MACX MCR-EX-SL-SD-21-60-LP(-SP)

Solenoid driver



Data sheet
103469_en_05

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1 Description

The device is designed for intrinsically and galvanically isolated control of intrinsically safe solenoid valves, alarm transmitters, and alarm indicators installed in the Ex area.

The intrinsically safe output circuit has a linear characteristic curve with an off-load voltage of 21 V DC and a current limit at 58 mA.

The devices are input loop-powered and therefore do not require additional auxiliary power.

The power needed is transmitted via the control signal on the input side.

The input and the output are electrically isolated from each other.

Sockets are integrated into the COMBICON screw-in connectors for connecting measuring devices.

The devices are certified for safety-related applications up to SIL 3 according to IEC 61508.

Installation in zone 2 in accordance with Ex ec type of protection is permitted.

Features

- 1-channel
- 19.2 V DC … 30 V DC input, loop-powered
- Intrinsically safe output [Ex ia] IIB, IIIC
- 58 mA output current limitation
- Input loop-powered, no additional auxiliary power required
- Up to SIL 3 according to IEC/EN 61508
- Installation in Ex zone 2 permitted
- Safe electrical isolation between input and output
- Mechanically compatible with the DIN rail connector
- Plug-in connection terminal blocks, either screw or spring-cage connection technology (Push-in Technology)
- Housing width of 12.5 mm

Make sure you always use the latest documentation.
It can be downloaded from the product at phoenixcontact.com/products.

This document is valid for the products listed in the “Ordering data” chapter.

This document applies as of 2017 for items with serial numbers greater than 1355645950.

You can use the Signal Conditioner app to call-up comprehensive module information via the integrated QR code reader.

2 Table of contents

1 Description 1
2 Table of contents 2
3 Ordering data 3
4 Technical data 6
5 Safety regulations and installation notes 10
6 Installation 12
7 Output characteristic curve 15
8 Derating 16
9 Calculating a valve circuit 17
10 Comparison of the safety data 18
11 Safety-related applications 19
12 Digital nameplate 22
13 Revision history 23

3 Ordering data

Description	Type	Item no.	Pcs./Pkt.
Ex i solenoid driver. For the intrinsically safe control of Ex i solenoid valves, alarm modules or LEDs installed in the Ex area. Current limitation at 58 mA. For gases up to Group IIB, loop-powered, electrical isolation, SIL 3. Screw connection.	MACX MCR-EX-SL-SD-21-60-LP	2865515	1
Ex i solenoid driver. For the intrinsically safe control of Ex i solenoid valves, alarm modules or LEDs installed in the Ex area. Current limitation at 58 mA. For gases up to Group IIB, loop-powered, electrical isolation, SIL 3. Push-in connection.	MACX MCR-EX-SL-SD-21-60-LP-SP	2924100	1

Accessories	Type	Item no.	Pcs./Pkt.
The partition plate is used to maintain Ex i isolating distances when Ex i and non-Ex i devices are mounted side by side on a DIN rail.	MCR-DP	1430594	1
Universal termination carrier for connecting 16 MACX Analog Ex i signal conditioners to digital or analog I/O cards, via D-SUB connector, 37-pos. (1:1 connection)	TC-D37SUB-ADIO16-EX-P-UNI	2924854	1
Cover for screw shafts of the MSTB connector ranges with a pitch of 5.0 mm and 5.08 mm. These can be aligned and shortened for use with different numbers of positions.	EA-MSTB 2,5/ 5	1831016	50
Insulating sleeve, color: white	MPS-IH WH	0201663	10
Insulating sleeve, color: red	MPS-IH RD	0201676	10
Insulating sleeve, color: blue	MPS-IH BU	0201689	10
Insulating sleeve, color: yellow	MPS-IH YE	0201692	10
Insulating sleeve, color: green	MPS-IH GN	0201702	10
Insulating sleeve, color: gray	MPS-IH GY	0201728	10
Insulating sleeve, color: black	MPS-IH BK	0201731	10
Test plug, with solder connection up to 1 mm² conductor cross section, number of positions: 1, color: gray	MPS-MT	0201744	10
Plastic label, Sheet, white, unlabeled, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, BLUEMARK CLED, PLOTMARK, CMS-P1-PLOTTER, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 10	UC-EMLP (11X9)	0819291	10
Plastic label, Sheet, yellow, unlabeled, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, BLUEMARK CLED, PLOTMARK, CMS-P1-PLOTTER, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 10	UC-EMLP (11X9) YE	0822602	10
Plastic label, can be ordered: by sheet, white, labeled according to customer specifications, mounting type: adhesive, lettering field size: 11 x 9 mm	UC-EMLP (11X9) CUS	0824547	1

Accessories	Type	Item no.	Pcs./Pkt.
Plastic label, can be ordered: by sheet, yellow, labeled according to customer specifications, mounting type: adhesive, lettering field size: 11 x 9 mm	UC-EMLP (11X9) YE CUS	0824548	1
Plastic label, Sheet, silver, unlabeled, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, BLUEMARK CLED, PLOTMARK, CMS-P1-PLOTTER, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 10	UC-EMLP (11X9) SR	0828094	10
Plastic label, can be ordered: by sheet, silver, labeled according to customer specifications, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 10	UC-EMLP (11X9) SR CUS	0828098	1
Plastic label, Card, white, unlabeled, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, THERMOMARK PRIME, THERMOMARK CARD 2.0, THERMOMARK CARD, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 135	US-EMLP (11X9)	0828789	10
Plastic label, Card, yellow, unlabeled, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, THERMOMARK PRIME, THERMOMARK CARD 2.0, THERMOMARK CARD, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 135	US-EMLP (11X9) YE	0828871	10
Plastic label, Card, silver, unlabeled, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, THERMOMARK PRIME, THERMOMARK CARD 2.0, THERMOMARK CARD, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 135	US-EMLP (11X9) SR	0828872	10
Device marker, Sheet, white, unlabeled, can be labeled with: TOPMARK NEO, TOPMARK LASER, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 255	LS-EMLP (11X9) WH	0831678	10
Device marker, Sheet, silver, unlabeled, can be labeled with: TOPMARK NEO, TOPMARK LASER, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 255	LS-EMLP (11X9) SR	0831705	10
Device marker, Sheet, yellow, unlabeled, can be labeled with: TOPMARK NEO, TOPMARK LASER, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 255	LS-EMLP (11X9) YE	0831732	10
Power and fault signaling module with screw connection, including corresponding ME 17,5 TBUS 1,5/ 5-ST-3,81 GY DIN rail connector	MACX MCR-PTB	2865625	1

