Your Global Automation Partner

TURCK

REM…|RES…
Encoders with SAE J1939 Interface

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 at 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
- Quick Start Guide

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 identification

These instructions apply to the following encoders with SAE J1939 interface:

- REM-…-9F32B-H1151
- RES-…-9F14B-H1151

2.2 Scope of delivery

The scope of delivery includes:

- Encoder – sensor
- Quick Start Guide

2.3 Legal requirements

The devices are subject to the following EU directives:

- 2014/30/EU (electromagnetic compatibility)
- 2011/65/EU (RoHS Directive)
- 2012/19/EU (WEEE II)

2.4 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

These devices are designed solely for use in industrial areas.

Encoders with an SAE J1939 interface are used to measure angular movements. To do this, the devices record mechanical rotary movements and convert them into digital output signals.

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.
- Any use that exceeds the maximum permissible mechanical speed (see technical data) is deemed to be not in accordance with the intended purpose.

3.3 General safety notes

- The device only meets the EMC requirements for industrial areas and is not suitable for use in residential areas.
- The device may only be assembled, installed, operated, parameterized and maintained by professionally-trained personnel.
- The device may only be used in accordance with applicable national and international regulations, standards and laws.
- If safe operation is no longer guaranteed: Take the device out of operation and ensure that it cannot be switched on again accidentally.

4 Product Description

The encoders in the REM… and RES… product series with SAE J1939 interface are available as solid shaft or hollow shaft versions. Devices are available in three different sizes, ranging from 58 to 100 mm.

The SAE J1939 encoders output the current angular position in digital form using parameter groups (PGs).

4.1 Device overview

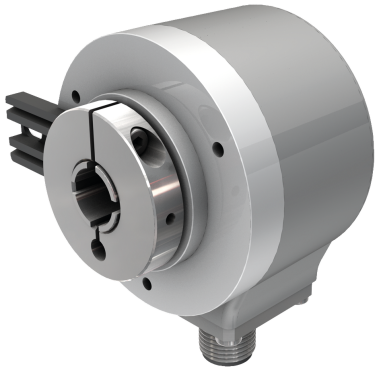


Fig. 1: Example – encoder with hollow shaft

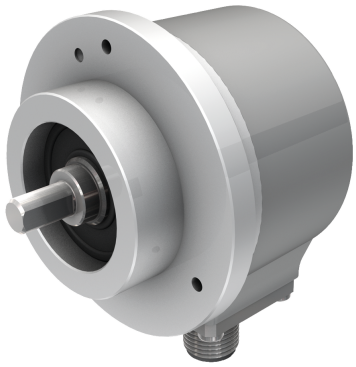


Fig. 2: Example – encoder with solid shaft

4.2 Operating principle

Encoders detect rotational movements, such as the angle velocity of a shaft. Encoders convert the rotational movements into electrical signals. The devices pass on the electrical signals to a higher-level controller for evaluation. Encoders are designed as absolute and incremental encoders with hollow or solid shafts.

Absolute encoders also supply the angle value after a startup if the value has changed when deactivated. Incremental encoders only detect position changes when active by counting periodic patterns. This normally involves the optical scanning of a rotating disk.

4.3 Functions and operating modes

4.3.1 Output function

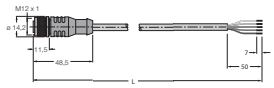
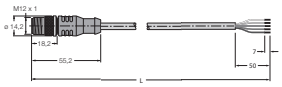
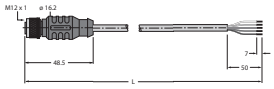
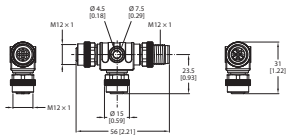
The device has an SAE J1939 interface in accordance with ISO 11898.

Various device functions can be set and parameterized by using the control software (see "Setting" section).

4.3.2 Terminating resistor

A bus terminating resistor can be switched on and off via the SAE J1939 interface.

