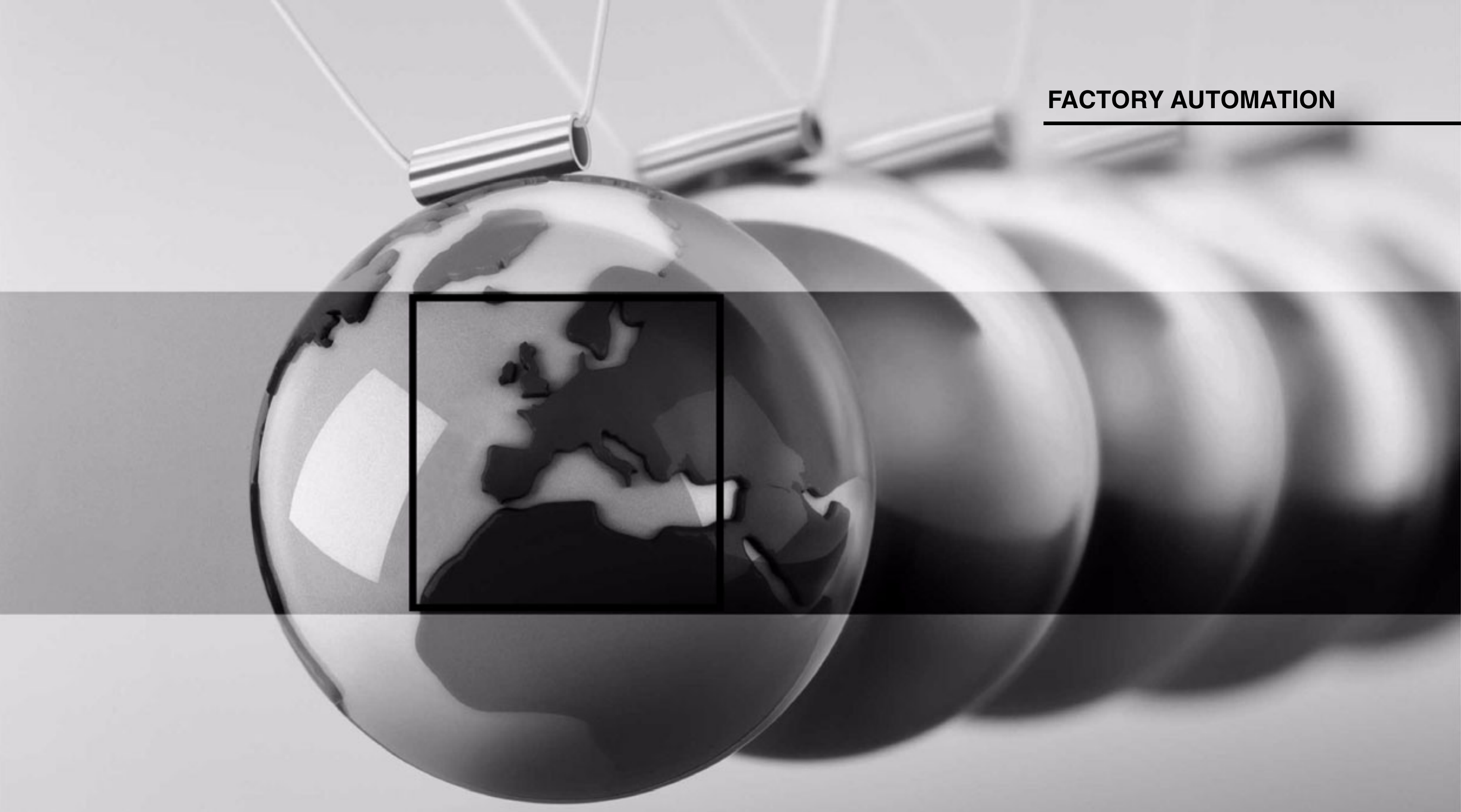
FACTORY AUTOMATION



MANUAL

F99 Fusion Inertial Measurement Unit IMU360D-F99-B20

with CAN SAE J1939 Protocol

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SENSING YOUR NEEDS

With regard to the supply of products, the current issue of the following document is applicable: The General Terms of Delivery for Products and Services of the Electrical Industry, published by the Central Association of the Electrical Industry (Zentralverband Elektrotechnik und Elektroindustrie (ZVEI) e.V.) in its most recent version as well as the supplementary clause: "Expanded reservation of proprietorship"

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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!

Visit www.pepperl-fuchs.com to access further documentation for full information about the product.

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
- 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.