Accessories	Type	Item no.	Pcs./Pkt.
Power and fault signaling module with Push-in connection, including corresponding ME 17,5 TBUS 1,5/ 5-ST-3,81 GY DIN rail connector	MACX MCR-PTB-SP	2924184	1
Primary-switched power supply, QUINT POWER, screw connection, DIN rail mounting, supply of devices possible via the TBUS DIN rail connector, protective coating, input: single-phase, output: 24 V DC/2.5 A	QUINT4-SYS-PS/1AC/24DC/2.5/SC	2904614	1
Actuation tool, for ST terminal blocks, insulated, also suitable for use as a bladed screwdriver, size: 0.6 x 3.5 x 100 mm, 2-component grip, with non-slip grip	SZS 0,6X3,5	1205053	10

4 Technical data

Hardware/firmware version	
Hardware/firmware version (2865515)	16 / -
Hardware/firmware version (2924100)	16 / -
The technical data and safety characteristics are valid as of the specified HW/FW version.	
Input data Voltage input	
Voltage input signal	19.2 V DC ... 30 V DC (24 V DC, -20 % ... +25 %)
Max. current input signal	95 mA (U_e = 24 V DC)
Output data Voltage output	
Output description	intrinsically safe
Current limitation	> 58 mA
Response time	< 20 ms
Output voltage	≥ 12.9 V DC (58 mA)
Non-load voltage	> 21.9 V DC
Short-circuit-proof	yes
General data	
Supply voltage range	loop-powered, no external supply necessary
Power dissipation	< 1.325 W
Maximum temperature coefficient	0.01 %/K
Degree of protection	IP20 (not assessed by UL)
Flammability rating according to UL 94	V0 (Housing)
Status display	Yellow LED (switching state / status, lights up when output circuit is active)
Dimensions W/H/D	12.5 mm / 112.5 mm / 113.7 mm (MACX MCR-EX-SL-SD-21-60-LP) 12.5 mm / 107.9 mm / 113.7 mm (MACX MCR-EX-SL-SD-21-60-LP-SP)
Depth (Snapped onto DIN rail NS 35/7,5 in accordance with EN 60715)	114.5 mm
Type of housing	PA 6.6-FR

Ambient conditions	
Ambient temperature (operation)	-40 °C ... 60 °C (Any mounting position)
Ambient temperature (operation)	-40 °C ... 70 °C (Derating)
Ambient temperature (storage/transport)	-40 °C ... 80 °C
Permissible humidity (operation)	10 % ... 95 % (non-condensing)
Altitude Ambient temperature (operation) Safety-related maximum voltage U_m Rated insulation voltage	≤ 2000 m -40 °C ... 70 °C 253 V AC 125 V DC 375 V_{PP} (IEC/EN 60079-11) 265 V ($U_{Isolation\ rated\ "ec"}$)
Height range Ambient temperature (operation) Safety-related maximum voltage U_m Rated insulation voltage	> 2000 m ... 3000 m -40 °C ... 63 °C 190 V AC 110 V DC 190 V (IEC/EN 60079-11) 190 V ($U_{Isolation\ rated\ "ec"}$)
Height range Ambient temperature (operation) Safety-related maximum voltage U_m Rated insulation voltage	> 3000 m ... 4000 m -40 °C ... 56 °C 60 V 60 V (IEC/EN 60079-11) 60 V ($U_{Isolation\ rated\ "ec"}$)
Height range Ambient temperature (operation) Safety-related maximum voltage U_m Rated insulation voltage	> 4000 m ... 5000 m -40 °C ... 49 °C 60 V 60 V (IEC/EN 60079-11) 60 V ($U_{Isolation\ rated\ "ec"}$)

Electrical isolation (≤ 2000 m above mean sea level)	
Electrical isolation	2-way isolation
Test voltage Overvoltage category Pollution degree	2.5 kV AC (50 Hz, 60 s) II 2
Output/input Standards/regulations Rated insulation voltage	 IEC/EN 60079-11 375 V_{PP}
Output/input Standards/regulations Rated insulation voltage Insulation	 IEC/EN 61010-1 300 V_{rms} Safe isolation

Safety data in accordance with ATEX and IECEx (≤ 2000 m above mean sea level)	
The following Ex i values apply to the ATEX and IECEx approval. For all other Ex approvals, you must refer to the respective certificates for the Ex i values.	
Max. output voltage U_o	25.1 V
Max. output current I_o	188 mA
Max. output power P_o	1.18 W
Maximum internal resistance R_i	133.4 Ω
Max. external inductivity L_o / Max. external capacitance C_o simple circuit	IIA/I : 8 mH / 2.93 µF
Max. external inductivity L_o / Max. external capacitance C_o simple circuit	IIB/IIIC : 4 mH / 0.83 µF
Max. external inductivity L_o / Max. external capacitance C_o mixed circuit	IIA/I : 5 mH / 510 nF ; 1 mH / 560 nF ; 0.5 mH / 660 nF ; 0.1 mH / 1000 nF
Max. external inductivity L_o / Max. external capacitance C_o mixed circuit	IIB/IIIC : 2 mH / 300 nF ; 0.15 mH / 500 nF
Max. internal inductance L_i	negligible
Max. internal capacitance C_i	negligible
Safety-related maximum voltage U_m	253 V AC
Safety-related maximum voltage U_m	125 V DC

