Inclination Sensor F99

CAN Bus with J1939 Protocol

Manual

CE

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Worldwide

Pepperl+Fuchs Group

Lilienthalstr. 200

68307 Mannheim

Germany

Phone: +49 621 776 - 0

E-mail: info@de.pepperl-fuchs.com

North American Headquarters

Pepperl+Fuchs Inc.

1600 Enterprise Parkway

Twinsburg, Ohio 44087

USA

Phone: +1 330 425-3555

E-mail: sales@us.pepperl-fuchs.com

Asia Headquarters

Pepperl+Fuchs Pte. Ltd.

P+F Building

18 Ayer Rajah Crescent

Singapore 139942

Phone: +65 6779-9091

E-mail: sales@sg.pepperl-fuchs.com

https://www.pepperl-fuchs.com

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1 Introduction

1.1 Content of this Document

This document contains information required to use the product in the relevant phases of the product life cycle. This may include information on the following:

- Product identification
- Delivery, transport, and storage
- Mounting and installation
- Commissioning and operation
- Maintenance and repair
- Troubleshooting
- Dismounting
- Disposal

Note

For full information on the product, refer to the further documentation on the Internet at www.pepperl-fuchs.com.

Note

For specific device information such as the year of construction, scan the QR code on the device. As an alternative, enter the serial number in the serial number search at www.pepperl-fuchs.com.

The documentation comprises the following parts:

- This document
- Datasheet

In addition, the documentation may comprise the following parts, if applicable:

- EU-type examination certificate
- EU declaration of conformity
- Attestation of conformity
- Certificates
- Control drawings
- Instruction manual
- Functional safety manual
- Other documents

1.2 Target Group, Personnel

Responsibility for planning, assembly, commissioning, operation, maintenance, and dismounting lies with the plant operator.

Only appropriately trained and qualified personnel may carry out mounting, installation, commissioning, operation, maintenance, and dismounting of the product. The personnel must have read and understood the instruction manual and the further documentation.

Prior to using the product make yourself familiar with it. Read the document carefully.

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1.3 Intended Use

The inclination sensors with J1939 interface are designed to reliably detect inclination angles in factory automation and mobile equipment applications.

Note

This product must not be used in applications, where safety of persons depend on the correct device function. This product is not a safety device according to EC machinery directive.

Always operate the device as described in these instructions to ensure that the device and connected systems function correctly. The protection of operating personnel and plant is guaranteed only if the device is operated in accordance with its intended use.

Responsibility for compliance with locally-valid safety regulations is borne by the operator.

Only use recommended original accessories.

1.4 Symbols Used

This document contains symbols for the identification of warning messages and of informative messages.

Warning Messages

You will find warning messages, whenever dangers may arise from your actions. It is mandatory that you observe these warning messages for your personal safety and in order to avoid property damage.

Depending on the risk level, the warning messages are displayed in descending order as follows:

Danger!

This symbol indicates an imminent danger.

Non-observance will result in personal injury or death.

Warning!

This symbol indicates a possible fault or danger.

Non-observance may cause personal injury or serious property damage.

Caution!

This symbol indicates a possible fault.

Non-observance could interrupt the device and any connected systems and plants, or result in their complete failure.

Informative Symbols

Note

This symbol brings important information to your attention.

Action

1. This symbol indicates a paragraph with instructions. You are prompted to perform an action or a sequence of actions.

1.5 General safety instructions

Responsibility for planning, assembly, commissioning, operation, maintenance, and dismounting lies with the plant operator.

Installation and commissioning of all devices may be performed only by trained and qualified personnel.

It is dangerous for the user to make changes and/or repairs. Additionally, doing so voids the warranty and excludes the manufacturer from any liability. In the event of any serious errors, stop using the device. Secure the device against unintended operation. To have the device repaired, return it to your local Pepperl+Fuchs representative or your sales center.

Note

Disposal

Electronic waste is dangerous. When disposing of the equipment, observe the current statutory requirements in the relevant country of use and local regulations.