4.4 Technical accessories

Dimension drawing	Type	Ident No.	Description
	RKC5701-5M	6931034	Bus cable for CAN (DeviceNet, CANopen), M12 female connector, straight, A-coded, cable length 5 m, jacket material: PUR, anthracite, open end; other cable lengths and qualities available, see www.turck.com
	RSC5701-5M	6931036	Bus cable for CAN (DeviceNet, CANopen), M12 male connector, straight, A-coded, cable length 5 m, jacket material: PUR, anthracite, open end; other cable lengths and qualities available, see www.turck.com
	RKC 572-2M	U5311-02	Bus cable for CAN (DeviceNet, CANopen), M12 female connector, straight, A-coded, cable length 5 m, jacket material: PVC, grey, open end; other cable lengths and qualities available, see www.turck.com
	RKC 572-2M/ S3117	U-54470	Bus cable for CAN (DeviceNet, CANopen), M12 female connector with no drain connection to pin 1 on BUS, straight, A-coded, cable length 2 m, jacket material: PVC, grey, open end; other cable lengths and qualities available, see www.turck.com
	FSM-2FKM57	6622101	T-splitter without cable for CAN (DeviceNet, CANopen), M12 adaptor, 5-pin

5 Installing

NOTICE
Incorrect mounting
Risk of damage to the sensor

- Do not modify or disassemble the encoder.
- Do not make adjustments to the shaft after mounting.
- Do not use a hammer to align the device.
- Avoid impact loads.
- Load the encoder shaft only within the permissible values (see technical data).
- Do not rigidly connect the rotary encoder to shafts and flanges at the same time. Use the coupling between the drive shaft and the encoder shaft or the hollow shaft encoder flange.

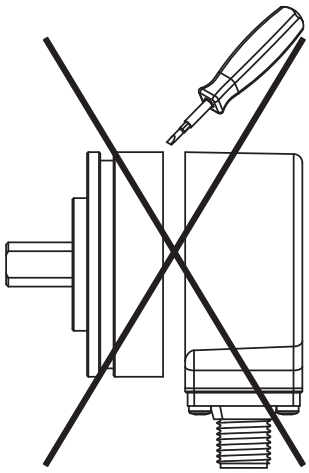


Fig. 3: Mounting view – do not open

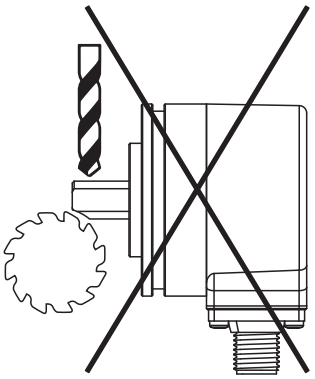


Fig. 4: Mounting view – do not make adjustments after mounting

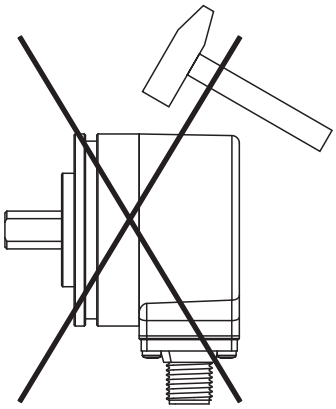


Fig. 5: Mounting view – do not use a hammer to align the device

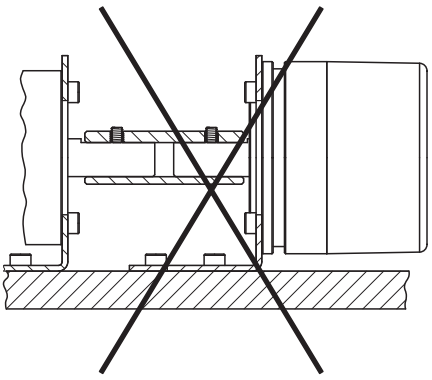


Fig. 6: Mounting view – do not rigidly connect the device to shafts and flanges at the same time

5.1 Mounting the solid shaft encoder using a coupling

- Check shaft for displacement.
- Refer to the technical data for the coupling for the maximum axial displacement, radial displacement, and angular displacement values.

