memory is active for 0.5 seconds in case the voltage drops below 1.0 V.

2.1.4 Directional earth fault protection (I0dir>; 67N/32N)

Table 2.4 Technical data for the directional earth fault function

Measurement inputs	
Current input (selectable)	Residual current channel I_{01} (Coarse) Residual current channel I_{02} (Fine) Calculated residual current: I_{L1} (A), I_{L2} (B), I_{L3} (C)
Current input magnitudes	RMS residual current (I_{01}, I_{02} or calculated I_0) TRMS residual current (I_{01} or I_{02}) Peak-to-peak residual current (I_{01} or I_{02})
Voltage input (selectable)	Residual voltage from U3 or U4 voltage channel Residual voltage calculated from U_{L1}, U_{L2}, U_{L3}
Voltage input magnitudes	RMS residual voltage U_0 Calculated RMS residual voltage U_0
Pick-up	
Characteristic direction	Unearthed (Varmetric 90°) Petersen coil GND (Wattmetric 180°) *Earthed* (Adjustable sector)
When the *earthed* mode is active: - Tripping area center - Tripping area size (+/-)	 0.00...360.00 deg, setting step 0.10 deg 45.00...135.00 deg, setting step 0.10 deg
Pick-up current setting Pick-up voltage setting	0.005...40.00 × I_n, setting step 0.001 × I_n 1.00...75.00 %$U0_n$, setting step 0.01 %$U0_n$
Inaccuracy: - Starting I01 (1 A) - Starting I02 (0.2 A) - Starting I0Calc (5 A) - Voltage U0 and U0Calc - U0/I0 angle (U > 15 V) - U0/I0 angle (U = 1...15 V)	 ±0.5 %$I0_{set}$ or ±3 mA (0.005...10.0 × I_{set}) ±1.5 %$I0_{set}$ or ±1.0 mA (0.005...25.0 × I_{set}) ±1.5 %$I0_{set}$ or ±15 mA (0.005...4.0 × I_{set}) ±1.0 %$U0_{set}$ or ±30 mV ±0.2° (I0Calc ±1.0°) ±1.0°
Operation time	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time (I_m/I_{set} ratio 1.05→)	 ±1.0 % or ±45 ms
IDMT setting parameters: - k Time dial setting for IDMT - A IDMT constant - B IDMT constant - C IDMT constant	 0.01...25.00, step 0.01 0...250.0000, step 0.0001 0...5.0000, step 0.0001 0...250.0000, step 0.0001
Inaccuracy: - IDMT operating time - IDMT minimum operating time	 ±1.5 % or ±25 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): - I_m/I_{set} ratio > 3 - I_m/I_{set} ratio = 1.05...3	 <55 ms (typically 45 ms) <65 ms
Reset	

Current and voltage reset U0/I0 angle	97 % of the pick-up current and voltage setting 2.0°
Reset time setting Inaccuracy: Reset time	0.000...150.000 s, step 0.005 s ±1.0 % or ±45 ms
Instant reset time and start-up reset	<50 ms

2.1.5 Negative sequence overcurrent/ phase current reversal/ current unbalance protection (I2>; 46/46R/46L)

Table 2.5 Technical data for the current unbalance function

Measurement inputs	
Current inputs	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C)
Current input calculations	Positive sequence current (I1) Negative sequence current (I2)
Pick-up	
Used magnitude	Negative sequence component I2pu Relative unbalance I2/I1
Pick-up setting	0.01...40.00 × I_n, setting step 0.01 × I_n (I2pu) 1.00...200.00 %, setting step 0.01 % (I2/I1)
Minimum phase current (at least one phase above)	0.01...2.00 × I_n, setting step 0.01 × I_n
Inaccuracy: - Starting I2pu - Starting I2/I1	 ±1.0 %-unit or ±100 mA (0.10...4.0 × I_n) ±1.0 %-unit or ±100 mA (0.10...4.0 × I_n)
Operating time	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time (I_m/I_{set} ratio > 1.05)	 ±1.5 % or ±60 ms
IDMT setting parameters: - k Time dial setting for IDMT - A IDMT Constant - B IDMT Constant - C IDMT Constant	 0.01...25.00, step 0.01 0...250.0000, step 0.0001 0...5.0000, step 0.0001 0...250.0000, step 0.0001
Inaccuracy: - IDMT operating time - IDMT minimum operating time	 ±2.0 % or ±30 ms ±20 ms
Retardation time (overshoot)	<5 ms
Instant operation time	
Start time and instant operation time (trip): - I_m/I_{set} ratio > 1.05	 <70 ms
Reset	
Reset ratio	97 % of the pick-up setting
Reset time setting Inaccuracy: Reset time	0.010...10.000 s, step 0.005 s ±1.5 % or ±60 ms
Instant reset time and start-up reset	<55 ms

2.1.6 Circuit breaker failure protection (CBFP; 50BF/52BF)

Table 2.6 Technical data for the circuit breaker failure protection function

Measurement inputs	
Current inputs	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C) Residual current channel I_{01} (Coarse) Residual current channel I_{02} (Fine)
Current input magnitudes	RMS phase currents RMS residual current (I_{01}, I_{02} or calculated I_0)
Pick-up	
Monitored signals	Digital input status, digital output status, logical signals
Pick-up current setting: - IL1...IL3 - I01, I02, I0Calc	0.10...40.00 × I_N, setting step 0.01 × I_N 0.005...40.00 × I_N, setting step 0.005 × I_N
Inaccuracy: - Starting phase current (5A) - Starting I01 (1 A) - Starting I02 (0.2 A) - Starting I0Calc (5 A)	±0.5 %I_{SET} or ±15 mA (0.10...4.0 × I_{SET}) ±0.5 %$I0_{SET}$ or ±3 mA (0.005...10.0 × I_{SET}) ±1.5 %$I0_{SET}$ or ±1.0 mA (0.005...25.0 × I_{SET}) ±1.0 %$I0_{SET}$ or ±15 mA (0.005...4.0 × I_{SET})
Operation time	
Definite time function operating time setting	0.050...1800.000 s, setting step 0.005 s
Inaccuracy: - Current criteria (I_M/I_{SET} ratio 1.05→) - DO or DI only	±1.0 % or ±55 ms ±15 ms
Reset	
Reset ratio	97 % of the pick-up current setting
Reset time	<50 ms

2.1.7 Harmonic overcurrent protection (Ih>; 50H/51H/68H)

Table 2.7 Technical data for the harmonic overcurrent function

Measurement inputs	
Current inputs	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C) Residual current channel I_{01} (Coarse) Residual current channel I_{02} (Fine)
Pick-up	
Harmonic selection	2^{nd}, 3^{rd}, 4^{th}, 5^{th}, 6^{th} 7^{th}, 9^{th}, 11^{th}, 13^{th}, 15^{th}, 17^{th} or 19^{th}
Used magnitude	Harmonic per unit (× I_N) Harmonic relative (Ih/IL)
Pick-up setting	0.05...2.00 × I_N, setting step 0.01 × I_N (× I_N) 5.00...200.00 %, setting step 0.01 % (Ih/IL)
Inaccuracy: - Starting × I_N - Starting × Ih/IL	<0.03 × I_N (2^{nd}, 3^{rd}, 5^{th}) <0.03 × I_N tolerance to Ih (2^{nd}, 3^{rd}, 5^{th})
Operation time	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy:	

- Definite time (I_M/I_{SET} ratio >1.05)	±1.0 % or ±35 ms
IDMT setting parameters: k Time dial setting for IDMT A IDMT constant B IDMT constant C IDMT constant	 0.01...25.00, step 0.01 0...250.0000, step 0.0001 0...5.0000, step 0.0001 0...250.0000, step 0.0001
Inaccuracy: - IDMT operating time - IDMT minimum operating time	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): I_M/I_{SET} ratio >1.05	 <50 ms
Reset	
Reset ratio	95 % of the pick-up setting
Reset time setting Inaccuracy: Reset time	0.010...10.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

NOTE Harmonics generally: The amplitude of the harmonic content **must** be least 0.02 × I_N when the relative mode (Ih/IL) is used!

Blocking: To achieve fast activation for blocking purposes with the harmonic overcurrent stage, note that the harmonic stage may be activated by a rapid load change or fault situation. An intentional activation lasts for approximately 20 ms if a harmonic component is not present. The harmonic stage stays active if the harmonic content is above the pick-up limit.

Tripping: When using the harmonic overcurrent stage for tripping, please ensure that the operation time is set to 20 ms (DT) or longer to avoid nuisance tripping caused by the above-mentioned reasons.

2.1.8 Arc fault protection (IArc>/I0Arc>; 50Arc/50NArc) (optional)

NOTE Not approved for marine.

Table 2.8 Technical data for the arc fault protection function.

Measurement inputs	
Current inputs	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C) Residual current channel I_{01} (Coarse) Residual current channel I_{02} (Fine)
Current input magnitudes	Sample-based phase current measurement Sample-based residual current measurement
Arc point sensor inputs	Channels S1, S2, S3, S4 (pressure and light sensor, or light-only sensor) Up to three (3) sensors* per channel
System frequency operating range	6.00...75.00 Hz
Pick-up	
Pick-up current setting (phase current) Pick-up current setting (residual current) Pick-up light intensity	0.50...40.00 × I_N, setting step 0.01 × I_N 0.10...40.00 × I_N, setting step 0.01 × I_N 8, 25 or 50 kLx (the sensor is selected in the order code)
Starting inaccuracy (IArc> and I0Arc>)	±3 % of the set pick-up value > 0.5 × I_N setting. 5 mA < 0.5 × I_N setting.
Point sensor detection radius	180 degrees

Operation time	
Light only: - Semiconductor outputs HSO1 and HSO2 - Regular relay outputs	 Typically 7 ms (3...12 ms) Typically 10 ms (6.5...15 ms)
Light + current criteria (zone 1...4): - Semiconductor outputs HSO1 and HSO2 - Regular relay outputs	 Typically 10 ms (6.5...14 ms) Typically 14 ms (10...18 ms)
Arc BI only: - Semiconductor outputs HSO1 and HSO2 - Regular relay outputs	 Typically 7 ms (2...12 ms) Typically 10 ms (6.5...15 ms)

More information
* See the **Option D: Arc protection Description of options** for the specifications of these sensors.