1.3 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

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

1.4 Intended Use

The Inertial Measurement Unit IMU360D-F99, with the F99-Fusion technology, is optimized to provide gyroscopic stabilized inclination and acceleration data as well as rotation rate data.

Read through these instructions thoroughly. Familiarize yourself with the device before installing, mounting, or operating.

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 only guaranteed if the device is operated in accordance with its intended use.

1.5 General Safety Notes

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

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

The device is only approved for appropriate and intended use. Ignoring these instructions will void any warranty and absolve the manufacturer from any liability.

If serious faults occur, stop using the device. Secure the device against inadvertent operation. In the event of repairs, return the device to your local Pepperl+Fuchs representative or sales office.

Note!

Disposal

Electronic waste is hazardous waste. When disposing of the equipment, observe the current statutory requirements in the respective country of use, as well as local regulations.

1.6 Declaration of conformity

This product was developed and manufactured under observance of the applicable European standards and guidelines.

Note!

A Declaration of Conformity can be requested from the manufacturer.

The product manufacturer, Pepperl+Fuchs GmbH, D-68307 Mannheim, has a certified quality assurance system that conforms to ISO 9001.

ISO**9001**

2 Product Description

2.1 Use and application

The F99 Fusion, Inertial Measurement Unit IMU360D-F99, combines an acceleration sensor and a gyroscope into a single device and links the two sensor elements to increase overall performance of the system and open up new possibilities. This devicer is optimized to provide gyroscopic stabilized inclination and acceleration data as well as rotation rate data.

Heart of the IMU360D-F99 is the adaptive sensor fusion algorithm. It is developed and implemented for inclination measurement with extreme effective compensation of external acceleration disturbance.

Triaxial acceleration sensor and triaxial gyroscope outputs are used as input of the fusion system. The adaptive sensor fusion algorithm is designed to compensate the measurement errors by combining accelerometer and gyroscope data adaptively to the current situation.

The following figures show the orientation and assignement of the axis for which the sensor can be used depending on the parameterization of the angle output system.

P + F Angles (INX / INY) Output

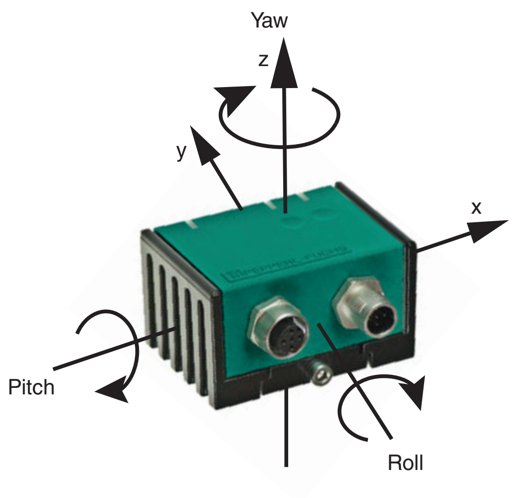

Figure 2.1

Euler Angles (zy'x''/ZXZ) Output

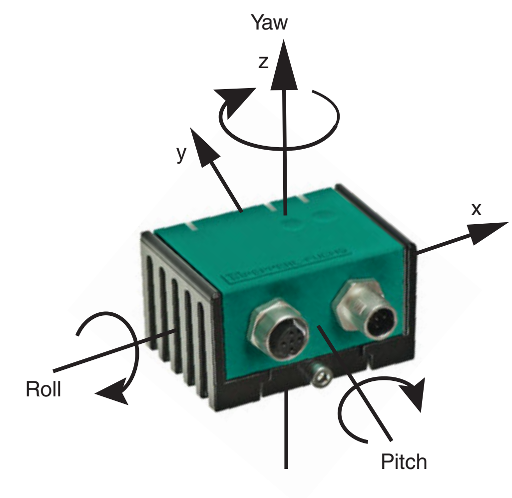

Figure 2.2

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Several selectable output values such as acceleration, rotational speed , inclination (Euler angle, Euler value, quaternions) and programmable filters allow you to perfectly adapt the measuring system to your application.

Parameterization and data transfer take place via the integrated CAN SAE J1939 interface.

In the following figure the signal path of input and output values is illustrated.