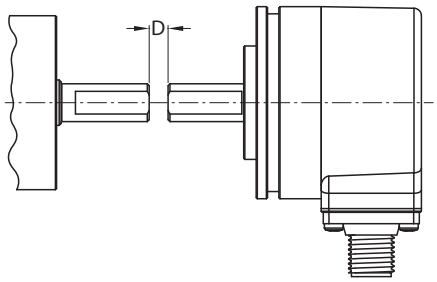


Fig. 7: Axial displacement

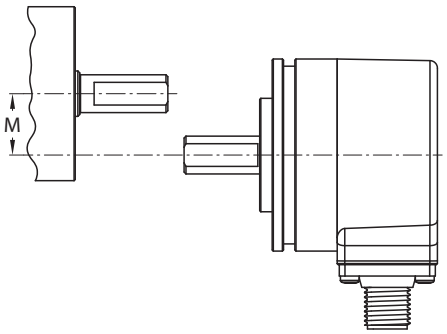


Fig. 8: Radial displacement

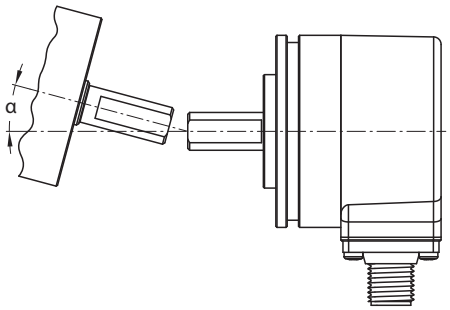


Fig. 9: Angular displacement

- During mounting, protect the coupling against excessive bending and damage.
- Align the coupling on the shaft.
- Secure the coupling on the device using tensioning screws or clamping screws. For the maximum tightening torque, refer to the data sheet of the screws used.

5.2 Mounting the hollow shaft encoder using a coupling

▶ Mount the encoder with the coupling on the shaft.

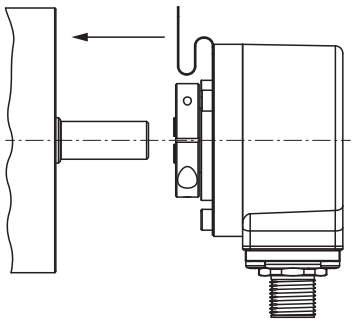


Fig. 10: Mounting on the shaft with the coupling

▶ Screw the coupling to the drive flange.

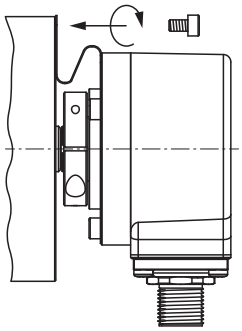


Fig. 11: Screwing the coupling to the drive flange

▶ Carefully tighten the clamping hub.

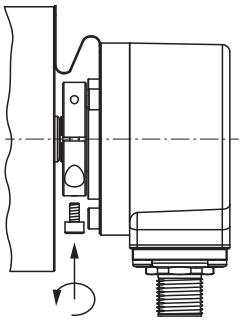


Fig. 12: Tightening the clamping hub

6 Connection

The encoder is equipped with one 5-pin M12 × 1 connector for CANopen input and output. The pin assignment can be found on the sensor label or the data sheet.

NOTE
Observe the maximum cable lengths for spurs and for the overall length of the CAN bus.

6.1 Wiring diagram

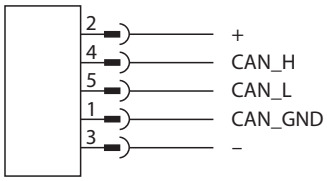


Fig. 13: Wiring diagram

The rotary encoders are equipped with a bus trunk cable in different lengths or an M12 connector, and can be terminated in the device. The rotary encoders are intended as end devices and are not equipped with an integrated T-coupler and looped-through bus. An optional T-coupler is available [▶ 9], see **www.turck.com**.