2.2 Voltage protections

2.2.1 Undervoltage protection (U<; 27)

Table 2.9 Technical data for the undervoltage function

Measurement inputs	
Voltage inputs	U_{L1}, U_{L2}, U_{L3} U_{L12}, U_{L23}, U_{L31} (+ U_0)
Voltage input magnitudes	RMS line-to-line or line-to-neutral voltages
Pick-up	
Pick-up terms	1 voltage 2 voltages 3 voltages
Pick-up setting	0.00...120.00 %U_N, setting step 0.01 %U_N
Inaccuracy: - Voltage	 ±1.5 %U_{SET} or ±30 mV
Low voltage block	
Pick-up setting	0.00...80.00 %U_N, setting step 0.01 %U_N
Inaccuracy: - Voltage	 ±1.5 %U_{SET} or ±30 mV
Operation time	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time (U_M/U_{SET} ratio 1.05→)	 ±1.0 % or ±35 ms
IDMT setting parameters: k Time dial setting for IDMT A IDMT constant B IDMT constant C IDMT constant	 0.01...25.00, step 0.01 0...250.0000, step 0.0001 0...5.0000, step 0.0001 0...250.0000, step 0.0001
Inaccuracy: - IDMT operating time - IDMT minimum operating time	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	

Start time and instant operation time (trip): - U_M/U_{SET} ratio 1.05→	<65 ms
Retardation time (overshoot)	<30 ms
Reset	
Reset ratio	103 % of the pick-up voltage setting
Reset time setting Inaccuracy: Reset time	0.010...10.000 s, step 0.005 s ±1.0 % or ±45 ms
Instant reset time and start-up reset	<50 ms

NOTE The low-voltage block is not in use when its pick-up setting is set to 0 %. The undervoltage function trip signal is active when the LV block is disabled and the device has no voltage injection.

NOTE After the low voltage blocking condition, the undervoltage stage does not trip unless the voltage exceeds the pick-up setting first.

2.2.2 Overvoltage protection (U>; 59)

Table 2.10 Technical data for the overvoltage function

Measurement inputs	
Voltage inputs	U_{L1}, U_{L2}, U_{L3} U_{L12}, U_{L23}, U_{L31} (+ U_0)
Voltage input magnitudes	RMS line-to-line or line-to-neutral voltages
Pick-up	
Pick-up terms	1 voltage 2 voltages 3 voltages
Pick-up setting	50.00...150.00 %U_N, setting step 0.01 %U_N
Inaccuracy: - Voltage	±1.5 %U_{SET}
Operating time	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time (U_M/U_{SET} ratio 1.05→)	±1.0 % or ±35 ms
IDMT setting parameters: k Time dial setting for IDMT A IDMT constant B IDMT constant C IDMT constant	 0.01...25.00, step 0.01 0...250.0000, step 0.0001 0...5.0000, step 0.0001 0...250.0000, step 0.0001
Inaccuracy: - IDMT operating time - IDMT minimum operating time	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): - U_M/U_{SET} ratio 1.05→	<50 ms
Reset	
Reset ratio	97 % of the pick-up voltage setting
Reset time setting	0.010...10.000 s, step 0.005 s

Inaccuracy: Reset time	±1.0 % or ±45 ms
Instant reset time and start-up reset	<50 ms

2.2.3 Neutral overvoltage protection (U0>; 59N)

Table 2.11 Technical data for the neutral overvoltage function

Measurement inputs	
Voltage input (selectable)	Residual voltage from U3 or U4 voltage channel Residual voltage calculated from U_{L1}, U_{L2}, U_{L3}
Voltage input magnitudes	RMS residual voltage U_0 Calculated RMS residual voltage U_0
Pick-up	
Pick-up voltage setting	1.00...50.00 % $U0_N$, setting step 0.01 × I_N
Inaccuracy: - Voltage U0 - Voltage U0Calc	 ±1.5 %$U0_{SET}$ or ±30 mV ±150 mV
Operation time	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time ($U0_M/U0_{SET}$ ratio 1.05→)	 ±1.0 % or ±45 ms
IDMT setting parameters: k Time dial setting for IDMT A IDMT constant B IDMT constant C IDMT constant	 0.01...25.00, step 0.01 0...250.0000, step 0.0001 0...5.0000, step 0.0001 0...250.0000, step 0.0001
Inaccuracy: - IDMT operating time - IDMT minimum operating time	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): - $U0_M/U0_{SET}$ ratio 1.05→	 <50 ms
Reset	
Reset ratio	97 % of the pick-up voltage setting
Reset time setting Inaccuracy: Reset time	0.000 ... 150.000 s, step 0.005 s ±1.0 % or ±50 ms
Instant reset time and start-up reset	<50 ms

2.2.4 Sequence voltage protection (U1/U2>/<; 47/27P/59NP)

Table 2.12 Technical data for the sequence voltage function

Measurement inputs	
Voltage inputs	U_{L1}, U_{L2}, U_{L3} U_{L12}, U_{L23}, U_{L31} (+ U_0)
Voltage input calculations	Positive sequence voltage (I1) Negative sequence voltage (I2)
Pick-up	

Pick-up setting	5.00...150.00 %U_N, setting step 0.01 %U_N
Inaccuracy: - Voltage	±1.5 %U_{SET} or ±30 mV
Low voltage block	
Pick-up setting	1.00...80.00 %U_N, setting step 0.01 %U_N
Inaccuracy: -Voltage	±1.5 %U_{SET} or ±30 mV
Operation time	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy -Definite Time (U_M/U_{SET} ratio 1.05→)	±1.0 % or ±35 ms
IDMT setting parameters: k Time dial setting for IDMT A IDMT constant B IDMT constant C IDMT constant	 0.01...25.00, step 0.01 0...250.0000, step 0.0001 0...5.0000, step 0.0001 0...250.0000, step 0.0001
Inaccuracy: - IDMT operating time - IDMT minimum operating time	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): - U_M/U_{SET} ratio <0.95/1.05→	<65 ms
Reset	
Reset ratio	97 or 103 % of the pick-up voltage setting
Reset time setting Inaccuracy: Reset time	0.010...10.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

2.2.5 Vector jump (Δφ; 78)

Table 2.13 Technical data for the vector jump protection function

Measurement inputs	
Voltage inputs	U_{L1}, U_{L2}, U_{L3} U_{L12}, U_{L23}, U_{L31} + U_0
Monitored voltages	Any or all system line-to-line voltage(s) Any or all system line-to-neutral voltage(s) Specifically chosen line-to-line or line-to-neutral voltage U4 channel voltage
Pick-up	
Pick-up setting	0.05...30.00°, setting step 0.01°
Inaccuracy: - Voltage angle	±30% overreach or 1.00 °
Low-voltage blocking	
Pick-up setting	0.01...100.00 %U_N, setting step 0.01 %U_N
Inaccuracy: - Voltage	±1.5 %U_{SET} or ±30 mV

Instant operation time	
Alarm and trip operation time: - (Im/Iset ratio > ±30% overreach or 1.00 °)	<40 ms (typically 30 ms) 50/60 Hz <50 ms (typically 40 ms) 16.67 Hz
Reset	
Trip pulse	~5-10ms

2.3 Frequency protections

2.3.1 Overfrequency and underfrequency protection (f>/<; 81O/81U)

Table 2.14 Technical data for the overfrequency and underfrequency function

Input signals	
Sampling mode	Fixed Tracking
Frequency reference 1 Frequency reference 2 Frequency reference 3	CT1IL1, CT2IL1, VT1U1, VT2U1 CT1IL2, CT2IL2, VT1U2, VT2U2 CT1IL3, CT2IL3, VT1U3, VT2U3
Pick-up	
f> pick-up setting f< pick-up setting	10.00...70.00 Hz, setting step 0.01 Hz 7.00...65.00 Hz, setting step 0.01 Hz
Inaccuracy (sampling mode): - Fixed - Tracking	±20 mHz (50/60 Hz fixed frequency) ±20 mHz (U > 30 V secondary) ±20 mHz (I > 30 % of rated secondary)
Operation time	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time (I_M/I_{SET} ratio +/- 50 mHz)	±1.5 % or ±50 ms (max. step size: 100 mHz)
Instant operation time	
Start time and instant operation time (trip): - I_M/I_{SET} ratio +/- 50 mHz (Fixed) - I_M/I_{SET} ratio +/- 50 mHz (Tracking)	<70 ms (max. step size: 100 mHz) <3 cycles or <60 ms (max. step size: 100 mHz)
Reset	
Reset ratio	0.020 Hz
Instant reset time and start-up reset: - I_M/I_{SET} ratio +/- 50 mHz (Fixed) - I_M/I_{SET} ratio +/- 50 mHz (Tracking)	<110 ms (max. step size: 100 mHz) <3 cycles or <70 ms (max. step size: 100 mHz)

NOTE The secondary voltage must exceed 2 volts or the current must exceed 0.25 amperes (peak-to peak) in order for the function to measure frequency.

NOTE The frequency is measured two seconds after a signal is received.

2.3.2 Rate-of-change of frequency protection (df/dt>/<; 81R)

Table 2.15 Technical data for the rate-of-change of frequency function

Input signals	
Sampling mode	Fixed Tracking
Frequency reference 1 Frequency reference 2 Frequency reference 3	CT1IL1, CT2IL1, VT1U1, VT2U1 CT1IL2, CT2IL2, VT1U2, VT2U2 CT1IL3, CT2IL3, VT1U3, VT2U3
Pick-up	
df/dt >/< pick-up setting	0.15...1.00 Hz/s, setting step 0.01 Hz
f> limit	10.00...70.00 Hz, setting step 0.01 Hz
f< limit	7.00...65.00 Hz, setting step 0.01 Hz
Pick-up inaccuracy	
- df/dt	±5.0 %I_{SET} or ±20 mHz/s
- frequency	±15 mHz (U > 30 V secondary) ±20 mHz (I > 30 % of rated secondary)
Operation time	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time (I_M/I_{SET} ratio +/- 50 mHz)	±1.5 % or ±110 ms (max. step size: 100 mHz)
Start time and instant operation time (trip):	
- f_M/f_{SET} ratio +/- 20 mHz (overreach)	<200 ms
- f_M/f_{SET} ratio +/- 200 mHz (overreach)	<90 ms
Reset	
f< and f> frequency limit	±0.020 Hz
df/dt	±10.0 % of pick-up or 50 mHz/s
Instant reset time and start-up reset: - f_M/f_{SET} ratio +/- 50 mHz	<325 ms (max. step size: 100 mHz)

NOTE Frequency is measured two seconds after a signal is received.