2 J1939 Interface description

2.1 J1939 Message Format

The J1939 interface uses the 29 bit CAN-ID. The CAN-ID in J1939 is assembled of a Parameter Group Number (PGN) and a source address.

A parameter group (PG) consists of various parameters, such as Offset value, direction of rotation, etc. That means, a PGN specifies what's in that data field.

The priority field has a width of 3 bits. It indicates the message priority. Priority "0" is the highest and "7" the lowest. A value of "PDU format" between 0x00 and 0xF0 causes messaging between two specific devices. In this case the field "PDU specific" equals the destination address. A value of "PDU format" higher than 0xF0 causes broadcast messaging to all devices in a group. "PDU format" higher than 0xF0 causes broadcast messaging to all devices in a group. "PDU specific" is then interpreted as a "group extension".

The device address (node ID) of every individual device in the network has to be unique. This can be assured by means of the address claiming procedure.

2.2 Interpretation of the CAN Identifier

The CAN identifier of a J1939 message contains Parameter Group Number (PGN), source address, priority, data page bit, extended data page bit and a target address (except for broadcast messages).

The identifier is composed as follows:

Priority	Extended data page	Data page	PDU format	PDU Specific (Destination address)	Source address
3 bit	1 bit	1 bit	8 bit	8 bit	8 bit

Table 2.1

The entire telegram contains the identifier and the data section.

Example Request PGN

Identifier (29 Bit)					Data Bytes							
Priority (3 bit)	PGN			Source address (8 bit)	1	2	3	4	5	6	7	8
0x07	0x00	0xEA	0x80	0x32	Requested PGN			xx	xx	xx	xx	xx
0x1CEA8032												

Table 2.2

The following table explains the 29 bit identifier of the example above.

Bit	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Byte	4					3 (PDU format)								2 (destination address)								1 (source address)							
Value	1	1	1	0	0	1	1	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0
	0x1	0xC				0xE				0xA				0x8				0x0				0x3				0x2			
	0x1CEA8032																												

Table 2.3

3 Address Claiming

As defined in the J1939 standard the sensor supports the dynamic address claiming. To switch off this function the arbitrary bit in the node name (Parameter-No. 6) should be set to 0. The sensor starts the claiming with the default node address 128 (0x80) (Parameter- No. 1). If an address conflict with a higher prior node occurs the network management will change the node address automatically using his internal address claimed table. In this table the sensor registers all claimed addresses from other nodes. The table will be cleared on a reset. The new claimed address after a conflict will be saved in the parameter set and used on a restart. If the dynamic claiming is not active or no free node address is available the sensor will use the null address 254. The null address is not saved in the parameter set. After a restart the sensor will use the last claimed address. The Parameter Group Number (PGN) 0x00FED8 "Commanded Address" is not supported.

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4 Process Data (PD)

After the sensor has claimed a node address the measured inclination values will be send automatically with a "Proprietary B" PGN message. The priority, the PGN and the transmission rate are changeable in the parameter mode. It's also possible to request the process data message with the "Request" PGN 0x00EA00.

Example Request PGN 0x FF 01:

Identifier			Data Bytes							
Priority	PGN	Source address	1	2	3	4	5	6	7	8
*	0x00EA00	*	Requested PGN			xx	xx	xx	xx	xx

Table 4.1

*: placeholder, necessary

xx: unused, bytes optional

4.1 Message Content

The process data message contains in the eight data bytes four signals with 2 bytes. The first three values are the X, Y and Z angle values. The last value is representing the sensor internal temperature..

Example process data message:

Identifier			Data Bytes							
Priority	PGN	Source address	1	2	3	4	5	6	7	8
7	0x00FF00	0x80	Value X		Value Y		Value Z		Temperature	

Table 4.2

4.2 Definition of the Signals (SLOT)

Angle Values

Angle Values	Value
Data Length	2 Bytes
Resolution	0.01 °/bit
Range [1]	0 ... 359.99 °
Offset [2]	0
Transfer Function	Angle [°] = (Data / 100) - Offset
Signal not available	65280
Specific codes	64256 (outside measurement range, low) 64257 (outside measurement range, high) 64258 (max. tilt sideways)

Table 4.3

1. Only as an example for 360° sensors. For detailed SLOT definitions refer to the datasheet of the individual sensor.
2. Only as an example for 360° sensors. For detailed SLOT definitions refer to the datasheet of the individual sensor.