Connection data	Screw connection	Push-in connection
Conductor cross section, rigid	0.2 mm² ... 2.5 mm²	0.2 mm² ... 2.5 mm²
Conductor cross section, flexible	0.2 mm² ... 2.5 mm²	0.2 mm² ... 2.5 mm²
Conductor cross section flexible (2 conductors with same cross section)		0.25 mm² ... 0.34 mm² (TWIN ferrule without plastic sleeve) 0.5 mm² ... 1.5 mm² (TWIN ferrule with plastic sleeve)
Conductor cross section AWG	24 ... 14	24 ... 14 24 ... 22 (TWIN ferrule without plastic sleeve) 20 ... 16 (TWIN ferrule with plastic sleeve)
Stripping length	7 mm	10 mm
Tightening torque	0.5 Nm ... 0.6 Nm	
Diameter Test socket in the connector	2 mm	

Conformance with EMC directive	
Noise immunity according to EN 61000-6-2	
Noise emission according to EN 61000-6-4	

Conformance/Approvals	
CE CE-compliant and EN 61326	
ATEX IBExU 07 ATEX 1133X	Ex I (M1) [Ex ia Ma] I Ex II (1) G [Ex ia Ga] IIB Ex II (1) D [Ex ia Da] IIIC Ex II 3 (1) G Ex ec [ia IIB Ga] IIC T4 Gc
IECEx IECEx IBE 08.0002X	[Ex ia Ma] I [Ex ia Ga] IIB [Ex ia Da] IIIC Ex ec [ia IIB Ga] IIC T4 Gc
CCC / China-Ex 2022122316115980	[Ex ia Ga] IIB [Ex ia Da] IIIC Ex ec [ia IIB Ga] IIC T4 Gc
UL, USA/Canada cULus, C.D.-No 83104549	UL 61010 Listed Class I, Div. 2, Groups A, B, C, D T4 Class I, Div. 2, Groups IIC, IIB, IIA T4 Associated apparatus for use in Class I, Division 1, Groups C,D Associated apparatus for use in Class II, Div.1 Groups E,F,G Associated apparatus for use in Class III, Division 1 Associated apparatus for use in Class I, Zone 0,1,2, Groups IIB, IIA
Shipbuilding approval DNV GL TAA000020C Temperature Humidity Vibration EMC Enclosure	 B B A A Required protection according to the Rules shall be provided upon installation on board
Safety Integrity Level (SIL, IEC 61508)	3
INMETRO DNV 18.0115 X	[Ex ia Ma] I [Ex ia Ga] IIB [Ex ia Da] IIIC Ex ec [ia IIB Ga] IIC T4 Gc

5 Safety regulations and installation notes

5.1 Installation notes

- The device is an item of associated equipment with an EPL [Ga], [Da] (category 1) with “intrinsic safety” type of protection and can be installed in zone 2 potentially explosive areas as an EPL Gc (category 3) device. Intrinsically safe circuits can be led up to zone 0 / zone 20. It satisfies the requirements of the following standards.
  IEC/EN 60079-0, IEC/EN 60079-7, IEC/EN 60079-11
  GB/T 3836.1, GB/T 3836.3, GB/T 3836.4
  ABNT NBR IEC 60079-0, ABNT NBR IEC 60079-7, ABNT NBR IEC 60079-11
  For detailed information, please refer to the declarations of conformity.
- Installation, operation, and maintenance may only be carried out by qualified electricians. Follow the installation instructions as described.
- When installing and operating the device, observe the applicable regulations and safety directives (including national safety directives), as well as the generally recognized technical regulations.
- Observe the safety information, conditions, and limits of use specified in the product documentation. Comply with them.
- The device must not be opened or modified. Do not repair the device yourself, replace it with an equivalent device. Repairs may only be carried out by the manufacturer. The manufacturer is not liable for damage resulting from violation.
- The IP20 degree of protection (IEC/EN 60529) specifies that the device is intended for use in a clean and dry environment. Do not subject the device to mechanical and/or thermal stress that exceeds the specified limits.
- The device complies with the EMC regulations for industrial areas (EMC class A). When using the device in residential areas, it may cause radio interference.
- The device must be stopped if it is damaged, has been subjected to an impermissible load, stored incorrectly, or if it malfunctions.
- The products must be installed in accordance with all applicable standards for electrical systems in potentially explosive areas.
- Only use copper connecting cables.

5.2 Intrinsic safety

- The device is approved for intrinsically safe (Ex i) circuits up to zone 0 (gas) and zone 20 (dust) in the Ex area. The safety technology values for intrinsically safe equipment and the connecting lines must be observed for the hook-up process (IEC/EC 60079-14) and the values specified in this installation note and/or the EU examination certificate must be observed.
- When carrying out measurements on the intrinsically safe side, observe the relevant regulations regarding the connection of intrinsically safe equipment. Use only these approved measuring devices in intrinsically safe circuits.
- If the device was used in circuits which are not intrinsically safe, it is forbidden to use it again in intrinsically safe circuits. Label the device clearly as being not intrinsically safe.

5.3 Installation in the Ex area (zone 2)

- Observe the specified conditions for use in potentially explosive areas! Install the device in a suitable, approved housing with a minimum degree of protection of IP54 that meets the requirements of IEC/EN 60079-7, GB/T 3836.1, or another degree of protection in accordance with ABNT NBR IEC 60079-7, Section 1. Also observe the requirements of IEC/EN 60079-14.
- Only devices which are designed for operation in Ex zone 2 and are suitable for the conditions at the installation location may be connected to the circuits in the Ex zone.
- In potentially explosive areas, connecting and disconnecting cables and plugs in non-intrinsically safe circuits and the latching of devices onto and unlatching devices from the DIN rail connector is only permitted in a de-energized state or when the atmosphere is not potentially explosive.
- The device must be stopped and immediately removed from the Ex area if it is damaged, was subject to an impermissible load, stored incorrectly or if it malfunctions.
- The specified ambient temperature range of $-40°C \leq T_{amb} \leq +60°C$ (+70°C with derating) refers to the temperature inside the installation housing.