2.4 Power protections

2.4.1 Power protection (P, Q, S>/<; 32)

Table 2.16 Technical data for the power protection function

Measurement inputs	
Current inputs	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C)
Voltage inputs	U_{L1}, U_{L2}, U_{L3} U_{L12}, U_{L23}, U_{L31} (+ U_0)
Calculated measurements	Three-phase active, reactive or apparent power (P, Q or S) value based on the chosen or set nominal amplitude.
Pick-up	
Comparator selection	> or <

> or <	-500.000...500.000 %/MVA_N, setting step 0.005 %/MVA_N
Inaccuracy: - Active, reactive, or apparent power	Typically <1.0 %P_{SET}
Operation time	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time (P_M/P_{SET} ratio 1.05→)	±1.0 % or ±35 ms
Instant operation time	
Start time and instant operation time (trip): - PQS_M/PQS_{SET} ratio 1.05→	<40 ms
Reset	
Reset ratio	97 or 103 %P_{SET}
Instant reset time and start-up reset	<40 ms

2.5 Transformer protections

2.5.1 Transformer thermal overload protection (TT>; 49T)

Table 2.17 Technical data for the transformer thermal overload protection function

Measurement inputs	
Current inputs	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C)
Current input magnitudes	TRMS phase currents (up to the 31st harmonic)
Setting specifications	
Time constants τ	1 heating, 1 cooling
Time constant value	0.0...500.00 min, step 0.1 min
Service factor (maximum overloading)	0.01...5.00 × I_N, step 0.01 × I_N
Thermal model biasing	- Ambient temperature (Set –60.0...500.0 deg, step 0.1 deg) - Negative sequence current
Thermal replica temperature estimates	Selectable between ºC and ºF
Outputs	
- Alarm 1 - Alarm 2 - Thermal trip - Trip delay - Restart inhibit	0...150 %, step 1 % 0...150 %, step 1 % 0...150 %, step 1 % 0.000...3600.000 s, step 0.005 s 0...150 %, step 1 %
Inaccuracy	
- Starting - Operating time	±0.5 % of the set pick-up value ±5 % or ± 500 ms

2.5.2 Generator/transformer differential protection (Idb>/Idi>/I0dHV>/I0dLV>; 87T/87N/87G)

Table 2.18 Technical data for the transformer differential protection function

Measurement inputs	
Current inputs (CT1 and CT2 current measurement module)	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C) Residual current channel I_{01} (Coarse) Residual current channel I_{02} (Fine) Calculated residual current: I_{L1} (A), I_{L2} (B), I_{L3} (C)
Current input magnitudes	The phase currents of the high-voltage and the low-voltage sides. Residual current measurement for HV/LV REF protection. Phase currents 2nd and 5th harmonic measurement.
Characteristics (differential and REF)	
Differential calculation mode Bias calculation mode	Add or subtract (CT direction) Average or maximum (sensitivity)
Idb> pick-up Turnpoint 1 Slope 1 Turnpoint 2 Slope 2	0.01...100.00 %, step 0.01 %, default 10.00 % 0.01...50.00 × I_N, step 0.01× I_N, default 1.00 × I_N 0.01...250.00 %, step 0.01 %, default 10.00 % 0.01...50.00 × I_N, step 0.01 × I_N, default 3.00 × I_N 0.01...250.00 % by step 0.01 %, default 200.00 %
Idi> pick-up	200.00...1500.00 %, step 0.01 %, default 600.00 %
Internal harmonic blocking selection	None, 2nd harmonic, 5th harmonic, both 2nd and 5th harmonic.
2nd harmonic blocking pick-up	0.01...50.00 %, step 0.01 %, default 15.00 %
5th harmonic blocking pick-up	0.01...50.00 %, step 0.01 %, default 35.00 %
Inaccuracy: - Differential current - 2nd harmonic	 ±3.0 %ISET or ±75 mA (0.10...4.0 x ISET) ±1.5 %I_{SIDE1}
Instant operation time	
Instant operation time >1.05 × I_{SET}	<40 ms (Harmonic blocking active)
Instant operation time >3.00 × I_{SET}	<30 ms (Harmonic blocking active)
Instant operation time >3.00 × I_{SET}	~15 ms (No harmonic blocking)
Reset	
Reset ratio: differential current	97 % of the differential current setting (typically)
Reset time	<50 ms

NOTE The harmonic current is set and calculated according to the highest amplitude of side 1, 2 or 3 currents (Ih%/$I_{SIDE1/2/3}$). The harmonic current is calculated individually for each phase.

2.5.3 Transformer status monitoring

Table 2.19 Technical data for the transformer status monitoring function

Features	
Control scale	Common transformer data settings for all functions in the transformer module, the protection logic, the HMI and the I/O.
Settings	Transformer application nominal data
Other features	Status hours counters (normal load, overload, high overload) Transformer status signals Transformer data for functions

Outputs	
Light/no load	$I_M < 0.2 \times I_N$
Inrush HV side detected	$I_M < 0.2 \times I_N \rightarrow I_M > 1.3 \times I_N$
Inrush LV side detected	$I_M < 0.2 \times I_N \rightarrow I_M > 1.3 \times I_N$
Load normal	$I_M > 0.2 \times I_N$... $I_M < 1.0 \times I_N$
Overloading	$I_M > 1.0 \times I_N$... $I_M < 1.3 \times I_N$
High overload	$I_M > 1.3 \times I_N$
Inaccuracy	
Current detection	±3 % of the set pick-up value > $0.5 \times I_N$ setting. 5 mA < $0.5 \times I_N$ setting
Detection time	±0.5 % or ±10 ms

2.5.4 Underimpedance protection (Z<; 21U)

Table 2.20 Technical data for the underimpedance function

Measurement inputs	
Current inputs	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C)
Voltage inputs	U_{L1}, U_{L2}, U_{L3} U_{L12}, U_{L23}, U_{L31} + U_0
Calculated impedances	Phase-to-phase impedances Phase-to-ground impedances Positive sequence impedance
Pick-up	
Pick-up setting	0.1...150.0 Ω, setting step 0.1 Ω
Inaccuracy: - Impedance calculation	Typically <1.0 %Z_{SET}
Operation time	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time (Z_M/Z_{SET} ratio <0.95)	±1.0 % or ±25 ms
Instant operation time	
Start time and instant operation time (trip): - Z_M/Z_{SET} ratio <0.95	<45 ms
Reset	
Reset ratio	103 %Z_{SET}
Reset time setting Inaccuracy: Reset time	0.010...150.000 s, step 0.005 s ±1.0 % or ±25 ms
Instant reset time and start-up reset	<45 ms

2.5.5 Volts-per-hertz overexcitation protection (V/Hz>; 24)

Table 2.21 Technical data for the volts-per-hertz overexcitation protection function

Measurement inputs	
Voltage input	U_{L1}, U_{L2}, U_{L3} U_{L12}, U_{L23}, U_{L31}

Voltage input magnitude	Maximum line-to-line voltage
Frequency reference 1 Frequency reference 2 Frequency reference 3	CT1IL1, CT2IL1, VT1U1, VT2U1 CT1IL2, CT2IL2, VT1U2, VT2U2 CT1IL3, CT2IL3, VT1U3, VT2U3
Pick-up	
Pick-up setting	0.01...75.00 %, setting step 0.01 %
Inaccuracy: - V/Hz	±1.0 %
Operation time	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time (VHZ_M/VHZ_{SET} ratio 1.05)	±1.0 % or ±25 ms
Instant operation time	
Start time and instant operation time (trip): - VHZ_M/VHZ_{SET} ratio 1.05)	<40 ms
Reset	
Reset ratio	97 % of the pick-up setting
Reset time setting Inaccuracy: Reset time	0.000...150.000 s, step 0.005 s ±1.0 % or ±25 ms
Instant reset time and start-up reset	<40 ms

2.5.6 Automatic voltage regulator (90)

Table 2.22 Technical data for the automatic voltage regulator function

Measurement inputs	
Voltage inputs	U_{L1}, U_{L2}, U_{L3} U_{L12}, U_{L23}, U_{L31} + U_0 U4 channel voltage
Voltage input magnitudes	RMS line-to-line voltages U4 channel RMS voltage
Current inputs	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C)
Current input magnitudes (I> blocking)	RMS phase currents
Pick-up	
Pick-up area (U>/<, U>>/<<, U>>>/<<<) Tap step effect (1...70 steps) I> blocking	0.10...30.00 %U_N, setting step 0.01 %U_N 0.01...10.00 %U_N, setting step 0.01 %U_N 0.00...40.00 × I_N, setting step 0.01 × I_N
Inaccuracy: - Voltage - Current	±1.5 %U_{SET} ±0.5 %I_{SET} or ±15 mA (0.10...4.0 × I_{SET})
Operating time	
Control pulse min/max and time between Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s 0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time (U_M/U_{SET} ratio 1.05→)	±1.5 % or ±50 ms
Integrated operating time setting: - Multiplier (k)	0.000...1800.00, setting step 0.005

Inaccuracy: - IDMT operating time - IDMT minimum operating time	 ±1.5 % or ±35 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): - U_M/U_{SET} ratio 1.05→	 <50 ms
Reset	
Reset ratio: - Voltage - Current	 95/105 % of the pick-up voltage setting 97 % of the pick-up current setting
Reset time setting Inaccuracy: Reset time	0.010...10.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

2.5.7 Underexcitation protection (X<; 40)

Synchronous machines require a certain amount of excitation to stay stable. If the excitation drops too low a synchronous machine can drop out of step. One way for the protection relay to sense underexcitation is by measuring the impedance. When the measured impedance enters the defined circle, the function will trip.

2.5.8 Pole slip protection (Pslip; 78)

Table 2.23 Technical data for the pole slip protection function

Input signals	
Current input magnitudes	Phase current RMS
Voltage input magnitudes	Phase to earth voltage RMS Phase to phase + residual voltage RMS (calculated phase to earth voltage)
Suitable voltage measurement modes	
Voltage measurement mode	3LN + U4 3LL + U4 (when U4 is used as U0) 2LL + U3 + U4 (when either U3 or U4 is used as U0) 3LN (LEA req. HW)
Pick-up	
X detection circle offset from origo (pri)	-50 000.00...50 000.00 Ohm, setting step 0.01 Ohm
R detection circle offset from origo (pri)	-50 000.00...50 000.00 Ohm, setting step 0.01 Ohm
Detection circle r (pri)	0.01...50 000.00 Ohm, setting step 0.01 Ohm
R+ side blinder location (pri)	0.00...50 000.00 Ohm, setting step 0.01 Ohm
R- side blinder location (pri)	-50 000.00...0.00 Ohm, setting step 0.01 Ohm
Minimum locus traverse time between blinders	0.000...1800.00 s, setting step 0.01 Ohm
Pole slip detection limit to trip	1...5 slips, setting step 1
Reset slip detection after last detected slip	0.000...1800.000 s, setting step 0.005 s
Fixed trip pulse	100 ms
Hysteresis	5%

2.6 Control functions

2.6.1 Synchrocheck (ΔV/Δa/Δf; 25)

Table 2.24 Technical data for the synchrocheck function

Input signals	
Voltage inputs	U1, U2, U3 or U4 voltage channel
Voltage input magnitudes	RMS line-to-line or line-to-neutral voltages U3 or U4 voltage channel RMS
Pick-up	
U diff < setting	2.00...50.00 %U_N, setting step 0.01 %U_N
Angle diff < setting	3.0...90.0 deg, setting step 0.10 deg
Freq diff < setting	0.05...0.50 Hz, setting step 0.01 Hz
Inaccuracy: - Voltage - Frequency - Angle	 ±3.0 %U_{SET} or ±0.3 %U_N ±25 mHz (U> 30 V secondary) ±1.5° (U> 30 V secondary)
Reset	
Reset ratio: - Voltage - Frequency - Angle	 99 % of the pick-up voltage setting 20 mHz ±2.0°
Activation time	
Activation (to LD/DL/DD) Activation (to Live Live)	<35 ms <60 ms
Reset	<40 ms
Bypass modes	
Voltage check mode (excluding LL)	LL+LD, LL+DL, LL+DD, LL+LD+DL, LL+LD+DD, LL+DL+DD, bypass
U live > limit U dead < limit	0.10...100.00 %U_N, setting step 0.01 %U_N 0.00...100.00 %U_N, setting step 0.01 %U_N

NOTE The minimum voltage for direction and frequency solving is 20.0 %U_N.