7 Commissioning

7.1 Parameters – default settings

The following default values are stored on the device:

Byte	Parameter name	Value	Meaning
0…1	OperatingParameter	0x04	Operating mode: Scaling active, CW direction of rotation
2…5	MUR	0x4000	Measuring units per revolution: 16384 steps
6…9	TMR	0x10000000	Total measuring range: 268435456
10…13	SensorCycleTime	0x32	Cycle time: 50 ms
14	CANBusTermination	0x01	Bus terminating resistor on
15…18	SensorPresetValue	–	
19	SensorPresetEnable	–	
20	BaudRate	0x01	250 kbps
	J1939 address	0x20	32

7.2 Parameter data

PG 0xEF00 is used by default for data transmission.

Byte no.	Bit							
	7	6	5	4	3	2	1	0
0	OperatingParameter (LSB…MSB)							
1								
2	MUR (LSB…MSB)							
3								
4								
5								
6	TMR (LSB…MSB)							
7								
8								
9								
10	SensorCycleTime (LSB…MSB)							
11								
12								
13								
14	CANBusTermination (LSB…MSB)							
15	SensorPresetValue (LSB…MSB)							
16								
17								
18								
19	SensorPresetEnable							
20	BaudRate							

7.2.1 Meaning of the parameter bits

Description	Meaning
OperatingParameter	Direction of rotation and scaling 0x00: Scaling not active, clockwise (CW) direction of rotation 0x01: Scaling not active, counter-clockwise (CCW) direction of rotation 0x04: Scaling active, clockwise (CW) direction of rotation 0x05: Scaling active, counter-clockwise (CCW) direction of rotation
MUR	Measuring units per revolution, adjustable from 1…16384 (0x01…0x4000) The MUR parameter can only be used when scaling is active. If the MUR parameter is changed, the ratio to the value of the TMR parameter is automatically reviewed. If the ratio of the parameters is invalid, the device issues an error message and the set value is discarded.
TMR	Total measuring range of singleturn and multiturn, adjustable from 1…4294967296 (0x01…0x000100000000) A factor is applied to the maximum physical resolution. The factor is always < 1. After the scaled total position of the measuring steps, the encoder returns to zero. The TMR parameter can only be used when scaling is active. If the TMR parameter is changed, the ratio to the value of the MUR parameter is automatically reviewed. If the ratio of the parameters is invalid, the device issues an error message and the set value is discarded.
SensorCycleTime	Cycle time in ms, in which the current position is transmitted via the measurement data PG, adjustable from 5…65535 (0x05…0xFFFF) Timer-controlled transmission is activated as soon as SensorCycleTime > 0 is entered in the configuration PGN.
CANBusTermination	Activating and deactivating bus terminating resistor. If the parameter is changed, the setting is applied without restarting. 0x00: Bus terminating resistor off 0x01: Bus terminating resistor on 0xFF: Do not change bus terminating resistor
SensorPresetValue	Position value of the encoder, adjustable from 1…4294967296 (0x01…0x000100000000) The position value is set to the specified preset value. This enables the zero position of the encoder to be compared to the machine zero point, for example. The value of the PresetValue parameter must be less than the value of the TMR parameter.
SensorPresetEnable	Activate the preset position value (PresetValue) of the encoder 0x00: Preset position value not active 0x01: Preset position value active If the preset position value is activated via the PresetEnable parameter, the BaudRate parameter must have the value 0xFF.
BaudRate	Transfer rate 0x01: 250 kbps 0x02: 500 kbps 0xFF: Do not change the transmission rate If the preset position value is activated via the PresetEnable parameter, the BaudRate parameter must have the value 0xFF.