5.4 Installation in areas with a danger of dust explosions (zone 22)

- The device is not suitable for installation in zone 22.
- If, however, you wish to use the device in zone 22, you must install it in housing that complies with IEC/EN 60079-31. When doing so, observe the maximum surface temperatures. Observe the requirements of IEC/EN 60079-14.
- Connection to the intrinsically safe circuit in areas with a danger of dust explosions (zone 20, 21 or 22) is only permitted if the equipment connected to this circuit is approved for this zone (e.g., category 1D, 2D or 3D).

5.5 Safety-related applications (SIL)

When using the device in safety-related applications, observe the instructions in “Safety-related applications”, as the requirements differ for safety-related functions.

5.6 UL note

The safety specifications, which are based on UL approval, can be found in the “Control Drawing”. The “Control Drawing” is part of the package slip.

6 Installation

6.1 Connection notes

WARNING: Electrical danger due to improper installation

Observe the connection notes for safe installation in accordance with EN/UL 61010-1:

- Disconnecting devices and branch circuit protection with suitable AC or DC rating shall be provided in the building installation.
- The device is intended for installation in a control cabinet or in a comparable enclosure. The device may only be operated when it has been installed. The control cabinet must meet the requirements of UL/IEC 61010-1 in terms of protection against spread of fire and protection against electric shock or burn.
- Provide a switch/circuit breaker close to the device that is labeled as the disconnect device for this device (or the entire control cabinet).
- Provide for an overcurrent protection device (I ≤ 16 A) in the installation.
- To protect the device against mechanical or electrical damage, install it in suitable housing with an appropriate degree of protection according to IEC/EN 60529.
- During installation, servicing, and maintenance work, disconnect the device from all effective power sources, provided you are not dealing with SELV or PELV circuits.
- If the device is not used as described in the documentation, the intended protection can be negatively affected.
- Thanks to its housing, the device has basic insulation to the neighboring devices, for 300 V_{eff}. If several devices are installed next to each other, this has to be taken into account, and additional insulation has to be installed if necessary! If the neighboring device is equipped with basic insulation, no additional insulation is necessary.
- The voltages present at the input and output are extra-low voltages (ELV). Depending on the application, hazardous voltage (>30 V) to ground may occur. For this event, a safe electrical isolation from the other connection has been implemented.

WARNING: Explosion hazard

If the device has been used in non-intrinsically safe circuits, it must not be used again in intrinsically safe circuits.

The device must be clearly marked as non-intrinsically safe.

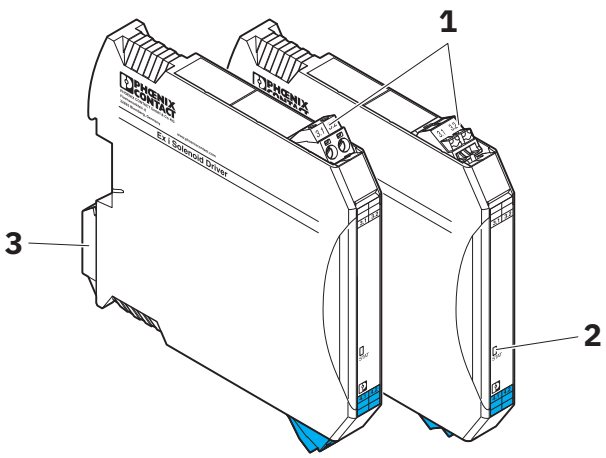
6.2 Electrostatic discharge

NOTE: Electrostatic discharge

The device contains components that can be damaged or destroyed by electrostatic discharge. When handling the device, observe the necessary safety precautions against electrostatic discharge (ESD) according to EN 61340-5-1 and EN 61340-5-2.

6.3 Structure

Figure 1 Structure



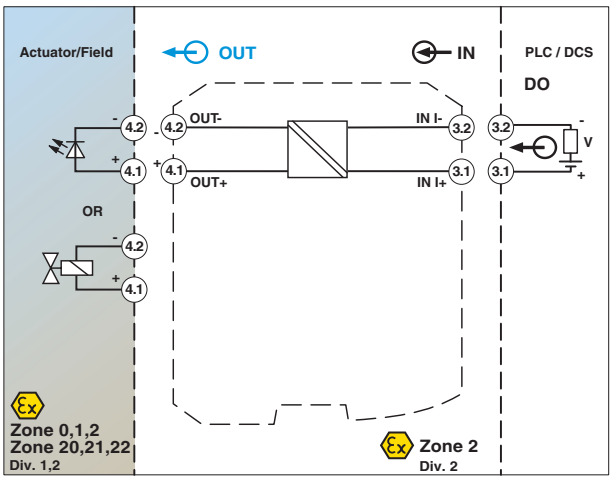
1 COMBICON plug-in screw or push-in connection terminal

2 Yellow “STAT” LED: switching state, lights up when output circuit is active

3 Snap-on foot for DIN rail mounting

6.4 Basic circuit diagram with connection terminal blocks

Figure 2 Basic circuit diagram



6.5 Signal input

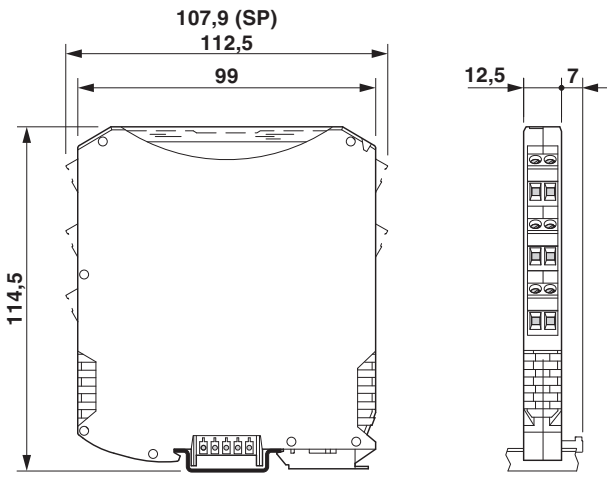
Terminal blocks 3.1 (+) and 3.2 (-), loop-powered