2.6.2 Cold load pick-up (68) CLP

Table 2.25 Technical data for the cold load pick-up function

Measurement inputs	
Current inputs	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C)
Current input magnitudes	RMS phase currents
Pick-up	
Pick-up current setting - $I_{LOW}/I_{HIGH}/I_{OVER}$	 0.01...40.00 × I_N, setting step 0.01 × I_N
Reset ratio	97 % of the pick-up current setting
Inaccuracy: - Current	 ±0.5 %I_{SET} or ±15 mA (0.10...4.0 × I_{SET})
Operation time	

Definite time function operating time settings: - t_{SET} - t_{MAX} - t_{MIN}	 0.000...1800.000 s, setting step 0.005 s 0.000...1800.000 s, setting step 0.005 s 0.000...1800.000 s, setting step 0.005 s
Inaccuracy: - Definite time (I_M/I_{SET} ratio = 1.05/0.95)	±1.0 % or ±45 ms
Instant operation time	
CLPU activation and release	<45 ms (measured from the trip contact)

NOTE A single-phase current (IL1, IL2 or IL3) is enough to prolong or release the blocking during an overcurrent condition.

2.6.3 Switch on to fault (SOTF)

Table 2.26 Technical data for the switch-on-to-fault function

Initialization signals	
SOTF activate input	Any blocking input signal (Object closed signal, etc.)
Pick-up	
SOTF function input	Any blocking input signal (I> or similar)
SOTF activation time	
Activation time	<40 ms (measured from the trip contact)
SOTF release time	
Release time setting	0.000...1800.000 s, setting step 0.005 s
Inaccuracy: - Definite time	±1.0 % or ±30 ms
SOTF instant release time	<40 ms (measured from the trip contact)

2.6.4 Object control and monitoring

Table 2.27 Technical data for the object control and monitoring function

General	
Number of objects	10
Supported object types	Circuit breaker Circuit breaker with withdrawable cart Disconnector (MC) Disconnector (GND) Custom object image
Signals	
Input signals	Digital inputs Software signals
Output signals	Close command output Open command output
Operation time	
Breaker traverse time setting	0.02...500.00 s, setting step 0.02 s
Max. close/open command pulse length	0.02...500.00 s, setting step 0.02 s
Control termination time out setting	0.02...500.00 s, setting step 0.02 s

Inaccuracy: - Definite time operating time	±0.5 % or ±10 ms
Breaker control operation time	
External object control time	<75 ms
Object control during auto-reclosing	See the technical sheet for the auto-reclosing function.

Table 2.28 Technical data for the circuit breaker wear monitoring function

Pick-up	
Breaker characteristics settings: - Nominal breaking current - Maximum breaking current - Operations with nominal current - Operations with maximum breaking current	 0.00...100.00 kA, setting step 0.001 kA 0.00...100.00 kA, setting step 0.001 kA 0...200 000 operations, setting step 1 operation 0...200 000 operations, setting step 1 operation
Pick-up setting for Alarm 1 and Alarm 2	0...200 000 operations, setting step 1 operation
Inaccuracy	
Inaccuracy for current/operations counter: - Current measurement element - Operation counter	 0.1× I_N > I < 2 × I_N ±0.2 % of the measured current, rest 0.5 % ±0.5 % of operations deducted

2.6.5 Programmable stage (PSx>/<; 99)

The programmable stage is a stage that the user can program to create more advanced applications, either as an individual stage or together with programmable logic. The device has ten programmable stages, and each can be set to follow one to three analog measurements. The programmable stages have three available pick up terms options: overX, underX and rate-of-change of the selected signal. Each stage includes a definite time delay to trip after a pick-up has been triggered.

The programmable stage cycle time is 5 ms. The pick-up delay depends on which analog signal is used as well as its refresh rate (typically under a cycle in a 50 Hz system).

2.6.6 Indicator object monitoring

Table 2.29 Technical data for the indicator object monitoring function

General	
Number of objects	20
Supported object types	Disconnector (GND) Custom object image
Signals	
Input signals	Digital inputs Software signals

2.6.7 Setting group selection

Table 2.30 Technical data for the setting group selection function

Settings and control modes	
Setting groups	8 independent, control-prioritized setting groups
Control scale	Common for all installed functions which support setting groups
Control mode	

Local	Any binary signal available in the device
Remote	Force change overrule of local controls either from the setting tool, HMI or SCADA
Operation time	
Reaction time	<5 ms from receiving the control signal

2.6.8 Parallel voltage regulator

The automatic voltage regulator function can control up to four transformer tap changers in parallel with plug and play GOOSE configuration. Tap control can be switched between parallel and independent control modes. Mimic can be set up to display feedback from each transformer. Tap control can be in "Master & follower" mode or "Circulating current" control mode.

2.7 Monitoring functions

2.7.1 Voltage transformer supervision (60)

Table 2.31 Technical data for the voltage transformer supervision function

Measurement inputs	
Voltage inputs	U_{L1}, U_{L2}, U_{L3} U_{L12}, U_{L23}, U_{L31}
Voltage input magnitudes	RMS line-to-line or line-to-neutral voltages
Pick-up	
Pick-up settings: - Voltage (low pick-up) - Voltage (high pick-up) - Angle shift limit	 0.05...0.50 × U_N, setting step 0.01 × U_N 0.50...1.10 × U_N, setting step 0.01 × U_N 2.00...90.00 deg, setting step 0.10 deg
Inaccuracy: - Voltage - U angle (U> 1 V)	 ±1.5 %U_{SET} ±1.5°
External line/bus side pick-up (optional)	0 → 1
Time delay for alarm	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time (U_M/U_{SET} ratio > 1.05/0.95)	 ±1.0 % or ±35 ms
Instant operation time (alarm): - U_M/U_{SET} ratio > 1.05/0.95	 <80 ms
VTS MCB trip bus/line (external input)	<50 ms
Reset	
Reset ratio	97/103 % of the pick-up voltage setting
Reset time setting Inaccuracy: Reset time	0.010...10.000 s, step 0.005 s ±2.0 % or ±80 ms
Instant reset time and start-up reset	<50 ms
VTS MCB trip bus/line (external input)	<50 ms

NOTE When turning on the auxiliary power of a device, the normal condition of a stage has to be fulfilled before tripping.

2.7.2 Disturbance recorder

Table 2.32 Technical data for the disturbance recorder function

Recorded values	
Recorder analog channels	0...20 channels Freely selectable
Recorder digital channels	0...95 channels Freely selectable analog and binary signals 5 ms sample rate (FFT)
Performance	
Sample rate	8, 16, 32 or 64 samples/cycle
Recording length	0.000...1800.000 s, setting step 0.001 s The maximum length is determined by the chosen signals.
Number of recordings	0...100, 60 MB of shared flash memory reserved The maximum number of recordings according to the chosen signals and operation time setting combined

2.7.3 Current transformer supervision

Table 2.33 Technical data for the current transformer supervision function

Measurement inputs	
Current inputs	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C) Residual current channel I_{01} (Coarse) Residual current channel I_{02} (Fine)
Current input magnitudes	RMS phase currents RMS residual current (I_{01}, I_{02})
Pick-up	
Pick-up current settings: - I_{SET} high limit - I_{SET} low limit - I_{SUM} difference - I_{SET} ratio - I2/I1 ratio	 0.10...40.00 × I_N, setting step 0.01 × I_N 0.10...40.00 × I_N, setting step 0.01 × I_N 0.10...40.00 × I_N, setting step 0.01 × I_N 0.01...100.00 %, setting step 0.01 % 0.01...100.00 %, setting step 0.01 %
Inaccuracy: - Starting IL1, IL2, IL3 - Starting I2/I1 - Starting I01 (1 A) - Starting I02 (0.2 A)	 ±0.5 %I_{SET} or ±15 mA (0.10...4.0 × I_{SET}) ±1.0 %$I2_{SET}$ / $I1_{SET}$ or ±100 mA (0.10...4.0 × I_N) ±0.5 %$I0_{SET}$ or ±3 mA (0.005...10.0 × I_{SET}) ±1.5 %$I0_{SET}$ or ±1.0 mA (0.005...25.0 × I_{SET})
Time delay for alarm	
Definite time function operating time setting	0.00...1800.00 s, setting step 0.005 s
Inaccuracy_ - Definite time (I_M/I_{SET} ratio > 1.05)	 ±2.0 % or ±80 ms
Instant operation time (alarm): - I_M/I_{SET} ratio > 1.05	 <80 ms (<50 ms in differential protection relays)
Reset	
Reset ratio	97/103 % of the pick-up current setting
Instant reset time and start-up reset	<80 ms (<50 ms in differential protection relays)

2.7.4 Current total harmonic distortion

Table 2.34 Technical data for the total harmonic distortion function

Input signals	
Current inputs	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C) Residual current channel I_{01} (Coarse) Residual current channel I_{02} (Fine)
Current input magnitudes	Current measurement channels (FFT result) up to the 31st harmonic component.
Pick-up	
Operating modes	Power THD Amplitude THD
Pick-up setting for all comparators	0.10...200.00 % , setting step 0.01 %
Inaccuracy	±3 % of the set pick-up value > 0.5 × I_N setting; 5 mA < 0.5 × I_N setting.
Time delay	
Definite time function operating time setting for all timers	0.00...1800.00 s, setting step 0.005 s
Inaccuracy: - Definite time operating time - Instant operating time, when I_M/I_{SET} ratio > 3 - Instant operating time, when I_M/I_{SET} ratio 1.05 < I_M/I_{SET} < 3	±0.5 % or ±10 ms Typically <20ms Typically <25 ms
Reset	
Reset time	Typically <10 ms
Reset ratio	97 %

2.7.5 Voltage total harmonic distortion

Table 2.35 Technical data for the voltage total harmonic distortion function

Input signals	
Voltage inputs	
Voltage input magnitudes	Voltage measurement channels up to the 31st harmonic component.