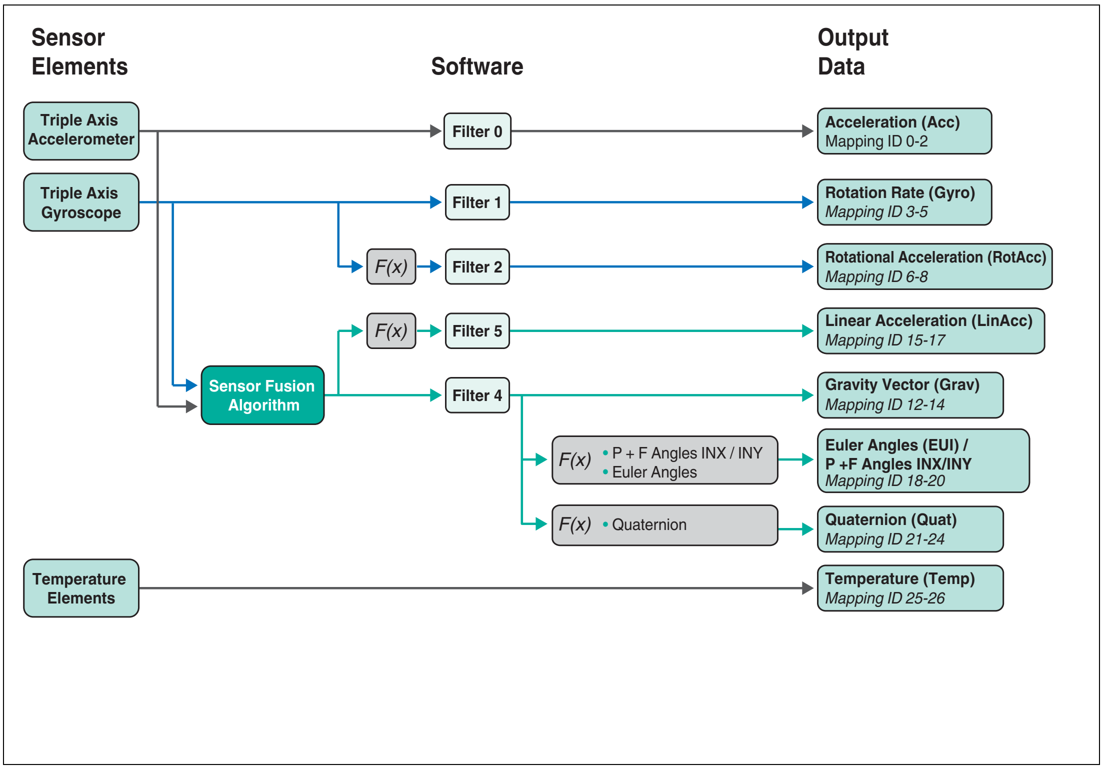


Figure 2.3

2.2 LED displays

The IMU360D-F99 has three LED indicators that allow rapid visual monitoring.

- The green **power** LED indicates the state of the power supply
- The yellow **run** LED indicates the bus and sensor status
- The red **err** LED indicates an error

LED	State	Description
Green: power	On	Voltage ok
	Off	No power or sensor defect
Yellow: run	On	Operational mode
	Blinking slowly	Parameter mode user
	Off	Error see red LED "err"
Red: err	On	■ Address claiming (max 250 ms) ■ or no bus connection ■ or CAN error passive level (max. 128 retries)
	Blinking slowly	Claiming conflict, Null address (254)
	Flashing	CAN err warning level
	Off	No error

Table 2.1

Possible sources of error causes:

- CAN master is not initialized
- Baud rate is wrong
- CAN-high and CAN-low channel are interchanged

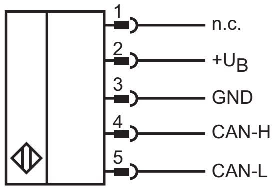
2.3 Accessories

Various accessories are available. See datasheet or relevant product page on the Internet www.pepperl-fuchs.com.

3 Installation

3.1 Electrical connection

The IMU360D-F99 is equipped with 2 connectors M12 x 1, 5-pin, male and female for CAN bus integration. If a terminator is required, it muss be attached externally on the female connector. Therefore e. g. "Terminator ICZ-TR-CAN/DN-V15" from Pepperl+Fuchs is available (also see datasheet of the sensor).



Pin	Wire color	Designation
1	Brown	Not used
2	White	+UB
3	Blue	GND
4	Black	CAN-H
5	Gray	CAN-L

Table 3.1 Connector assignment

Note!

The wire colors listed above apply when one of the bus cables from the Pepperl+Fuchs accessories range is used.

Warning!

Damage to the device

Connecting an alternating current or excessive supply voltage can damage the device or cause the device to malfunction.

Electrical connections with reversed polarity can damage the device or cause the device to malfunction.

Connect the sensor to direct current (DC). Ensure that the supply voltage rating is within the specified sensor range. Ensure that the connecting wires on the cordset in use are connected correctly.