6.6 Signal output (Ex-i)

Terminals 4.1 (+) and 4.2 (-)

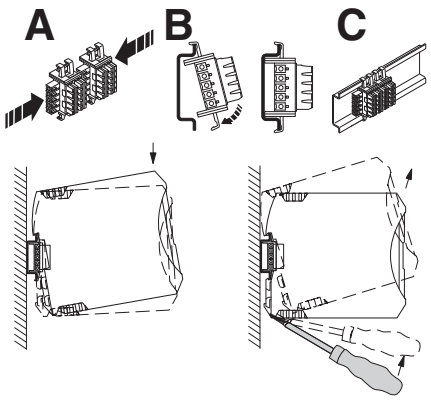
6.7 Dimensions

Figure 3 Dimensions



6.8 Mounting

Figure 4 Mounting and removing



- Mount the device on a 35 mm DIN rail in accordance with EN 60715.
- The device is loop-powered and therefore does not require a separate power supply. The DIN rail connectors are used to supply active devices. A DIN rail connector is not required to operate this solenoid driver. However, the devices can be snapped onto a DIN rail connector. An electrically conductive connection is not established. This means that it is not necessary to disconnect an existing DIN rail connector element connection.
- When using the DIN rail connector, first insert it in the 35 mm DIN rail in accordance with EN 60715 (A – C). DIN rails with a height of 7.5 mm or more can be used. The DIN rail connector is used to bridge the power supply and communication.
- The snap-in direction of device (D) and DIN rail connector (C) must be observed: snap-on foot on the bottom and connector on the left.
- Install the module in a suitable housing to meet the requirements for the protection class.

6.9 Partition plate

If you want to mount Ex i and non-Ex i devices next to each other on a DIN rail, you will require the MCR-DP partition plate (item no. 1430594). The partition plate ensures that Ex i isolating distances are maintained.

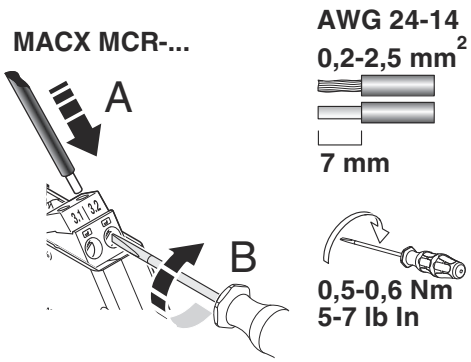
The partition plate is tailored to the MINI Analog, MINI Analog Pro, and MACX Analog device series and the QUINT4 system power supply (item no. 2904614).

The partition plate is compatible with the ME … TBUS DIN rail connectors (e.g., item no. 1090049, 2695439).

6.10 Connecting the cables

Screw connection

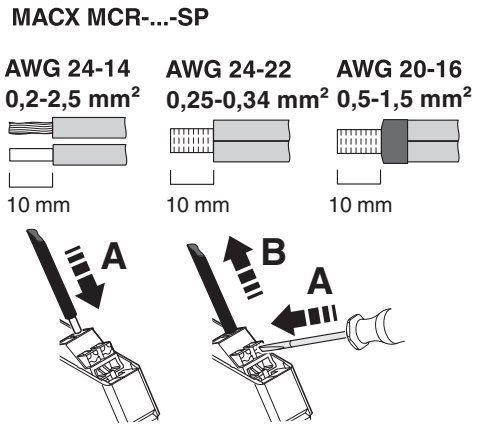
Figure 5 Screw connection



- Strip the wire by approximately 7 mm and crimp the ferrules.
- Insert the wire into the corresponding connection terminal block.
- Use a screwdriver to tighten the screw in the opening above the connection terminal block.
  Tightening torque: 0.6 Nm

Push-in connection (PSPT):

Figure 6 Push-in connection



If you want to use conductors with ferrule:

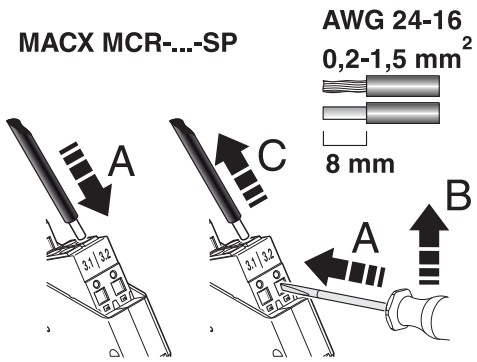
- Strip the wire by approximately 10 mm and crimp ferrules to the end of the wire.
- Insert the wire into the corresponding connection terminal block.
- Push in the pushbutton with a screwdriver to release.

If you want to use conductors without ferrule:

- Strip 10 mm off the wire.
- Push the pushbutton in with a screwdriver.
- Insert the wire into the corresponding connection terminal block.
- Push in the pushbutton with a screwdriver to release.

Push-in connection (TVFKC):

Figure 7 Push-in connection



If you want to use conductors with ferrule:

- Strip the wire by approximately 8 mm and crimp ferrules to the end of the wires.
- Insert the wire into the corresponding connection terminal block.
- Push in the pushbutton with a screwdriver to release.

If you want to use conductors without ferrule:

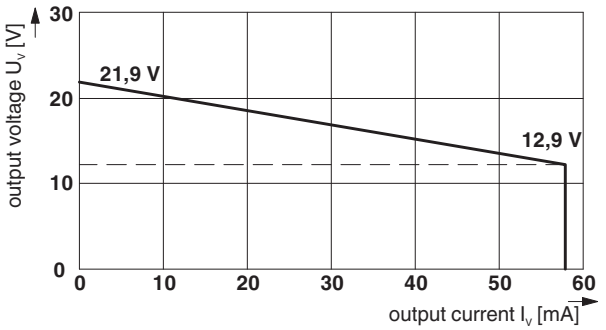
- Strip 8 mm off the wire.
- Push the pushbutton in with a screwdriver.
- Insert the wire into the corresponding connection terminal block.
- Push in the pushbutton with a screwdriver to release.