Temperature

Temperature	Value
Data Length	2 Bytes
Resolution	0.146 °C/bit
Range	- 40°C ... 120 °C
Offset	40 °C
Transfer Function	Temperture [°C] = (Data / 6.4) -40
Signal not available	65280

Table 4.4

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5 Parameter Mode

The parameter mode uses the "Proprietary A" PGN 0x00EF00 for a peer-to-peer communication. Therefor the PGN includes the sensor node address in the last byte. To read and write the parameters the eight data bytes has to contain the following commands. The written parameter values are saved permanent when the parameter mode is left. Then the sensor starts with a complete reset and the new parameter set.

5.1 Starting Parameter Mode

Identifier			Data Bytes							
Priority	PGN	Source address	1 CMD	2 Password	3	4	5	6	7	8
*	0x00EFnn	*	0xEB	0x55	xx	xx	xx	xx	xx	xx

Table 5.1

nn: destination address --> sensor node address

*: placeholder, necessary

xx: unused, bytes optional

5.2 Reading Parameters

Identifier			Data Bytes							
Priority	PGN	Source address	1 CMD	2 Parameter Number	3	4	5	6	7	8
*	0x00EFnn	*	0xE0	pp	xx	xx	xx	xx	xx	xx

Table 5.2

pp: the number of the parameter (see parameter overview)

nn: destination address --> sensor node address

*: placeholder, necessary

xx: unused, bytes optional

5.3 Writing Parameters

Identifier			Data Bytes							
Priority	PGN	Source address	1 CMD	2 Parameter Number	3	4	5	6	7	8
*	0x00EFnn	*	0xE1	pp	dd	dd	dd	dd	dd	dd

Table 5.3

dd: data to write, LSB in Byte 3

pp: the number of the parameter (see parameter overview)

nn: destination address --> sensor node address

*: placeholder, necessary

5.4 Factory Reset

Identifier			Data Bytes							
Priority	PGN	Source address	1 CMD	2 Password	3	4	5	6	7	8
*	0x00EFnn	*	0xE2	0x00	xx	xx	xx	xx	xx	xx

Table 5.4

nn: destination address --> sensor node address

*: placeholder, necessary

xx: unused, bytes optional

Note

Complete factory reset by sending leaving parameter mode and then switching the power supply off and on again.

5.5 Leaving Parameter Mode

Identifier			Data Bytes							
Priority	PGN	Source address	1 CMD	2 Password	3	4	5	6	7	8
*	0x00EFnn	*	0xEB	0x00	xx	xx	xx	xx	xx	xx