7.3 Process data

PG 0xFFAA is used by default for data transmission.

Byte no.	Bit							
	7	6	5	4	3	2	1	0
0	EncoderPosition (LSB…MSB)							
1								
2								
3								
4	EncoderSpeed (LSB…MSB)							
5								
6	EncoderDiagStatus (LSB…MSB)							
7								

7.3.1 Meaning of the status bits

Description	Meaning
EncoderPosition	Position value Possible values: 0…4294967296 (0x00…0x000100000000) When scaling is activated, the TMR/MUR ratio is active, otherwise the 32-bit raw position of the sensor is output.
EncoderSpeed	Current speed in min^{-1} as a 16-bit value (signed) The signature indicates the direction of rotation.
EncoderDiagStatus	Diagnostic messages 0x0000: No error 0xEE00: General error 0xEE01: Invalid resolution, parameter MUR is 0 or >16384 (0x4000) 0xEE02: Value of the TMR parameter is 0 Other values: Other error

8 Operation

8.1 LEDs

LED indication	Meaning
Green	Bus connection active Address claimed If cycle time ≠ 0: Acyclic PGN transfer active
Flashing green	No errors with device
Red	No connection to the master Possible causes: ■ Short-circuit at the bus ■ No bus available ■ Incorrect transmission rate ■ Address conflict (no address yet available or address claim lost)
Red and green flash alternately	Data connection to sensor faulty or sensor defective. Contact Turck.
Red and green flash simultaneously	Watchdog error Contact Turck.

9 Setting

9.1 Example: change device parameters

NOTE
The following example includes fictitious values and invalid configuration parameters.

In the following example, the device parameters of an encoder with the bus address 0x20 must be changed. The bus address of the controller is 0x01. The following table contains sample configuration data:

Parameter	Byte	Value		
		Hexadecimal	Hexadecimal (Endian)	Decimal
OperatingParameter	2	0x0102	0x0201	258
MUR	4	0x03040506	0x06050403	50595078
TMR	4	0x0708090A	0x0A090807	117967114
SensorCycleTime	4	0x0B0C0D0E	0x0E0D0C0B	185339150
CANBusTermination	1	0x0F	0x0F	16
SensorPresetValue	4	0x10111213	0x13121110	269554195
SensorPresetEnable	1	0x14	0x14	20
BaudRate	1	0x15	0x15	21

SAE J1939 transmits the data with the least significant byte first (little-endian format). As an example, the following raw data stream is transmitted to the encoder:
02 01 06 05 04 03 0A 09 08 07 0E 0D 0C 0B 0F 13 12 11 10 14 15 (see "Hexadecimal (Endian)" column)

- The data must be distributed over several CAN frames and transmitted via the CMDT transport protocol.
- CAN frames must be sent as extended frames (29-bit identifiers).
- A maximum of 8 bytes of user data can be transmitted per CAN frame.

▶ Establish a CMDT connection with the coded parameters.
▶ Send RTS packet with the following content to the encoder and wait for the sensor to respond:

- Control byte: 0x10
- Message size: 0x15
- Total number of packets: 3
- Maximum number of packets: 0xFF
- PG number: 0xEF00
- Source address: 0x01
- Destination address: 0x20

	Byte							
	0	1	2	3	4	5	6	7
Send RTS request for CAN ID: 0x18EC2001	0x10	0x15	0x00	0x03	0xFF	0x00	0xEF	0x00
CTS response to CAN ID received: 0x18EC0120	0x11	0x03	0x01	0xFF	0xFF	0x00	0xEF	0x00

- ▶ Send configuration data from the controller to the encoder in three CAN frames: 02 01 06 05 04 03 0A 09 08 07 0E 0D 0C 0B 0F 13 12 11 10 14 15
- ▶ Maintain a time interval of 50 ms between transmission of the CAN frames.

The sequence number of the frames is displayed in byte 0 during transmission. Bytes 1…7 continuously contain the raw data.