6.11 Startup

- Before startup, check that the device is operating and wired correctly, in particular with regard to the wiring and marking of the intrinsically safe circuits.

7 Output characteristic curve

Figure 8 Output characteristic curve

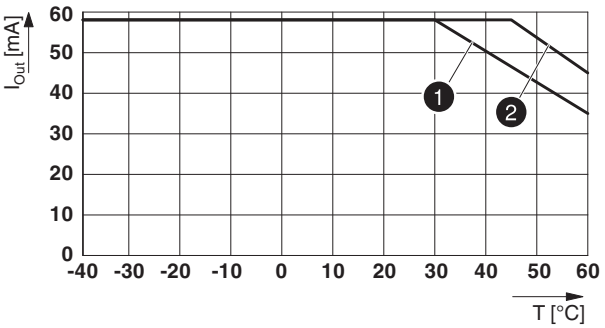


Off-load voltage U_V [V]	21
Output current I_V [mA]	58

8 Derating

The curve shows the maximum output current depending on the mounting position and ambient temperature range.

Figure 9 Derating diagram for -40°C ... +60°C



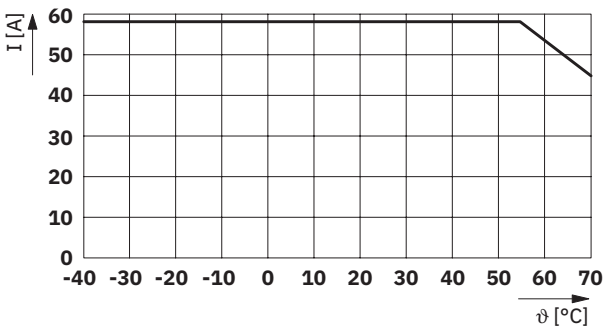
1 = DIN rail perpendicular

2 = Horizontal DIN rail

NOTE: observe ambient temperature!

Observe the installation conditions in the section “Operation” >60°C".

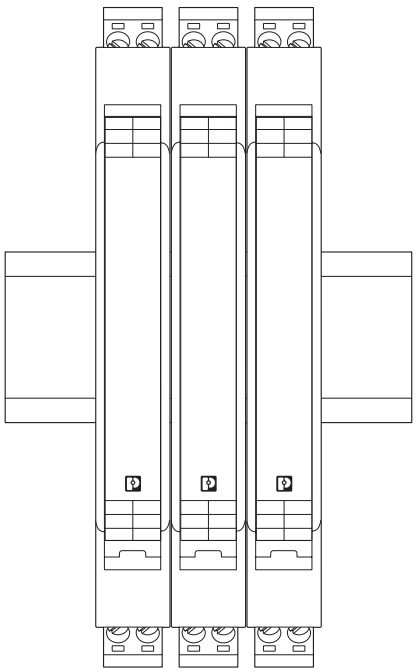
Figure 10 Derating diagram for -40°C ... +70°C (>+60 °C only horizontal installation permitted)



8.1 Operation ≤60°C

The device is designed for operation in any mounting position with an ambient temperature range of -40°C ... +60°C.

Figure 11 Operation ≤60°C



NOTE

The extended operating temperature range of >+60°C ... ≤+70°C only applies to ATEX, CCC EX, INMETRO, and IECEx approvals.

The range up to ≤ +60 °C applies to all other approvals.

8.2 Operation >60°C

Operation >60°C is possible if the following installation conditions are observed.

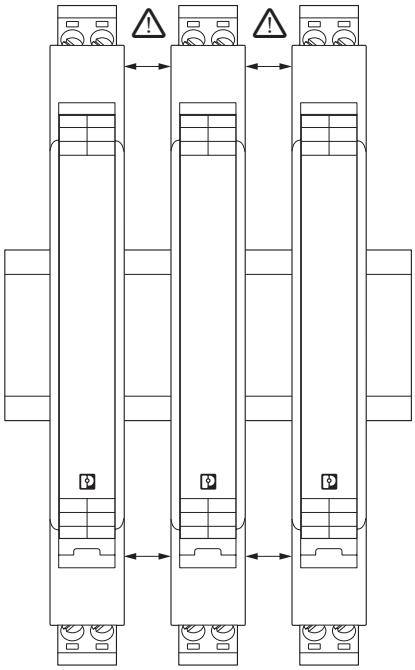
NOTE: Overheating during operation

Special installation conditions apply for operation in the ambient temperature range of >+60°C ... +70°C.

Ensure minimum spacing of 6.2 mm on all sides of the device and make sure that this is maintained.

Always install the device vertically with 6.2 mm spacing on a horizontally mounted DIN rail.

Figure 12 Operation >60°C



9 Calculating a valve circuit

In order to connect a solenoid valve to the module, it is necessary to compare the safety data, and calculate the measurements.

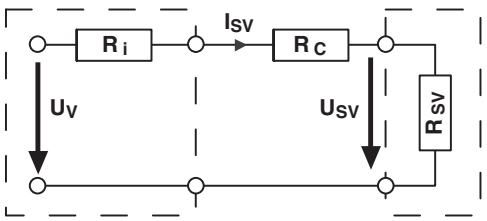
R_i	Internal resistance of the solenoid driver (see technical data)
U_v	Guaranteed voltage of the solenoid driver without load (see technical data)
I_v	Current that can be supplied by the solenoid driver
R_c	Maximum permissible cable resistance when solenoid driver and valve are interconnected
R_{sv}	Effective coil resistance of the solenoid valve (the copper resistance of the coil depends on the temperature)
I_{sv}	The current required by the solenoid coil in order for the valve to pick up
U_{sv}	The voltage which is present at the coil with I_{SV}.