2.7.6 Voltage memory

Table 2.36 Technical data for the voltage memory function

Measurement inputs	
Voltage inputs	U_{L1}, U_{L2}, U_{L3} U_{L12}, U_{L23}, U_{L31} + U_0
Current inputs (back-up frequency)	Phase current inputs: I_{L1} (A), I_{L2} (B), I_{L3} (C)
Pick-up	
Pick-up voltage setting Pick-up current setting (optional)	2.00...50.00 %U_N, setting step 0.01 x %U_N 0.01...50.00 × I_N, setting step 0.01 × I_N
Inaccuracy: - Voltage - Current	±1.5 %U_{SET} or ±30 mV

	±0.5 %I_{SET} or ±15 mA (0.10...4.0 × I_{SET})
Operation time	
Angle memory activation delay	<20 ms (typically 5 ms)
Maximum active time	0.020...50.000 s, setting step 0.005 s
Inaccuracy: - Definite time (U_M/U_{SET} ratio >1.05)	±1.0 % or ±35 ms
Angle memory	
Angle drift while voltage is absent	±1.0° per 1 second
Reset	
Reset ratio: - Voltage memory (voltage) - Voltage memory (current)	 103 % of the pick-up voltage setting 97 % of the pick-up current setting
Reset time	<50 ms

NOTE Voltage memory is activated only when all line voltages fall below set pick-up value.
NOTE Voltage memory activation captures healthy situation voltage angles, one cycle before actual activation (50Hz/ 20ms before “bolted” fault)

3. Technical specifications

3.1 Electromagnetic compatibility

Emission	Standard	Class	Value
Conducted Disturbance Emission	IEC 60255-26	A	0.15 to 30 MHz IACS E10 Setup according to CISPR 16. Conducted emission measured from 10kHz
	IEC 61000-6-4	A	
Radiated emission (below 1 GHz)	IEC 60255-26		30 to 1000 MHz
	IEC 61000-6-4	A	IACS E10 Setup according to CISPR 16. Radiated emission measured from 150 kHz to 2000 MHz
Radiated emission (above 1 GHz)	IEC 60255-26		1 to 6 GHz
	IEC 61000-6-4	A	

Immunity	Standard	Level	Value
Electrostatic Discharge	IEC 60255-26		8 kV air discharge
	IEC 61000-4-2 IACS E10	3	6 kV direct discharge
Radiated immunity	IEC 60255-26		10 V/m; 80 MHz to 1 GHz; 1.4 GHz to 2.7 GHz IACS E10 80 MHz to 2 GHz 10 V/m 3 s dwell time
	ENV 50204 (GSM)	3	10 V/m; 2 W at 0.6 m
Fast transient/burst immunity	IEC 60225-26		2 kV
	IEC 61000-4-4 IACS E10	3	2 kV 2 kV
Surge immunity	IEC 60255-26		1 kV symmetrical (line to line)
	IEC 61000-4-5 IACS E10	3	2 kV unsymmetrical (line to earth) 0.5 kV symmetrical (line to line) (only for IACS E10) 1 kV unsymmetrical (line to earth) (only for IACS E10)
Conducted immunity	IEC 60255-26		0.15 to 80 MHz; 10 V
	IEC 61000-4-6	3	IACS E10 3 s dwell time.
Power frequency magnetic field immunity	IEC 60255-26		30 A/m continuous
	IEC 61000-4-8	4	300 A/m; 1 s to 3 s
Pulse magnetic field immunity	IEC 61000-4-9	5	1000 A/m
Damped oscillatory magnetic field immunity	IEC 61000-4-10	4	30 A/m
Oscillatory transient immunity – Ring wave	IEC 61000-4-12	4	100 kHz 4 kV common mode
			2 kV differential mode
Oscillatory transient immunity – Slow damped oscillatory wave	IEC 61000-4-18 ANSI/IEEE Std C37.90.1	3	100 kHz 1 kV differential mode 2.5 kV common mode
Oscillatory transient immunity – Slow damped oscillatory wave	IEC 60255-26 IEC 61000-4-18	3	1.0 MHz 2.5 kV common mode
	ANSI/IEEE Std C37.90.1		2.5 kV differential mode

Immunity	Standard	Level	Value
Voltage dips	IEC 60255-26		0 %
	IEC 61000-4-11		DC 10 ms
	IEC 61000-4-29		AC 0.5 cycle (10 ms)
Voltage dips	IEC 60255-26		40 %
	IEC 61000-4-11		DC 200 ms
	IEC 61000-4-29		AC 10/12 cycles (10 ms) Tested both 50/60 Hz
Voltage dips	IEC 60255-26		70 %
	IEC 61000-4-11		DC 500 ms
	IEC 61000-4-29		AC 25/30 cycles (10 ms)
Voltage interruptions	IEC 60255-26		0 %
	IEC 61000-4-11 IACS E10		DC 5 s (3 interruptions w. 10 s interval) DC 30 s/60 s (3 interruptions w. 60 s interval)
	IEC 61000-4-29 IACS E10		AC 250 cycles (5 s) (3 interruptions w. 10 s interval) AC 30 s (3 interruptions w. 90 s interval) 1 additional interruption during booting
Voltage variations permanent	IACS E10		DC +30 % 24H DC -15 % 15 min AC +6 % V AC/+5 % Hz 15 min AC +6 % V AC/-5 % Hz 15 min AC -10 % V AC/-5 % Hz 15min AC -10 % V AC/+5 % Hz 15 min
Voltage variations transient	IACS E10		AC +20 % V AC 1.5 s/+10 % Hz 5 s AC -20 % V AC 1.5 s/-10 % Hz 5 s
Ripple	IEC 60255-26		15 % of DC; 100 Hz
	IEC 61000-4-17		
Power Frequency Immunity	IEC 60255-26		150 V, 50 Hz, common mode
	IEC 61000-4-16		300 V, 50 Hz, differential mode

3.2 Mechanical durability

Energised	Standard	Class	Value
Vibration response	IEC 60255-27 IEC 60255-21-1	2	10 to 58.1 Hz: 0.15 mmpp 58.1 to 150 Hz: 1 g 1 cycle in each axis
Vibration	IACS E10		3 to 13.2 Hz 2 mmpp 13.2 to 100 Hz 0.7 g
Shock response	IEC 60255-27 IEC 60255-21-2	2	10 g; 11 ms

De-energised	Standard	Class	Value
Vibration endurance	IEC 60255-27 IEC 60255-21-1	2	10 to 150 Hz; 2 g acceleration; 20 sweep cycles
Shock withstand	IEC 60255-27	2	30 g; 11 ms

De-energised	Standard	Class	Value
	IEC 60255-21-2		
Bump	IEC 60255-27 IEC 60255-21-2	2	20 g; 16 ms

3.3 Environment

General	Standard	Value
Cold non-operation	I EC 60255-27 IEC 60255-1 IACS E10	-25 °C; 16 h
Dry heat operation	IEC 60255-27 IEC 60255-1 IACS E10	60 °C; 16 h
Damp heat (static)	IEC 60255-27 IEC 60255-1	55 °C; 93 % RH; 10 days
Cyclic temperature with humidity (damp heat cyclic)	IEC 60255-27 IEC 60255-1 IACS E10	55 °C @ 93 % RH; 25 °C @ 97 % RH, 12 h + 12 h; 6 cycles 55 °C @ 95 % RH; 12 h + 12 h; 2 cycles
Change of temperature	IEC 60255-1	5 cycles; -25 °C to 70 °C

Storage	Standard	Value
Low temperature storage	IEC 60255-27 IEC 60255-1	-40 °C; 16 h
High temperature storage	IEC 60255-27 IEC 60255-1	70 °C; 16 h

3.4 Safety

Electrical	Standard	Value
Insulation resistance	IEC 60255-27 IACS E10	Before environmental tests: >100 MΩ at DC 500 V >100 MΩ at DC 500 V (Uw >65 V) >10 MΩ at DC 50 V (Uw <65 V) After environmental tests: >10 MΩ at DC 500 V (Uw >65 V) >1 MΩ at DC 50 V (Uw <65 V)
Reverse polarity	IEC 60255-27	
Gradual shut down/start-up tests	IEC 60255-27	
Impulse voltage	IEC 60255-27	5 kV; 1.2/50 µs; 0.5 J
Power frequency dielectric withstand	IEC 60255-27	3.5 kV; 50 Hz; 1 min (PS, DI, DO, I, RS485 AO) 4.35 kV; 50 Hz; 1 min (U)
Protective bonding impedance	IEC 60255-27	<0.1 Ω at 20 A 60 s
Insulation class		Class I
Over-voltage CAT	IEC 60255-27	III

Enclosure	Standard	Value
Dust/water ingress	IEC 60255-27 IEC 60529	IP 54 (front), IP 20 (back)

4. Hardware

4.1 Processor and power supply

Table 4.1 General information for the CPU module

Terminal block connection	
Screw connection terminal block (standard)	Phoenix Contact MSTB 2,5/5-ST-5,08
Spring cage terminal block (option)	Phoenix Contact FKC 2,5/20-STF-5,08
Solid or stranded wire Nominal cross section	2.5 mm^2
RS-485 serial terminal block connection	
Screw connection terminal block (standard)	Phoenix Contact MC 1,5/ 5-ST-3,81
Spring cage terminal block (option)	Phoenix Contact FK-MCP 1,5/ 5-ST-3,81
Solid or stranded wire Nominal cross section	1.5 mm^2

4.1.1 Auxiliary supply

Table 4.2 Power supply model H

Rated values	
Rated auxiliary voltage	100...120 VDC
Power consumption	< 20 W (no option cards) < 40 W (maximum number of option cards)
Maximum permitted interrupt time	< 40 ms with 110 VDC
DC ripple	< 15 %
Other	
Minimum recommended fuse rating	MCB C2

Table 4.3 Power supply model L

Rated values	
Rated auxiliary voltage	24...48 VDC
Power consumption	< 20 W (no option cards) < 40 W (maximum number of option cards)
Maximum permitted interrupt time	< 40 ms with 24 VDC
DC ripple	< 15 %
Other	
Minimum recommended fuse rating	MCB C2

4.1.2 Isolated digital inputs

Table 4.4 CPU model-isolated digital inputs, with thresholds defined by order code

