Your Global Automation Partner

TURCK

RI360...-QR20-9F16B...
Miniature Encoders with SAE J1939 Output

Instructions for Use

Contents

1 About these instructions

These operating instructions describe the structure, functions and the use of the product and will help you to operate the product as intended. Read these instructions carefully before using the product. This is to avoid possible damage to persons, property or the device. Retain the instructions for future use during the service life of the product. If the product is passed on, pass on these instructions as well.

1.1 Target groups

These instructions are aimed a qualified personal and must be carefully read by anyone mounting, commissioning, operating, maintaining, dismantling or disposing of the device.

1.2 Explanation of symbols used

The following symbols are used in these instructions:

DANGER
DANGER indicates a dangerous situation with high risk of death or severe injury if not avoided.

WARNING
WARNING indicates a dangerous situation with medium risk of death or severe injury if not avoided.

CAUTION
CAUTION indicates a dangerous situation of medium risk which may result in minor or moderate injury if not avoided.

NOTICE
NOTICE indicates a situation which may lead to property damage if not avoided.

NOTE
NOTE indicates tips, recommendations and useful information on specific actions and facts. The notes simplify your work and help you to avoid additional work.

▶ **CALL TO ACTION**
This symbol denotes actions that the user must carry out.

⇨ **RESULTS OF ACTION**
This symbol denotes relevant results of actions.

1.3 Other documents

Besides this document the following material can be found on the Internet at www.turck.com:

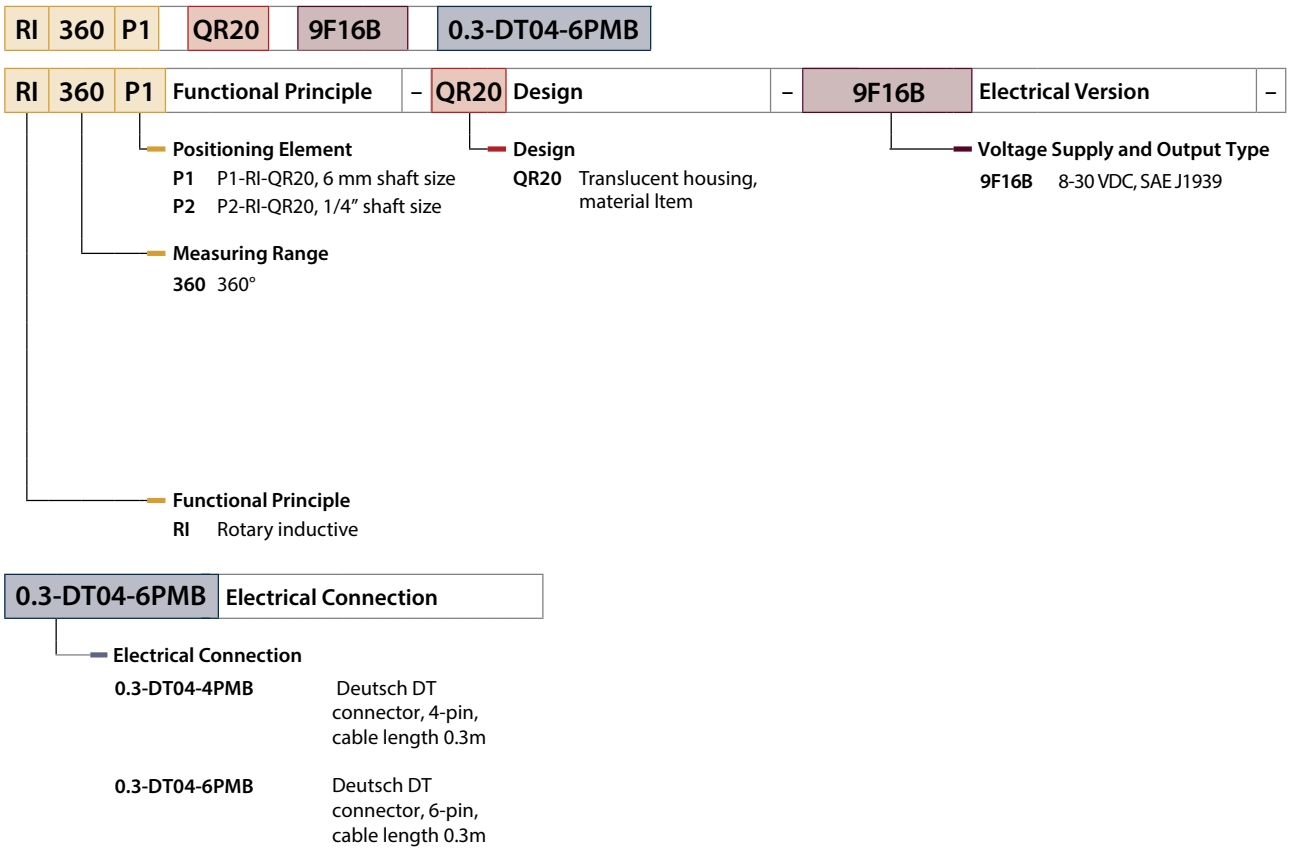
- Data sheet

1.4 Feedback about these instructions

We make every effort to ensure that these instructions are as informative and as clear as possible. If you have any suggestions for improving the design or if some information is missing in the document, please send your suggestions to techdoc@turck.com.

2 Notes on the product

2.1 Product idenfication



2.2 Scope of delivery

The scope of delivery includes:

- Encoder – sensor
- Positioning element
- Quick-Start Guide

2.3 Manufacturer and service

Hans Turck GmbH & Co. KG
Witzlebenstraße 7
45472 Mülheim an der Ruhr
Germany

Turck supports you with your projects, from initial analysis to the commissioning of your application. The Turck product database contains software tools for programming, configuration or commissioning, data sheets and CAD files in numerous export formats. You can access the product database at the following address: www.turck.de/products

For further inquiries in Germany contact the Sales and Service Team on:

- Sales: +49 208 4952-380
- Technology: +49 208 4952-390

Outside Germany, please contact your local Turck representative.

3 For your safety

The product is designed according to state-of-the-art technology. However, residual risks still exist. Observe the following warnings and safety notices to prevent damage to persons and property. Turck accepts no liability for damage caused by failure to observe these warning and safety notices.

3.1 Intended use

The miniature encoders of the RI…-QR20… series with SAE J1939 output are used for angle position measurement.

The devices may only be used as described in these instructions. Any other use is not in accordance with the intended use. Turck accepts no liability for any resulting damage.

3.2 Obvious misuse

The devices are not safety components and must not be used for personal or property protection.

3.3 General safety instructions

The device meets the EMC requirements for industrial areas. When used in residential areas, take measures to avoid radio interference.

4 Product description

The inductive miniature encoders of the RI…-QR20 series consist of a sensor and the positioning element. These two independent and sealed units are fully encapsulated and designed with protection to IP68/IP69K and for contactless operation.

The QR20 rotary encoders are provided with SAE J1939 communication. The range in which angle movements can be measured are programmed by the user.

4.1 Device overview

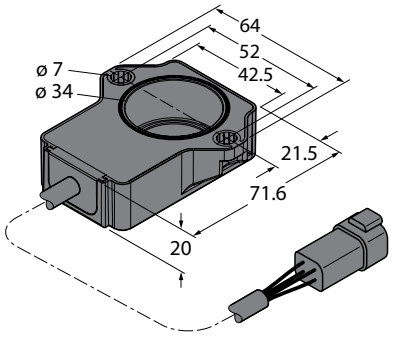


Fig. 2: QR20 miniature rotary encoder with Deutsch connector

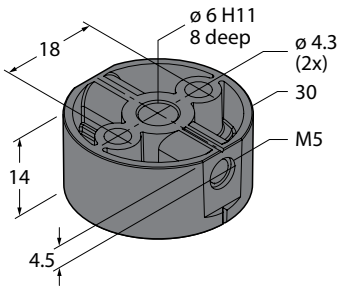


Fig. 4: P1-RI-QR20 positioning element

4.1.1 Indication elements

The devices are provided with three LEDs for displaying communication bus and device signal.

4.2 Properties and features

- Rectangular, plastic
- Compact and robust housing
- Versatile mounting possibilities
- Measuring range indication via LED
- Immune to electromagnetic interference
- Degree of protection IP68/IP69K
- Protection from salt spray
- Resolution: 16 bit

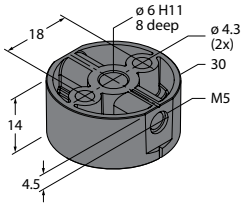
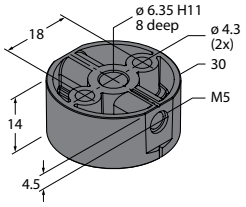
SAE J1939 communication:

- For vehicle electrical systems,12 V and 24 V
- Increased noise immunity 100 V/m based on ISO 11452
- Protection from line-conducted interference (SAE J 113-11)
- Extended temperature range

4.3 Operating principle

The QR20 miniature encoders have contactless operation based on the inductive resonant circuit measuring principle. Measurement is immune to magnetic fields as the positioning element is not based on a magnet but on an inductive coil system, through which the sensor and the positioning element (resonator) can form an oscillation circuit. Sensor and positioning element form an inductive measuring system. An induced voltage generates appropriate signals in the receiver coils of the sensor, depending on the location of the positioning element. The signals are evaluated in the internal 16-bit processor of the sensor and output as SAE J1939 communication signals. The QR20 is an absolute encoder and outputs a unique value for every shaft position.