R_{SV} and U_{SV} are dependent on the ambient temperature due to the copper resistance.

The values for R_{SV} and I_{SV} must be obtained from the valve manufacturer.

Calculate the cable resistance R_c using the following formula.

Figure 13 Equivalent circuit



$$R_C \triangleq \frac{U_V}{I_{SV}} - R_i - R_{SV}$$

We recommend calculating the following value for the cable resistance R_c: actual cable resistance + 25 Ω.

In the event of a negative resistance, it is no longer possible to guarantee that the connection will function.

Function requirements: $I_v \geq I_{sv}$ and $R_c > 0\ \Omega$

A list of suitable valves can be found at www.phoenixcontact.com/products.

10 Comparison of the safety data

WARNING: Explosion hazard

Compare the safety data before connecting a device located in the Ex i area to this device.

Provide proof of intrinsic safety according to standard IEC/EN 60079-14 and other national standards and installation specifications, if applicable.

Safety data

Field devices	U_i, I_i, P_i, L_i, C_i
Ex i solenoid driver	U_o, I_o, P_o, L_o, C_o

The values for U_o, I_o, P_o, L_o, C_o are to be found under "Safety data in accordance with ATEX and IECEx" in the "Technical data" section.

Example for proof of intrinsic safety

Data	Condition
$U_i \geq U_o$	-
$I_i \geq I_o$	-
$P_i \geq P_o$	-
$L_i + L_c \leq L_o$	$L_i < 1\%$ of L_o or $C_i < 1\%$ of C_o
$C_i + C_c \leq C_o$	
$L_i + L_c \leq 0.5\ L_o$	$L_i \geq 1\%$ of L_o and $C_i \geq 1\%$ of C_o
$C_i + C_c \leq 0.5\ C_o$	

L_c and C_c depend on the cables used.

Proof of intrinsic safety (simple intrinsically safe circuit)

In a simple intrinsically safe circuit without external concentrated capacitances (C_i) and without external concentrated inductances (L_i), the full values of C_o and L_o can be exploited (see “Safety data in accordance with ATEX and IECEx” in the “Technical data” section).

Proof of intrinsic safety (mixed intrinsically safe circuit)

Condition for the mixed intrinsically safe circuit with external concentrated capacitances (C_i) and/or external concentrated inductances (L_i):

– L_i <1% of L_o**or** C_i <1% of C_o

Here, the full values of C_o and L_o can also be exploited (see “Safety data in accordance with ATEX and IECEx” in the “Technical data” section).

– L_i ≥1% of L_o**and** C_i ≥1% of C_o

Values of 50% of C_o and L_o are to be used here:

– $C_i + C_c \leq 0.5\ C_o$

– $L_i + L_c \leq 0.5\ L_o$

To implement longer cables, you can also use the certified value pairs as an alternative to the values reduced by 50%; they can be found under “Safety data in accordance with ATEX and IECEx” in the “Technical data” section.

11 Safety-related applications

The following notes apply for the devices:

Designation	Item No.
MACX MCR-EX-SL-SD-21-60-LP	2865515
MACX MCR-EX-SL-SD-21-60-LP-SP	2924100

A hardware assessment (FMEDA report) is available for the devices listed above: Exida 06/06-05 R004 V2R0 (January 18, 2008) and Exida 16/04-017 R025 V1R1 (March 10, 2017)

The values of the current FMEDA report Exida 16/04-017 R025 V1R1 (March 10, 2017) are documented below in accordance with IEC 61508-1:2010.

11.1 Safety function

The solenoid driver is a single-channel device. The **safety function** relates to the forwarding of a control signal to the downstream valve. The safe state of the device is an input that has not been activated and therefore an output that is de-energized.

The safe state is entered in the event of an input voltage failure or by removing the device connection terminal blocks.

In accordance with IEC 61508, the device is suitable for the following operating modes:

– Low demand rate
– Continuous demand rate
– High demand rate

11.2 Safety integrity requirements

Error rates

– Type A device (according to IEC/EN 61508-2)
– Safety integrity level (SIL) 3
– HFT 0
– 1oo1 architecture
– MTTR 24 h
– Ambient temperature 40°C

Failure rate in FIT

λ_{SU}	λ_{SD}	λ_{DU}	λ_{DD}	SFF	DC_D
50	0	0	0	100 %	0 %

The MTBF is 237 years.

PFD_{avg} values

T [PROOF]	1 year	5 years	10 years
PFD_{avg}	0.0	0.0	0.0

PFH = 0/h

The device is therefore suitable for SIL 3 applications.

Due to a PFD_{avg} value of 0, it is not necessary to perform regular proof tests. This is, however, still recommended.

Safety circuit according to IEC / EN 61508-1			
Sensor	Device	Processing	Actuator
25 %	<10 %	15 %	50 %

The maintenance/test interval depends on the characteristic data of all devices involved in the safety chain. The intervals may be shorter or longer depending on this characteristic data.

In SIL 3 applications, it is recommended that the maximum possible test interval is determined together with data from the other devices involved in the safety chain.

11.3 Fall time in the safe state

Following a state change at the input (input has not been not activated), the output enters the safe state in < 60 ms (or < 20 ms from 8 mA current consumption of the valve when switched on).

11.4 Conditions

– The failure rates of the components used remain constant throughout the period of use.
– The propagation of errors by the device in the system is not taken into consideration.
– The repair time (replacement) should be 24 hours.
– The failure rates of the external power supply are not taken into consideration.
– The average temperature at which the device is to be used is +40°C. In this case, normal industrial conditions are assumed.
– The specified error rates are based on an ambient temperature of +40°C. For an ambient temperature of +60°C, the error rates must be multiplied by factor 2.5. Factor 2.5 is based on guide values.

11.5 Installation and startup

NOTE: Installation, operation, and maintenance may only be carried out by professionals.