Number of digital inputs	3
Rated values	
Rated auxiliary voltage	265 V (AC/DC)
Nominal voltage	Order code defined: 24, 110, 220 V (AC/DC) **Caution:** When the working voltage is above 150 V AC, do not mix AC and DC voltage inside any relay groups or digital input groups.
Pick-up threshold Release threshold	Order code defined: 19, 90,170 V Order code defined: 14, 65, 132 V
Scanning rate	5 ms
Settings	
Pick-up delay	Software settable: 0...1800 s
Polarity	Software settable: Normally On/Normally Off
Current drain	2 mA

4.1.3 Digital outputs

Table 4.5 Digital outputs (Normally Open)

Number of digital outputs	4
Rated values	
Rated auxiliary voltage	265 V (AC/DC) **Caution:** When the working voltage is above 150 V AC, do not mix AC and DC voltage inside any relay groups or digital input groups.
Continuous carry	5 A
Make and carry 0.5 s Make and carry 3 s	30 A 15 A
Breaking capacity, DC (L/R = 40 ms) at 48 VDC at 110 VDC at 220 VDC	 1 A 0.4 A 0.2 A
Control rate	5 ms
Settings	
Polarity	Software settable: Normally Open / Normally Closed

Table 4.6 Digital outputs (Change-Over)

Number of digital outputs	1 configurable (plus 1 for fault signaling)
Rated values	
Rated auxiliary voltage	265 V (AC/DC) **Caution:** When the working voltage is above 150 V AC, do not mix AC and DC voltage inside any relay groups or digital input groups.
Continuous carry	2.5 A
Make and carry 0.5 s Make and carry 3 s	30 A 15 A

Breaking capacity, DC (L/R = 40 ms) at 48 VDC at 110 VDC at 220 VDC	 1 A 0.3 A 0.15 A
Control rate	5 ms
Settings	
Polarity	Software settable: Normally Open / Normally Closed

4.1.4 Communication ports

Front panel local communication port	
Port, media	Ethernet RJ-45, Copper
Number of ports	1
Port protocols	PC-protocols, FTP, Telnet
Data transfer rate	100 MB
System integration	Cannot be used for system protocols, only for local programming
Rear panel system communication port A	
Port, media	Ethernet RJ-45, Copper
Number of ports	1
Port protocols	Modbus TCP, DNP 3.0, FTP, Telnet, IEC 61850, IEC-104
Data transfer rate	100 MB
System integration	Can be used for system protocols and for local programming
Rear panel system communication port B	
Port, media	RS-485, Copper
Number of ports	1
Port protocols	Modbus RTU, DNP 3.0, IEC-103, IEC-101, SPA
Data transfer rate	65580 kB/s
System integration	Can be used for system protocols

4.2 Current measurement module

The MVR has two current measurement modules.

Table 4.7 Technical data for the current measurement module

Connections	
Measurement channels/CT inputs	Three phase current inputs: IL1 (A), IL2 (B), IL3 (C) Two residual current inputs: Coarse residual current input I01, Fine residual current input I02
Phase current inputs (A, B, C)	
Sample rate	64 samples per cycle in frequency range 6...75Hz
Rated current I_N	5 A (configurable 0.2...10 A) 5 A (configurable 0.2...20 A)
Thermal withstand	20 A (continuous) 100 A (for 10 s) 500 A (for 1 s)

	1250 A (for 0.01 s)
Frequency measurement range	From 6...75Hz fundamental, up to the 31st harmonic current
Current measurement range	25 mA...250 A (RMS)
Current measurement inaccuracy	0.005...4.000 × I_N < ±0.5 % or < ±15 mA 4...20 × I_N < ±0.5 % 20...50 × I_N < ±1.0 %
Temperature-dependent current measurement inaccuracy	Reference temperature: 25 °C Operation temperature range: -25 to 55 °C Inaccuracy: An additional ±15 mA per 10 °C
Angle measurement inaccuracy	< ±0.2° (I> 0.1 A) < ±1.0° (I≤ 0.1 A)
Burden (50/60 Hz)	<0.1 VA
Transient overreach	<8 %
Coarse residual current input (I01)	
Rated current I_N	1 A (configurable 0.1...10 A)
Thermal withstand	25 A (continuous) 100 A (for 10 s) 500 A (for 1 s) 1250 A (for 0.01 s)
Frequency measurement range	From 6...75 Hz fundamental, up to the 31st harmonic current
Current measurement range	5 mA...150 A (RMS)
Current measurement inaccuracy	0.002...10.000 × I_N < ±0.5 % or < ±3 mA 10...150 × I_N < ±0.5 %
Temperature-dependent current measurement inaccuracy	Reference temperature: 25 °C Operation temperature range: -25 to 55 °C Inaccuracy: An additional ±0.8 mA per 10 °C
Angle measurement inaccuracy	< ±0.2° (I> 0.05 A) < ±1.0° (I≤ 0.05 A)
Burden (50/60Hz)	<0.1 VA
Transient overreach	<5 %
Fine residual current input (I02)	
Rated current I_N	0.2 A (configurable 0.001...10 A)
Thermal withstand	25 A (continuous) 100 A (for 10 s) 500 A (for 1 s) 1250 A (for 0.01 s)
Frequency measurement range	From 6...75 Hz fundamental, up to the 31st harmonic current
Current measurement range	1 mA...75 A (RMS)
Current measurement inaccuracy	0.002...25.000 × I_N < ±0.5 % or < ±0.6 mA 25...375 × I_N < ±1.0 %
Temperature-dependent current measurement inaccuracy	Reference temperature: 25 °C Operation temperature range: -25 to 55 °C Inaccuracy: An additional ±0.4 mA per 10 °C
Angle measurement inaccuracy	< ±0.2° (I> 0.01 A) < ±1.0° (I≤ 0.01 A)
Burden (50/60Hz)	<0.1 VA
Transient overreach	<5 %
Screw connection terminal block (standard)	

Terminal block	Phoenix Contact FRONT 4-H-6,35
Solid or stranded wire Nominal cross section	4 mm^2
Ring lug terminal block connection (option)	
Ring terminal dimensions	Max 8mm diameter, with minimum 3,5mm screw hole

NOTE Current measurement accuracy has been verified with 50/60 Hz.

The amplitude difference is 0.2 % and the angle difference is 0.5 degrees higher at 16.67 Hz and other frequencies.

4.3 Voltage measurement module

Table 4.8 Technical data for the voltage measurement module

General information	
Compatibility	MVR-200 series and MVR-250 series models
Connection	
Measurement channels/VT inputs	4 independent VT inputs (U1, U2, U3 and U4)
Measurement	
Sample rate	64 samples per cycle in frequency range 6...75Hz
Voltage measuring range	0.50...480.00 V (RMS)
Voltage measurement inaccuracy	For 2...480 V AC: ±0.2 % or ±10 mV, whichever is biggest
Temperature-dependent voltage measurement inaccuracy	Reference temperature: 25 °C Operation temperature range: -25 to 60 °C Inaccuracy: An additional ±30 mV per 10 °C
Angle measurement inaccuracy	±0.2 degrees (15...300 V) ±1.5 degrees (1...15 V)
Voltage measurement bandwidth (freq.)	7...75 Hz fundamental, up to the 31st harmonic voltage
Terminal block connection	
Screw connection terminal block (standard)	Phoenix Contact PC 5/ 8-STCL1-7,62
Spring cage terminal block (optional)	Phoenix Contact SPC 5/ 8-STCL-7,82
Solid or stranded wire Nominal cross section	6 mm^2
Input impedance	~24.5 MΩ
Burden (50/60 Hz)	<0.02 VA
Thermal withstand	630 V_{RMS} (continuous)

NOTE Voltage measurement accuracy has been verified with 50/60 Hz.

The amplitude difference is 0.2 % and the angle difference is 0.5 degrees higher at 16.67 Hz and other frequencies.

4.4 Power and energy measurement

Table 4.9 Power and energy measurement accuracy

Power measurement P, Q, S	Frequency range 6...75 Hz
Inaccuracy	0.3 % <1.2 × I_N or 3 VA secondary

	1.0 % >1.2 × I_N or 3 VA secondary
Energy measurement	Frequency range 6...75 Hz
Energy and power metering inaccuracy	0.5% down to 1A RMS (50/60Hz) as standard 0.2% down to 1A RMS (50/60Hz) option available (see the order code for details)
Temperature-dependent power measurement inaccuracy	Reference temperature: 25 °C Operation temperature range: -25 to 60 °C Inaccuracy (UL 100V, IL 5A): An additional ±1.5 W per 10 °C

4.5 Frequency measurement

Table 4.10 Frequency measurement accuracy.

Frequency measurement performance	
Frequency measuring range	6...75 Hz fundamental, up to the 31st harmonic current or voltage
Inaccuracy	20 mHz*

NOTE * If one of these conditions is met, the frequency inaccuracy is ±30 mHz:

- f ≠ 50 Hz or 60 Hz.
- Frequency tracking via voltages is applied.
- U < 15 V.

4.6 Digital inputs and outputs

4.6.1 Digital input module (option card B)

Table 4.11 Technical data for the digital input module

Number of digital inputs	8 x isolated (2 groups)
Rated values	
Rated auxiliary voltage	5...265 V (AC/DC)
Current drain	2 mA
Scanning rate Activation/release delay	5 ms 5...11 ms
Settings	
Pick-up threshold Release threshold	Software settable: 16...200 V, setting step 1 V Software settable: 10...200 V, setting step 1 V
Pick-up delay	Software settable: 0...1800 s
Drop-off delay	Software settable: 0...1800 s
Polarity	Software settable: Normally On/Normally Off
Terminal block connection	
Screw connection terminal block (standard)	Phoenix Contact MSTB 2,5/10-ST-5,08
Spring cage terminals block (option)	Phoenix Contact FKC 2,5/10-STF-5,08
Solid or stranded wire Nominal cross section	 2.5 mm^2

4.6.2 Digital output module (option card C)

Table 4.12 Technical data for the digital output module

Number of digital outputs	5
Rated values	
Rated auxiliary voltage	265 V (AC/DC)
Continuous carry	5 A
Make and carry 0.5 s Make and carry 3 s	30 A 15 A
Breaking capacity, DC (L/R = 40 ms) at 48 VDC at 110 VDC at 220 VDC	 1 A 0.4 A 0.2 A
Control rate	5 ms
Settings	
Polarity	Software settable: Normally On/Normally Off
Terminal block connection	
Screw connection terminal block (standard)	Phoenix Contact MSTB 2,5/10-ST-5,08
Spring cage terminals block (option)	Phoenix Contact FKC 2,5/10-STF-5,08
Solid or stranded wire Nominal cross section	 2.5 mm^2

4.7 Analogue inputs

4.7.1 RTD input module (option card F)

Table 4.13 Technical data for the RTD input module.