4.4 Technical accessories

Dimension drawing	Type	Description
	P1-RI-QR20	Positioning element for RI-QR20 rotary encoder, for Ø 6 mm shafts
	P2-RI-QR20	Positioning element for RI-QR20 rotary encoder, for Ø 6.35 mm shafts
	DT06-4S-0877-*M	US Connection cable, Deutsch DT 4-socket, overmold backshell, IP67/IP69K
	DT06-6S-0877-*M	US Connection cable, Deutsch DT 6-socket, overmold backshell, IP67/IP69K

5 Installing

There are two mounting options for the rotary encoder:

- Mount the positioning element in the housing so that it is fully surrounded by the housing (mounting option 1).
- Mount the positioning element above the sensor housing (mounting option 2).

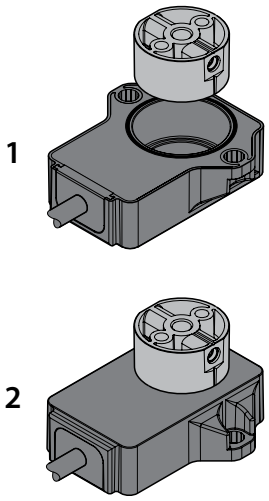


Fig. 20: Mounting types

5.1 Mounting the positioning element in the housing (mounting option 1)

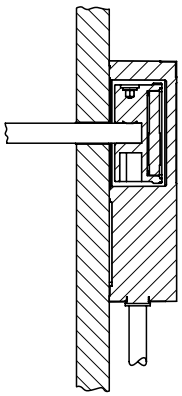


Fig. 21: Mounting the positioning element in the housing

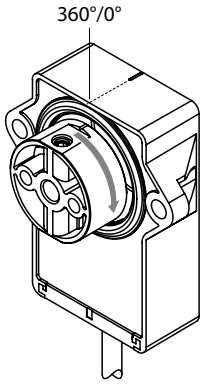


Fig. 22: Aligning the positioning element

- ▶ Push the positioning element onto the shaft.
- ▶ Fasten the positioning element on the shaft.
- ▶ Place the encoder sensor with the front facing the shaft over the positioning element and align to the required position of the zero point. The positioning element has the correct clearance if the opening of the sensor is flush with the shaft.
- ▶ Fasten the encoder with two screws in order to produce a closed and protected unit.

5.2 Mounting the positioning element above the sensor housing (mounting option 2)

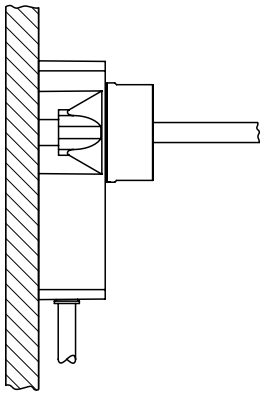


Fig. 23: Mounting the positioning element above the sensor housing

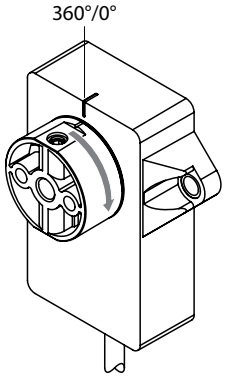
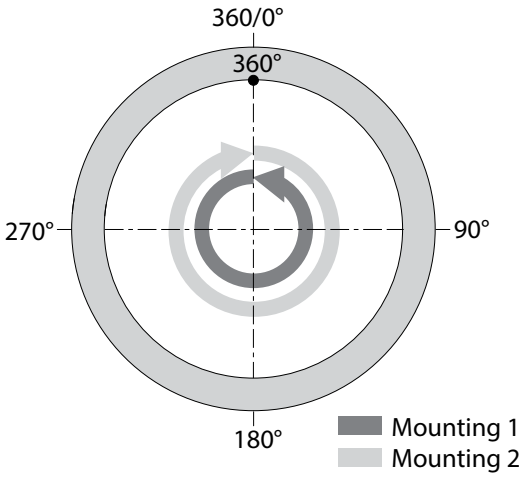


Fig. 24: Aligning the positioning element

- Fasten the encoder sensor with two screws in the surrounding area and with the rear facing the shaft.
- Push the positioning element onto the shaft and align to the required position of the zero point.
- Fasten the positioning element on the shaft.