During installation, observe the instructions in the package slip:

Designation	MNR No.
PACKB.MACX MCR-EX-SL-SD-21-60-LP(-SP)	9040243

The package slip is supplied with the device. It can also be downloaded at: www.phoenixcontact.com/products.

- Connect the device according to the installation notes.
- Make sure that the connected actuator corresponds to the function data.
- Check that the device operates correctly with the actuator connected.
- Start up the safety circuit and check that it operates correctly.

11.6 Notes on operation

The yellow LED (STAT) indicates the switching state and lights up when the output circuit is active.

11.7 Recurring checks

Even where the PFD_{avg} value is 0, it is still recommended that you check the function of the device in conjunction with the entire safety circuit.

1. Take appropriate steps to prevent incorrect use.
2. Prevent other areas of the system from being affected by the proof test (e.g., set the controller to test mode).
3. When a voltage between 19.2 V and 30 V is applied at the input, check whether a voltage > 0 V can be measured at the output terminal blocks. The field device must switch simultaneously.
4. Restore the safety circuit to full functionality.
5. Resume normal operation.

11.8 Repair

The devices have a long service life, are protected against malfunctions, and are maintenance-free.

However, if a device should fail, send it back to Phoenix Contact immediately. The type of malfunction and possible cause must also be stated.

Please use the original packaging or other suitable safe packaging when sending devices back for repairs or recalibration.

Phoenix Contact GmbH & Co. KG
Abteilung Service und Reparatur
Flachsmarktstr. 8
32825 Blomberg
GERMANY

11.9 Standards

The devices are developed and tested according to the following standards:

IEC/EN 61508-1: 2011	Functional Safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements
IEC/EN 61508-2: 2011	Functional Safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
IEC/EN 61326-1: 2006	Electrical equipment for measurement, control and laboratory use - EMC requirements

11.10 Abbreviations

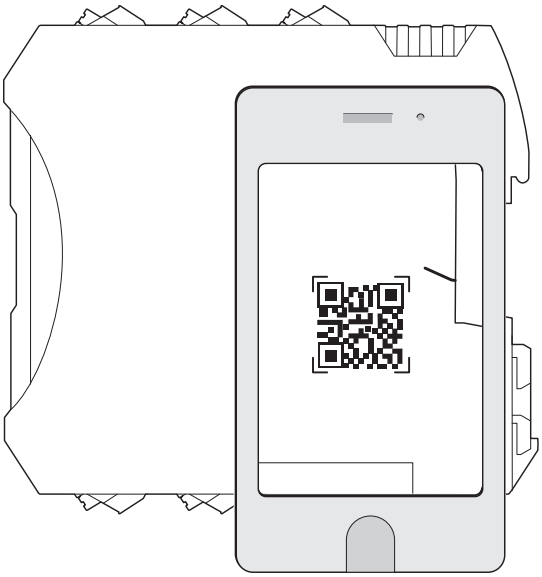
Abbreviation		Meaning
DC_D	Diagnostic coverage of dangerous failures	Diagnostic coverage of dangerous failures: $DC_D = \lambda_{DD}/(\lambda_{DU} + \lambda_{DD})$
DC_S	Diagnostic coverage of safe failures	Diagnostic coverage of safe failures: $DC_S = \lambda_{SD}/(\lambda_{SU} + \lambda_{SD})$
FIT	Failure in time	1 FIT = 1 failure/10^9 h
HFT	Hardware fault tolerance	Hardware fault tolerance: ability of a function unit to continue with the execution of a demanded function despite existing faults or deviations
λ_D	Rate of dangerous failures	Proportion of dangerous failures per hour
λ_{DD}	Rate of dangerous detected failures	Proportion of detected dangerous failures per hour
λ_{DU}	Rate of dangerous undetected failures	Proportion of undetected dangerous failures per hour
λ_S	Rate of safe failures	Proportion of safe failures per hour
λ_{SD}	Rate of safe detectable failures	Proportion of detectable safe failures per hour
λ_{SU}	Rate of safe undetectable failures	Proportion of undetectable safe failures per hour
MTBF	Mean time between failures	Mean time between consecutive failures
MTTR	Mean time to repair	Mean time to repair following a system failure
PFD_{avg}	Average probability of failure on demand	Average probability of dangerous failure on demand of a safety function
PFH_D	Probability of a dangerous failure per hour	Probability of failure per hour for the safety function
PL	Performance level	The performance level indicates the capability of safety-related parts of a control system to carry out a safety function in foreseeable conditions (PL: a, b, c, d, e)
SFF	Safe failure fraction	Proportion of safe failures: proportion of failures without the potential to set the safety-related system to a dangerous or impermissible function state
SIL	Safety integrity level	International standard IEC 61508 defines four discrete safety integrity levels (SIL 1 to 4). Each level corresponds to a probability range for the failure of a safety function. The higher the safety integrity level of safety-related systems, the lower the probability that the demanded safety functions will not be performed.
T[PROOF]		Proof test interval

12 Digital nameplate

The digital nameplate provides the option of obtaining product-specific data related to a specific serial number.

If you scan the QR code (digital nameplate) on the device, you can, for example, retrieve documents on the production status as well as clearly identify the hardware and firmware status of the device at hand.

Figure 14 Scan QR code



13 Revision history

Document revision	Hardware revision	Firmware revision	Date	Description
07	(2865515) 16	-	2024-09-09	Block diagram updated
	(2924100) 16	-		Update of the temperature ranges and addition of derating
				Technical data updated for altitude ranges between 2000 m and 5000 m
				Description of new Push-in connection technology (PSPT) added
				Description of digital nameplate added
				New accessory MCR-DP (item no. 1430594) added
				Adaptation within the scope of an update of the ATEX approval with change to the Ex i values
				Adaptation within the scope of an update of the IECEX approval with change to the Ex i values
				Adaptation within the scope of an update of the CCC Ex approval
				Adaptation within the scope of an update of the INMETRO approval
				Removal of the UKCA approval
				Removal of the EAC Ex approval