Table 5.5

nn: destination address --> sensor node address

*: placeholder, necessary

xx: unused, bytes optional

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5.6 Parameter Overview

No.	Name	Valid values	Default value	Size [bytes]	Description
0	Baud rate	0 ... 8	5	1	Index 0 ... 8 for 10, 20, 50, 100,125, 250, 500, 800, 1000 kBaud **Note:** J1939 uses only 250 and 500 kBaud.
1	Node Address	0 ... 253	128 (0x80)	1	Actual node address / the NULL address will not be saved
2	PD PGN	0x00000 ... 0x3FFFF	0x0FF00	4	PGN for sending process data including the data page and extended data page bits
3	PD Prority	0 ... 7	7	1	Priority of the process data message
4	PD Interval	0 ... 60,000	200	2	Sending interval of the process data message, multiplied with 5 ms 0 = no message will be send 1 ... 60,000 = 5 ... 300,000 ms
5	PD Sync	0 ... 1	0	1	0 = Off, 1 = PD will be sent synchronized to the calculation (see Sampling Rate)
6	Arbitrary Address Capable	0 ... 1	1	1	Part of the J1939 node name 0 = address claiming deactivated 1 = address claiming activated
7	Industry Group	0 ... 7	2	1	Part of the J1939 node name, see J1939 standard
8	Vehicle System Instance	0 ... 15	0	1	Part of the J1939 node name, see J1939 standard
9	Vehicle System	0 ... 127	0	1	Part of the J1939 node name, see J1939 standard
10	Function	0 ... 255	0	1	Part of the J1939 node name, see J1939 standard
11	Function Instance	0 ... 31	0	1	Part of the J1939 node name, see J1939 standard
12	ECU Instance	0 ... 7	0	1	Part of the J1939 node name, see J1939 standard
13	Offset	No limits	0	6	Offset value 3. + 4. byte = X value, 5. + 6. byte = Y value,7. + 8. byte = Z value (see chapter 6.2)
14	Rotating Direction	No limits	0	3	Defines the rotating direction 3. byte = X value, 4. byte = Y value, 5. byte = Z value (see chapter 6.1)
15	Filter Factor	1 ... 1,000	1	2	Factor for low pass filter
16	Filter Average	1 ... 512	100	2	Value count for average filter
17	Sampling Rate	1 ... 60,000	1	2	Sampling Rate 1 ms ... 60,000 ms
18	Filter Startup	No limits	0	2	Amount of unfiltered values after startup 65,535 = no average filter
19	Filter Sync	1 ... 65,535	1	2	All n values the filter function will call the calculation function

Table 5.6

Parameters No. 15 ... No. 19 are settings that should be only changed by advanced users.

5.7 Answer Messages

In the answer message the source address is the address of the sensor (default value 0x80).The destination address is the node ID of the node that has sent the request. The priority is always 6 (0x06).

On each parameter message the sensor will send an answer with a code in the first byte of the data bytes section.

Identifier (29 Bit)					Data Bytes							
Priority (3 bit)	PGN			Source address (8 bit)	1	2	3	4	5	6	7	8
	Data page (2 bit)	PDU format (8 Bit)	Destination address (8 bit)									
0x06	0x00	0xEF	0x32	0x80	Code	optional Parameter Number	optional read Parameter Data					
0xEF80												

Table 5.7

Code	Description
D0	ok/password accepted/parameter successfully written or read
D1	no access password not set
D2	parameter data out of limits
D3	too less data for this parameter
D4	parameter number out of range
D5	no valid parameter
D6	command unknown

Table 5.8

6 Miscellaneous

6.1 Rotating Direction

The default clockwise rotating direction can be changed with Parameter No.14. Each process data value is represented by one byte in this parameter and can be set independently.

Byte content:

00 = rotation direction as given by factory setting (see data sheet of your individual sensor)

01 = inverse rotation direction

Identifier			Data Bytes							
Priority	PGN	Source address	1 CMD	2 Parameter Number	3 X	4 Y	5 Z	6	7	8
*	0x00EFnn	*	0xE1	0x0E	dd	dd	dd	xx	xx	xx

Table 6.1

dd: data to write

nn: destination address --> sensor node address

*: placeholder, necessary

xx: unused, bytes optional

6.2 Offset

Also an individual offset can be set for each inclination value. The offset is a signed value (two's complement) with a range from -32,768 to +32,767. The offset will be added after the rotation direction calculation, so a change of Parameter No. 14 will affect the offset setting and resulting inclination value.

Identifier			Data Bytes							
Priority	PGN	Source address	1 CMD	2 Parame-ter Number	3 + 4 X offset		5 + 6 Y offset		7 + 8 Z offset	
*	0x00EFnn	*	0xE1	0x0D	low byte	high byte	low byte	high byte	low byte	high byte

Table 6.2

nn: destination address --> sensor node address

*: placeholder, necessary

6.3 Network Termination

There is no network termination inside the sensor. Please use an external 120 Ω network termination resistor.

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