5.3 Functions and operating modes

The sensor output increases given the direction of rotation and the chosen mounting option shown in the figure below.



6 Connection

The miniature encoder is provided with SAE J1939 communication and is available in the following connection variants:

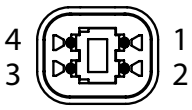
- Cable with 4-pin Deutsch connector
- Cable with 6-pin Deutsch connector

NOTICE
Faulty connection
Risk of damage
- ▶ Ensure correct connection.

NOTE
Turck recommends the use of shielded connection cables.

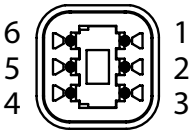
- ▶ Ensure that the entire plant is in a de-energized state during the electrical installation.
- ▶ Connect the female connector of the connection cable to the male connector of the device.

6.1 Wiring diagrams



Pin 1: V+
Pin 2: CAN_H
Pin 3: V- (GND)
Pin 4: CAN_L

Deutsch connection 4-pin layout



Pin 1: CAN_H
Pin 2: CAN_L
Pin 3: V+
Pin 4: V- (GND)
Pin 5: N/C
Pin 6: CAN_Shield

Deutsch connection 6-pin layout

7 Commissioning

7.1 Communication protocols and packet structure

The device supports standardized J1939 PGNs in addition to PGNs that are specific to Turck sensor technologies.

The standardized J1939 PGNs supported are as follows:

PGN Request **0xEA** **234(dec)**

Requests a specific PGN from the device. This shall be utilized to make various diagnostics available on-demand.

Transport Protocol Communication Management (TP.CM)0xEC00 **60416(dec)**

Used in the J1939 Trasport Protocol for functions including the Broadcast Area Message(BAM) indicating that a device wishes to send data greater than 8 bytes, as well as Request-To-Send (RTS) and Clear-To-Send (CTS) messages.

Transport Protocol Data Transfer (TP.DT) **0xEB00** **60160(dec)**

This PGN is used to transmit the data for messages longer than 8 bytes.

Address Claimed **0xEE00** **60928(dec)**

This is used for dynamic network management in J1939. The PGN's data field consists of the globally-unique 64-bit device NAME which contains information including Turck's manufacturer code and a unique serial number.

Commanded address **0xFED8** **65240(dec)**

This PGN is used to instruct a device with a specific NAME to use a certain address. It is 9 bytes (the NAME, plus the designated address) and therefore must be transmitted with a BAM (one TP.CM packet and one TP.DT packet).

Acknowledgement **0xE800** **5932(dec)**

Used to acknowledge certain J1939 network operations. As an example, the device transmits this PGN when it receives a PGN request.

Proprietary A **0xEF+00(Destination Address)** **61184(dec)**

The only non-broadcast manufacturer-specific PGN in the J1939 standard. Turck uses this for all manufacturer and device-specific commands to send instructions and configure the device.

Proprietary B **0xFF00 - 0xFFFF** **65280 – 65535(dec)**

SAE has set aside these PGNs for manufacturer-specified data. These are all broadcast messages and therefore no destination address is specified in the identifier.

7.2 Addresses and names

Upon power up, the device sends a J1939 Packet over CAN called a NAME. The NAME is a 64 bit(8 bytes) label that provides a unique identity to each item. Confirm the following CAN frame is transmitted from the DUT:

- Identifier: 0x18EEFF80
- Data: 0x D0 00 8E 00 72 80 00 00

Note that the last byte in the identifier is the J1939 address and is 0x80(128dec). This is the default address of each device.
The NAME will be transmitted in the little-endian format in the data field and takes the following packet structure:

Arbitrary Address Capable	Industry Group	Vehicle System Instance	Vehicle System	Reserved	Function	Function Instance	ECU Instance	Manufacturer Code	Identity Number
1 bit	3 bit	4 bit	7 bit	1 bit	8 bit	5 bit	3 bit	11 bit	21 bit