	Byte							
	0	1	2	3	4	5	6	7
Send TP, sequence no. 1, CAN ID: 0x18EB2001	0x01	0x02	0x01	0x06	0x05	0x03	0x03	0x0A
Send TP, sequence no. 2, CAN ID: 0x18EB2001	0x02	0x09	0x08	0x07	0x0E	0x0D	0x0C	0x0F
Send TP, sequence no. 3, CAN ID: 0x18EB2001	0x03	0x0F	0x13	0x12	0x11	0x10	0x14	0x15

The encoder confirms successful transmission:

	Byte							
	0	1	2	3	4	5	6	7
EoMA received, CAN ID: 0x18EC0120	0x13	0x15	0x00	0x03	0xFF	0x00	0xEF	0x00

9.2 Example: change the device address

The device address of the encoder can be changed by sending the **commended address** PGN (CA).

- The new address is permanently stored in the flash memory of the encoder.
- The encoder restarts with the new address.
- The encoder sends its address claim and, if necessary, measurement data from the new address.

The following image shows the data exchange log for an address change. Cyclic measurement data transmission has been switched off for the purposes of providing the example.

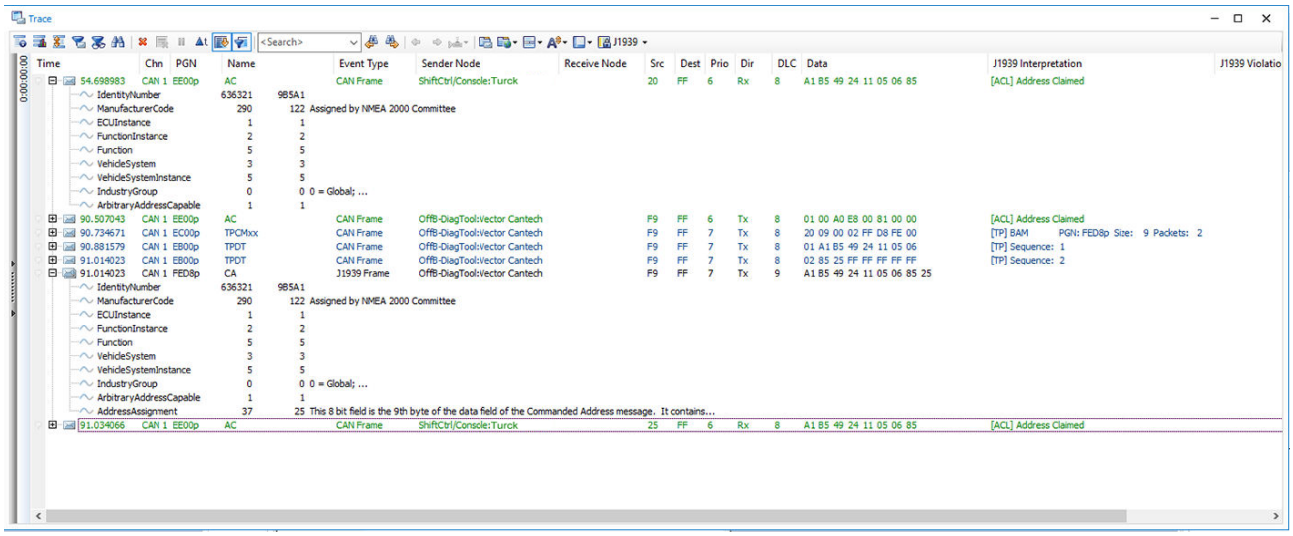


Fig. 14: Example – data exchange log

- At time point 54.69, the encoder is registered at the bus with address 0x20 once the power supply is switched on.
- At time point 90.50, the diagnostic tool (in this case: Vector CANalyzer) is registered at the bus.
- From time point 90.73…91.01, the diagnostic tool sends the **commended address** PGN to the encoder. This transmission is distributed over three physical CAN frames via the J1939 BAM protocol. The J1939 name of the address claim is displayed again. At the end of the transmission, there is the new address 0x25 and padding bytes with the content 0xFF.