General information	
Hardware configuration code	F
Sensors	
Channels 1-8	2/3/4-wire RTD Pt100 or Pt1000
Terminal block connection	
Maximum cross section (solid or stranded wire)	1.5 mm^2

4.8 Analogue outputs

4.8.1 Analogue output module (mA out & mA in) (option card I)

Table 4.14 Technical data for the analogue output module

Signals	
Output magnitudes Input magnitudes	4 × mA output signal (DC) 1 × mA input signal (DC)
mA input	
Range (hardware)	0...33 mA

Range (measurement) Inaccuracy	0...24 mA ±0.1 mA
Update cycle Response time @ 5 ms cycle Update cycle time inaccuracy	5...10 000 ms, setting step 5 ms ~ 15 ms (13...18 ms) Max. +20 ms above the set cycle
mA input scaling range Output scaling range	0...4000 mA -1 000 000.0000...1 000 000.0000, setting step 0.0001
mA output	
Inaccuracy @ 0...24 mA	±0.01 mA
Response time @ 5 ms cycle [fixed]	< 5 ms
mA output scaling range Source signal scaling range	0...24 mA, setting step 0.001 mA -1 000 000.000...1 000 000.0000, setting step 0.0001
Terminal block connection	
Screw connection terminal block (standard)	Phoenix Contact MSTB 2,5/10-ST-5,08
Spring cage terminals block (option)	Phoenix Contact FKC 2,5/10-STF-5,08
Solid or stranded wire Nominal cross section	 2.5 mm^2

4.9 Additional communication options

4.9.1 Double RJ45 Ethernet & IRIG-B communication module (option card G)

Table 4.15 Technical data for the double RJ-45 Ethernet communication module.

General information	
Hardware configuration code	G
Ethernet connector features	
Protocols	IEC 61850 IEC 104 Modbus/TCP DNP3 FTP
Data transfer rate	100 MB/s
System integration	Can be used for system protocols and for local programming
Number of ports	2
Communication ports	Copper Ethernet RJ-45
IRIG-B Connector	
Maximum cross section (solid or stranded wire)	1.5 mm^2

4.9.2 Double ST 100 Mbps Ethernet communication module (option card H)

Table 4.16 Technical data for the double ST 100 Mbps Ethernet communication module

General information	
Dimensions	74 mm X 179 mm
Ports	ST connectors (2) and IRIG-B connector (1)
Protocols	

Protocols	IEC61850, DNP/TCP, Modbus/TCP, IEC104 & FTP
ST connectors	
Connector type	Duplex ST connectors 62.5/125 µm or 50/125 µm multimode fiber 100BASE-FX
Transmitter wavelength	1260...1360 nm (nominal: 1310 nm)
Receiver wavelength	1100...1600 nm
Maximum distance	2 km
IRIG-B Connector	
Screw connection terminal block	Phoenix Contact MC 1,5/ 2-ST-3,5 BD:1-2
Solid or stranded wire Nominal cross section	1.5 mm^2

4.9.3 Double LC 100 Mbps Ethernet communication module (option card J)

Table 4.17 Technical data for the double LC 100 Mbps Ethernet communication module

Protocols	
Protocols	HSR and PRP
Ports	
Quantity of fiber ports	2
Communication port C & D	LC fiber connector Wavelength 1300 nm
Fiber cable	50/125 µm or 62.5/125 µm multimode (glass)

4.9.4 Double RJ-45 (HSR, PRP) Ethernet communication module (option card K)

Table 4.18 Technical data for the double RJ-45 100 Mbps Ethernet communication module.

General information	
Hardware configuration code	K
Features	
Protocols	IEC 61850 IEC 104 Modbus/TCP DNP3 FTP
Redundancy	HSR and PRP
Data transfer rate	100 MB/s
System integration	Can be used for system protocols and for local programming
Ports	
Number of ports	2
Communication port	Copper Ethernet RJ-45

4.9.5 RS-232 & serial fiber communication module (option cards L to O)

Table 4.19 Technical data for the RS-232 & serial fiber communication module.

Ports	
RS-232	
Serial fiber (GG/PP/GP/PG)	
Serial port wavelength	
660 nm	
Cable type	
1 mm plastic fiber	
Terminal block connections	
Spring cage terminals block	Phoenix Contact DFMC 1,5/ 6-STF-3,5
Solid or stranded wire Nominal cross section	 1.5 mm^2

4.10 Arc protection module (option card D)

Table 4.20 Technical data for the point sensor arc protection module

Connections	
Input arc point sensor channels	S1, S2, S3, S4 (pressure and light, or light only)
Sensors* per channel	3
Maximum cable length	200 m
Performance	
Pick-up light intensity	8, 25 or 50 kLx (the sensor is selectable in the order code)
Point sensor detection radius	180 degrees
Start and instant operating time (light only)	Typically <5 ms with dedicated semiconductor outputs (HSO) Typically <10 ms regular output relays

More information
* See the **Option D: Arc protection Description of options** for the specifications of these sensors.

Table 4.21 High-Speed Outputs (HSO1...2)

Rated values	
Rated auxiliary voltage	250 VDC
Continuous carry	2 A
Make and carry 0.5 s Make and carry 3 s	15 A 6 A
Breaking capacity, DC (L/R = 40 ms)	1 A/110 W
Control rate	5 ms
Operation delay	<1 ms
Polarity	Normally Off
Contact material	Semiconductor

Table 4.22 Binary input channel

Rated values	
Voltage withstand	265 VDC
Nominal voltage Pick-up threshold Release threshold	24 VDC ≥16 VDC ≤15 VDC
Scanning rate	5 ms
Polarity	Normally Off
Current drain	3 mA

Table 4.23 Terminal block connections

Arc point sensor terminal block connections	
Spring cage terminal block	Phoenix Contact DFMC 1,5/ 6-STF-3,5
Solid or stranded wire Nominal cross section	1.5 mm^2
Binary input and HSO terminal block connections	
Screw connection terminal block (standard)	Phoenix Contact MSTB 2,5/5-ST-5,08
Spring cage terminals block (option)	Phoenix Contact FKC 2,5/10-STF-5,08
Solid or stranded wire Nominal cross section	2.5 mm^2

NOTE The polarity must be correct!

4.11 MVR-25x display

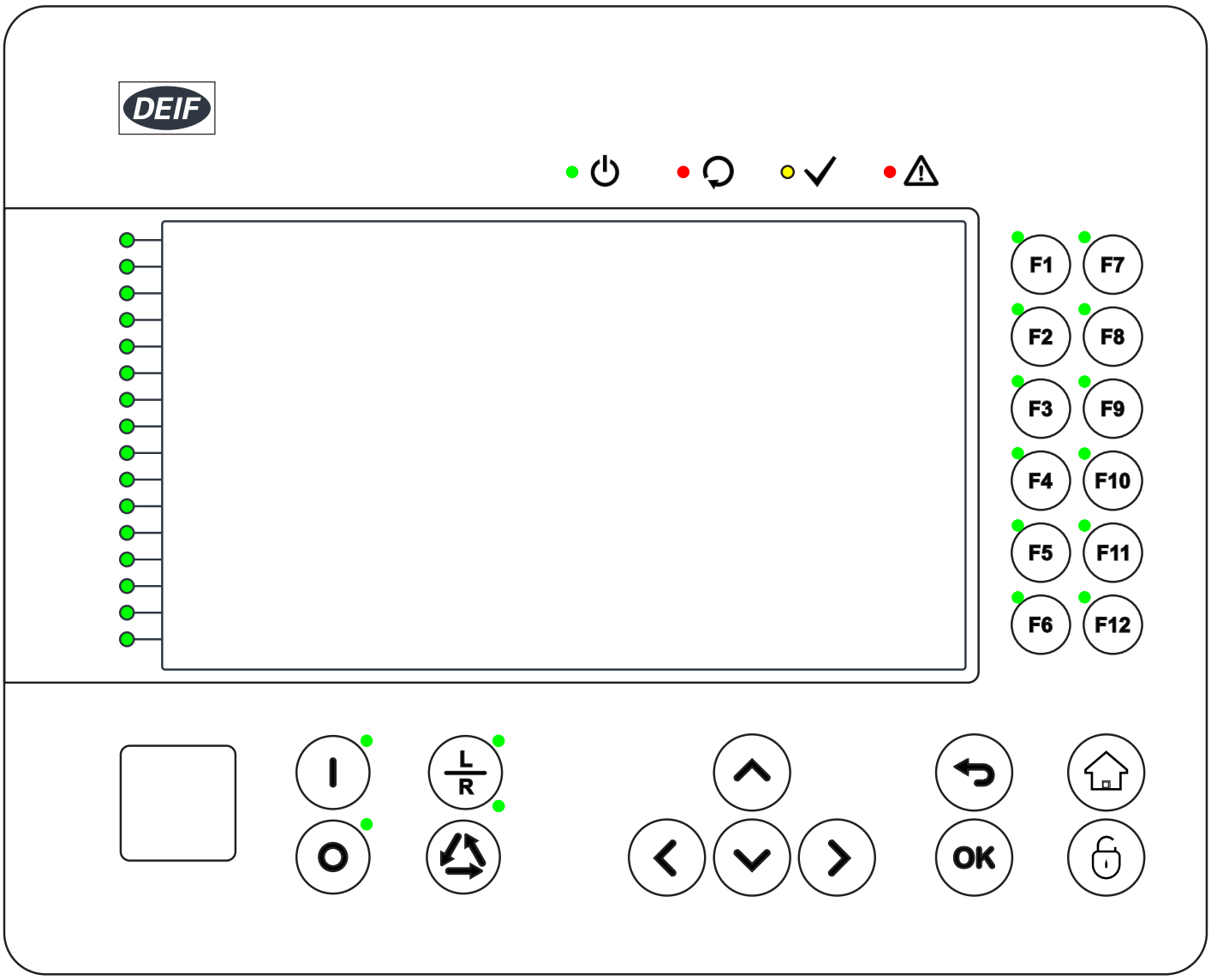
4.11.1 Display

Table 4.24 Technical data for the HMI TFT display

Dimensions and resolution	
Number of dots/resolution	800 x 480
Size	154.08 × 85.92 mm (6.06 × 3.38 in)
Display	
Type of display	TFT
Color	RGB color

4.12 Folios and configuration

MVR-25x folio



To meet marine class society requirements:

- The MVR must be configured so that the **Trip LED** ( ) is lit whenever a protection activates a breaker trip.
- For each trip protection, select *Trip ON* in the NOC EventMask. In this way, the cause of any trip is shown on the main screen and immediately visible to the operator.
- Alarm LED colours must be configured as follows:

Alarm state	Details	LED colour
OK	There is no alarm.	Green
Warning	There is an alert for the operator, but no alarm action.	Yellow (*Orange*)
Trip or Fault	The controller has sent a trip signal the breaker.	Red

4.13 Mechanical specifications

Device dimensions	250 series casing height	208 mm, width 257 mm, depth 210 mm
Package dimensions (W x H x D)	250 series	345 x 240 x 258 mm

Weight	Device	1.5 kg
	In package	2.0 kg
Material	Housing	Metal
IP protection level	Front	IP54
	Rear	IP20
Tightening torque - M4 nuts	Front	1.1 N·m for 250 series

4.14 Environment

IEC 60255-27 degree of pollution	2
Maximum altitude above sea level	2000 m (6561.68 ft)
Operation temperature range	-25 °C to +60 °C

4.15 Safety

Wiring specification

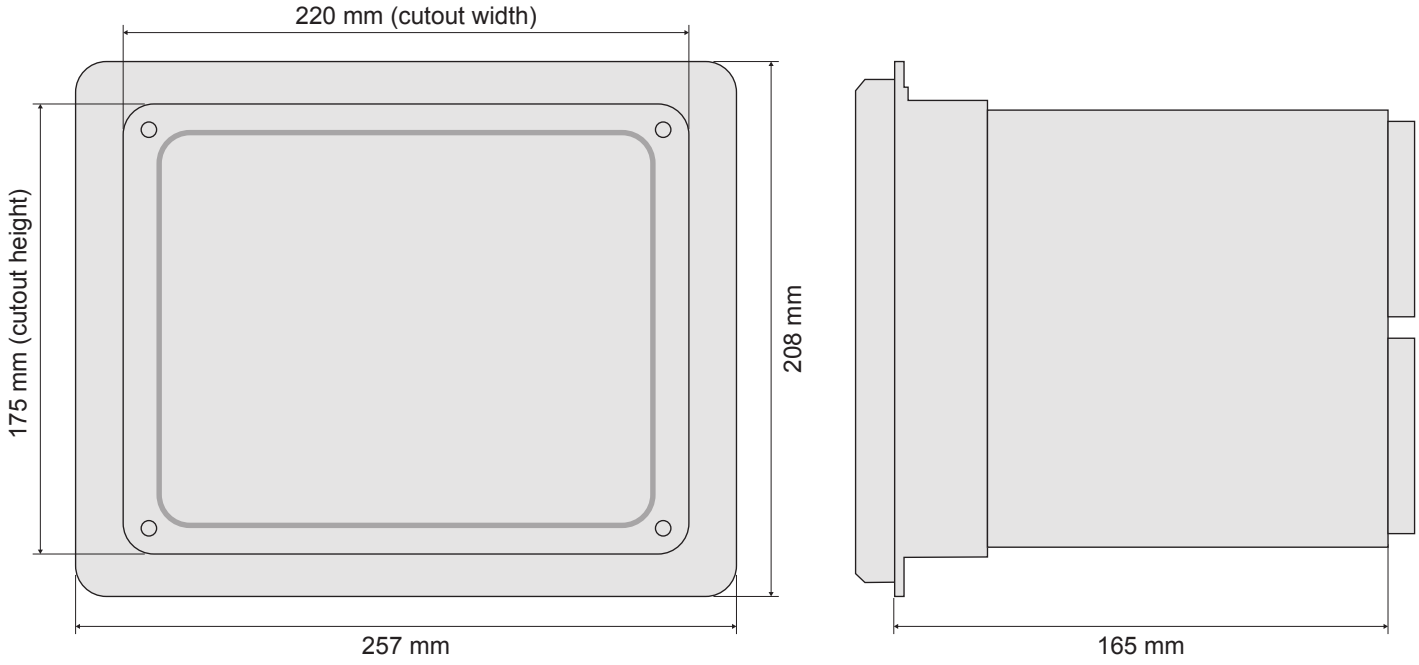
Wiring must be multi-stranded, minimum 90 °C copper conductors only.

Galvanic isolation

Ethernet: 550 V, 50 Hz, 1 minute
COM ports: 550 V, 50 Hz, 1 minute
Between Option I (mA I/O) and other I/O ports: 550 V, 50 Hz, 1 minute
Between CT and other I/O ports: 2200 V, 50 Hz, 1 minute
Between Relay and other I/O ports: 2200 V, 50 Hz, 1 minute
Between DI and other I/O ports: 2200 V, 50 Hz, 1 minute
Between PSU and other I/O ports: 2200 V, 50 Hz, 1 minute

4.16 Dimensions

MVR-250 dimensions

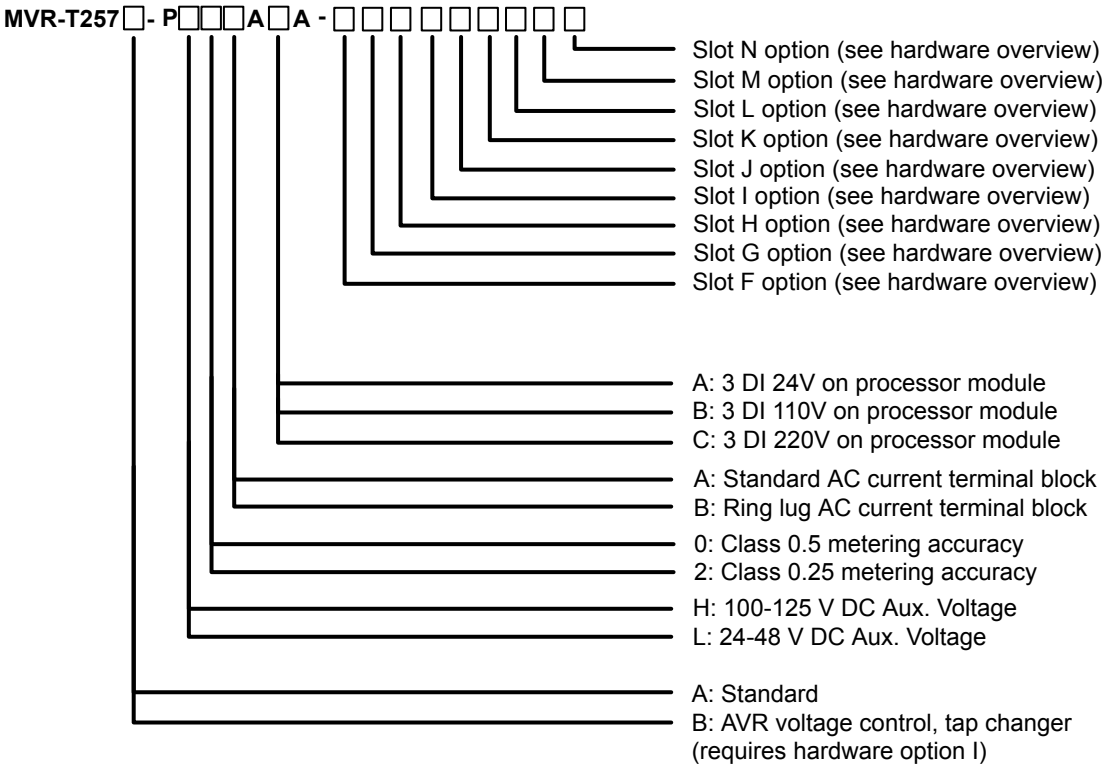


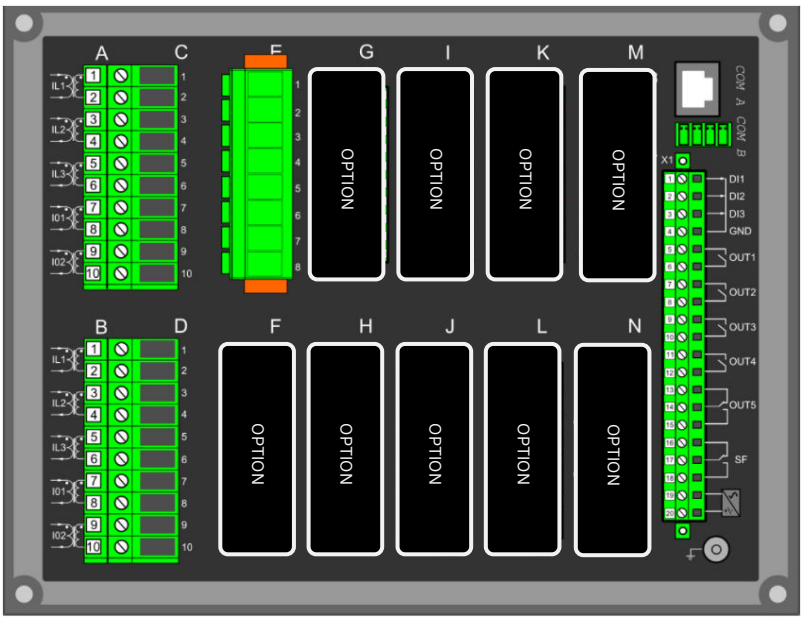
5. Ordering information

5.1 MVR Ordering

The drawings show the rear view of the MVR without hardware options.

MVR Transformer relay MVR-T257





Hardware options overview

Option	Description
A	None (empty slot)
B	8 x isolated (2 groups) digital inputs • 10 to 200 V DC
C	5 x relay outputs • 220 V AC, 3 A • 220 V DC, 0.3 A
D	Arc protection This option is not included in the marine approval.
F	RTD analogue input module (8 channels) This option is not included in the marine approval.
G	2 x RJ45 100Mb Ethernet & IRIG-B* This option is not included in the marine approval.
H	2 x ST 100Mb Ethernet & IRIG-B* This option is not included in the marine approval.
I	4 x analogue outputs • 0 to 24 mA scalable 1 x analogue input • 0 to 24 mA scalable Max. 2 modules per relay
J	Double LC 100Mb Ethernet*
K	2 x RJ45 100 Mb Ethernet (HSR, PRP redundant protocols)* This option is not included in the marine approval.
L	1 x RS232 Fiber PP (Plastic-Plastic)*
M	1 x RS232 Fiber PG (Plastic-Glass)*
N	1 x RS232 Fiber GP (Glass-Plastic)*
O	1 x RS232 Fiber GG (Glass-Glass)*

NOTE * Only one additional communication module per relay, to be placed in the last slot (Slot N).

Additional features

- 5-year extended warranty
- Conformal coating of printed circuit boards

NOTE These features have to be ordered separately.

5.2.1 Disclaimer

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The English version of this document always contains the most recent and up-to-date information about the product. DEIF does not take responsibility for the accuracy of translations, and translations might not be updated at the same time as the English document. If there is a discrepancy, the English version prevails.

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