Byte Number in CAN Message	Meaning
0	Bits 0-7: Identity Number, LSB
1	Bits 0-7: Identity Number
2	Bits 0-4: Identity Number, MSB Bits 5-7: Manufacturer Code, LSB
3	Bits 0-7: Manufacturer Code, MSB
4	Bits 0-2: ECU Instance Bits 3-7: Function Instance
5	Bits 0-7: Function
6	Bit 0: Reserved Bits 1-7: Vehicle System
7	Bits 0-3: Vehicle System Instance Bits 4-6: Industry Group Bit 7: Arbitrary Adress bit

7.2.1 Parameter data

PGN 0xFF10 is used for primary sensor data transmission. Every 50ms, the device transmits data in the following CAN format:

Identifier: 0x18FF1080

Data: Sensor data as described here:

Data Bytes							
7		6	5	4	3	2	1	0
Reserved(6)	Target Status (2)	Reserved (8)	Speed MSB (8)	Speed LSB (8)	Position MSB (8)	Position LSB (8)	Turn count MSB (8)	Turn count LSB (8)

Note that “target status” refers to the detection of the target resonator. It is represented with the following values:

- 0 – No target detected
- 1 – Target detected but low amplitude
- 2 – Target detected, amplitude good

8 Operation

8.1 LED indications

3 Status LED's: Bus Status: (1) Green (1) Red

Signal status: (1) Green

Bus LED status	Description	Cause of error
Off	The device is in the "reset" status or there is no power supply	Data transmission line break. Incorrect baud rate, inverted data line
Blinking Green and Red (alternating colors)	The device is in the "pre-operational" state	Address claiming
Blinking Green	The device is in the "operational" state, bus connection successful	Cyclic transfer
Blinking Red	Bus connection interrupted	No acknowledgement
On: Red	Bus failure / Bus off	Short circuit on the bus

Signal LED status	Description
On: Green	Position element signal is in ideal range
Blinking Green	Position element signal is weak
Off	Position element is out of range

9 Commands and setting

9.1 Set CAN termination 64(hex) 100(dec)

	Data Length	Data Bytes (MSB...LSB)							
		7	6	5	4	3	2	1	0
CAN-ID	8 bytes	Reserved (48)						CAN Termination Status (8)	Command (8)
0x18EF8000		**00**	**00**	**00**	**00**	**00**	**00**	**00**	**64**

CAN Termination Status:
- 0 for off
- 1 for on

9.2 Reboot 65(hex) 101(dec)

	Data Length	Data Bytes (MSB...LSB)							
		7	6	5	4	3	2	1	0
CAN-ID	8 bytes	Reserved (56)							Command (8)
0x18EF8000		**00**	**00**	**00**	**00**	**00**	**00**	**00**	**65**

Description: Reboots the device software

9.3 Factory reset 66(hex) 102(dec)

CAN-ID	Data Length	Data Bytes (MSB...LSB)							
		7	6	5	4	3	2	1	0
	8 bytes	Reserved (56)							Command (8)
0x18EF8000		**00**	**00**	**00**	**00**	**00**	**00**	**00**	**66**

Description: Resets all non-volitile parameters to factory settings

9.4 Set sensor parameters C8(hex) 200(dec)

CAN-ID	Data Length	Data Bytes (MSB...LSB)							
		7	6	5	4	3	2	1	0
	8 bytes	Reserved (8)	Position Offset MSB (8)	Position Offset (8)	Set Position Offset (8)	Filter Settings (2)	Scale Factor MSB (8)	Scale Factor LSB (8)	Command (8)
0x18EF8000		**00**	**00**	**00**	**00**	**01**	**00**	**B6**	**C8**

Scale Factor: The divisor for the 16-bit position data. Default value is 1. May expand to a 16-bit field.
Example: Set singleturn feedback to degrees
65536/360=182. Use B6(182dec) as the Scale factor.

Filter Setting: Position data filter configuration.
- 0 for no filter
- 1 for standard(default)
- 2 for smooth

Set Position Offset: the Byte is ignored if value is 0. If the value is set to 1, the current target positon will be set to the new “zero” point.

Position Offset: The “zero” point of the position sensor is set to this value. The value is ignored if Byte 4 is set to 1.

Note: These parameters are non-volatile and will be saved in the event of a power cycle. Factory reset command will reset these parameters to their defaults.

9.5 Set Multi-turn count C9(hex) 201(dec)

	Data Length	Data Bytes (MSB...LSB)							
		7	6	5	4	3	2	1	0
CAN-ID	8 bytes	Reserved (40)					Multi-turn count MSB (8)	Multi-turn count LSB (8)	Command (8)
0x18EF8000		**00**	**00**	**00**	**00**	**00**	**00**	**00**	**C9**

Description: Used to set the Multiturn value of the sensor.