	Byte							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Send TP, BAM, CAN ID: 0x18EB2001	0x20	0x09	0x00	0x02	0xFF	0xD8	0xFE	0x00
Send TP, sequence no. 1, CAN ID: 0x18EB2001	0x01	0xA1	0xB5	0x49	0x24	0x11	0x05	0x06
Send TP, sequence no. 2, CAN ID: 0x18EB2001	0x02	0x85	0x25	0xFF	0xFF	0xFF	0xFF	0xFF

- At time point 91.03, the encoder is registered at the bus again with the new address 0x25.

9.3 Example: resetting the device to factory settings

In the following example, the device parameters of an encoder with the bus address 0x20 are reset to the default values [▶ 15] . The preset value is set to 0. The bus address of the controller is 0x01.

Parameter	Byte	Value		
		Hexadecimal	Hexadecimal (Endian)	Decimal
OperatingParameter	2	0x04	0x0400	4
MUR	4	0x4000	0x00400000	16384
TMR	4	0x10000000	0x00000010	268435456
SensorCycleTime	4	0x32	0x32000000	50
CANBusTermination	1	0x01	0x01	1
SensorPresetValue	4	0x00000000	0x00000000	0
SensorPresetEnable	1	0x01	0x01	1
BaudRate	1	0x01	0x01	1

SAE J1939 transmits the data with the least significant byte first (little-endian format). As an example, the following raw data stream is transmitted to the encoder:
04 00 00 40 00 00 00 00 00 10 32 00 00 00 01 00 00 00 00 01 01 (see "Hexadecimal (Endian)" column)

- The data must be distributed over several CAN frames and transmitted via the CMDT transport protocol.
- CAN frames must be sent as extended frames (29-bit identifiers).
- A maximum of 8 bytes of user data can be transmitted per CAN frame.

▶ Establish a CMDT connection with the coded parameters.

▶ Send RTS packet with the following content to the encoder and wait for the sensor to respond:

- Control byte: 0x10
- Message size: 0x15
- Total number of packets: 3
- Maximum number of packets: 0xFF
- PG number: 0xEF00
- Source address: 0x01
- Destination address: 0x20

	Byte							
	0	1	2	3	4	5	6	7
Send RTS request for CAN ID: 0x18EC2001	0x10	0x15	0x00	0x03	0xFF	0x00	0xEF	0x00
CTS response to CAN ID received: 0x18EC0120	0x11	0x03	0x01	0xFF	0xFF	0x00	0xEF	0x00

▶ Send configuration data from the controller to the encoder in three CAN frames:
04 00 00 40 00 00 00 00 00 10 32 00 00 00 01 00 00 00 00 01

▶ Maintain a time interval of 50 ms between transmission of the CAN frames.

The sequence number of the frames is displayed in byte 0 during transmission. Bytes 1…7 continuously contain the raw data.

	Byte							
	0	1	2	3	4	5	6	7
Send TP, sequence no. 1, CAN ID: 0x18EB2001	0x01	0x04	0x00	0x00	0x40	0x00	0x00	0x00
Send TP, sequence no. 2, CAN ID: 0x18EB2001	0x02	0x00	0x00	0x10	0x32	0x00	0x00	0x00
Send TP, sequence no. 3, CAN ID: 0x18EB2001	0x03	0x01	0x00	0x00	0x00	0x00	0x01	0x01

The encoder confirms successful transmission:

	Byte							
	0	1	2	3	4	5	6	7
EoMA received, CAN ID: 0x18EC0120	0x13	0x15	0x00	0x03	0xFF	0x00	0xEF	0x00

10 Troubleshooting

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.

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/retoure-service-6079.php
and must be completely filled in, and affixed securely and weather-proof to the outside of the packaging.

13 Disposal

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

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