10 Troubleshooting

The strength of the resonance coupling is indicated by an LED. Any faults are indicated via the LEDs.

If the device does not function as expected, first check whether ambient interference is present. If there is no ambient interference present, check the connections of the device for faults.

If there are no faults, there is a device malfunction. In this case, decommission the device and replace it with a new device of the same type.

If additional support is requested, the following PGNs may be helpful to access.

10.1 PGN: 0xFFE0 Contains device application firmware version number

Data Length	Data Bytes (MSB...LSB)							
	7	6	5	4	3	2	1	0
8 bytes	Reserved (32)				App Version A (8)	App Version B (8)	App Version C (8)	App Version D (8)

Version is expressed in the format A. B. C. D (e.g 1.0, 3.0), in order of revision significance.

10.2 PGN: 0xFFE1 Contains bootloader version number

Data Length	Data Bytes (MSB...LSB)							
	7	6	5	4	3	2	1	0
8 bytes	Reserved (32)				BL Version A (8)	BL Version B (8)	BL Version C (8)	BL Version D (8)

Version is expressed in the format A. B. C. D (e.g 1.0, 3.0), in order of revision significance.

11 Maintenance

Ensure that the plug connections and cables are always in good condition.

The devices are maintenance-free, clean dry if required.

12 Repair

The device must not be repaired by the user. The device must be decommissioned if it is faulty. Observe our return acceptance conditions when returning the device to Turck.

12.1 Returning devices

Returns to Turck can only be accepted if the device has been equipped with a Decontamination declaration enclosed. The decontamination declaration can be downloaded from
https://www.turck.de/en/return-service-6079.php
and must be completely filled in, and affixed securely and weather-proof to the outside of the packaging.

13 Decommissioning

- Disconnect the connection cable from the power supply and/or processing units.
- Disconnect the connection cable from the device.
- Undo the connections of the device or if necessary the mounting aid for the mounting area.
- If present: Undo the connection between the device and the mounting aid.

14 Disposal

The devices must be disposed of correctly and must not be included in general household garbage.

15 Technical data

Technical data	
Measuring principle	Inductive
Max. Rotational Speed	3000 rpm
Starting torque, shaft load (radial/axial)	Not applicable with contactless measuring principle
Resolution	0.09°
Measuring range	0…360°
Nominal distance	1 mm
Repeat accuracy	≤ 0.025 % of full scale
Linearity deviation	≤ 0.3 % of full scale
Ambient temperature	-40…+85 °C
Storage temperature	-40…+125 °C
Temperature changes (EN 60068-4-2)	-40…+85 °C, 20 cycles
Operating voltage	8…30 VDC
Ripple	≤ 10 % U_{ss}
Insulation test voltage	≤ 0.5 kV
Short-circuit protection	Yes
Wire breakage / reverse polarity protection	Yes
Output type	Absolute singleturn
Communication protocol	SAE J1939
Baud rate	250k bits/s
Speed accuracy	+/- 10 rpm
Sampling rate	800 Hz
Load dump protection (ISO 16750-2)	Impulse 5a: 151 V, Impulse 5b: 58 V, Criterion A
Current consumption	< 50 mA
Design	**Rectangular, QR20**
Dimensions	71.6 × 62.5 × 20 mm
Flange type	Flange without mounting bracket
Shaft type	Blind hole shaft
Shaft diameter D	6 mm 6.35 mm
Housing material	Plastic, Ultem
Electrical connection	RI…-QR20…-DT04-4PMB: Cable with male 4-pin connector, Deutsch DT04-4PMB RI…-QR20…-DT04-6PMB: Cable with male 6-pin connector, Deutsch DT04-6PMB
Vibration resistance	55 Hz (1 mm)
Vibration resistance (EN 60068-2-6)	20 g, 10…3000 Hz, 50 cycles, 3 axes
Shock resistance (EN 60068-2-27)	100 g, 11 ms ½ sine; each 3 ×, 3 axes
Continuous shock resistance (EN 60068-2-29)	40 g, 6 ms ½ Sinus, 4000 × each, 3 axes
Salt spray test (EN 60068-2-52)	Degree of severity 5 (4 test cycles)
Type of protection	IP68/IP69K
MTTF	423 years to SN 29500 (Ed. 99) 40 °C
Power-on indication	**LED, green**
Measuring range indication	Multifunction LED green, green flashing

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