Connecting the sensor to the voltage

Connect the operating voltage to pins 2 and 3 of the 5-pin connector.

↳ The "Power" LED lights up green.

4 Commissioning

4.1 Definition of Baud Rate and Node ID

The factory settings for establishing communication with the sensor are for

- Baud rate: 250 kBit/s
- Node ID: 128

As defined in the J1939 standard the sensor supports the dynamic address claiming starting with default address 128_{dez}. If this feature is not desired you can deactivate it. Details see chapter "J1939 Interface Description", section "Address Claiming"

For setting a specific node ID for the device you can parameterize parameter Index No. 1. Details see chapter "Parameter Table" and also chapter "Examples".

The following settings are adjustable with the sensor.

J1939 interface	Default setting	Range	Comment
Baud rate	250 kBit/s	10 kBit/s, 20 kBit/s, 50 kBit/s, 100 kBit/s, 125 kBit/s, 250 kBit/s, 500 kBit/s, 800 kBit/s, 1 MBit/s	J1939 standard uses only 250 and 500 kBit/s
Node ID	128	0 ... 253	

Table 4.1

Note!

For identification of the sensor in his system environment the sensor provides some characters you can parameterize during commissioning. To enable a quick commissioning of the sensor the Process Data Objects (PDO) PDO 0 ... 7 are preallocated. Detailed information about these issues you can find in the tables of the following section "J1939 Messages - Default Values".

Identification of the sensor in his system environment

Parameterize the sensor idenfication characters according to section "Identification characters for system environment".

4.2 Identification characters for system environment

For identification of the sensor in his system environment the sensor provides some characters you can parameterize during commissioning.

The following table contains the default values of Interface configuration and J1939 name. They can be defined in the parameters "J1939 Interface" and "J1939 -Name" as listed in chapter "Parameter Table".

J1939 Name	Default	Range	Comment
Arbitrary Address Capable	0	0, 1 (1 bit)	Specifies if the ECU can choose another source address if it loses the address claim procedure
Industry Group	0	0 ... 7 (3 bit)	Specifies the industry. (e.g. off-highway)
Vehicle System Instance	0	0…15 (4 bit)	Identifies a particular occurrence of vehicle system. (e.g. trailer #3)
Vehicle System	0	0…127 (7 bit)	Identifies vehicle system (e.g. trailer)
Reserved	1	0, 1 (1 bit)	Fix bit for internal use only
Function	0	0… 255 (8 bit)	Identifies the function (e.g. ABS)
Function Instance	0	0… 31 (5 bit)	Identifies the function instance (e.g. ABS #1)
ECU Instance	0	0… 7 (3 bit)	Identifies the ECU instance inside of the function field.
Manufacturer Code	632	0… 2047 (11 bit)	632: Pepperl+Fuchs manufacturer code
Identity Number	Unique serial number (fix)	0… 2097151 (21 bit)	Product serial number

Table 4.2

4.3 J1939 Messages - Default Values

To enable a quick commissioning of the sensor the Process Data Objects (PDO) PDO 0 ... 7 are preallocated as described in the table below.

After the sensor has claimed a node address the measured values will be send automatically with "Proprietary B" PGN messages. The priority, the PGN and the transmission rate and the process data mapping is changeable in the parameter mode. It's also possible to request the process data messages with the "Request" PGN 0x00EAnn. See also chapter "J1939 Interface Description", section "Process Data (PD)".

The following table contains the default values of the PDO Output data. The PDO output data can be defined according to section "PDO Mapping" in the parameter "PDO[x].Map" of the respective PDO as listed in chapter "Parameter Table".

		Identifier (29 bit)			Data bytes							
Message	Cycle time internal	Prio.	PGN	Source Address	1	2	3	4	5	6	7	8
Address Claimed	Once at Startup	6	0xEEFF	Node-ID	J1939 Name (64 bit)							
Acceleration (PDO 0)	10 ms	7	0xFF00	Node-ID	Acc X		Acc Y		Acc Z			
Angular rate (PDO 1)	10 ms	7	0xFF01	Node-ID	Gyro X		Gyro Y		Gyro Z			
Rotational Acceleration (PDO 2)	10 ms	7	0xFF02	Node-ID	RotAcc X		RotAcc Y		RotAcc Z			
Gravity Vector (PDO 3)	10 ms	7	0xFF03	Node-ID	Gravity Vector X		Gravity Vector Y		Gravity Vector Z			
Linear Acceleration (PDO 4)	10 ms	7	0xFF04	Node-ID	Linear Acc X		Linear Acc Y		Linear Acc Z			
Angle 1) (PDO 5)	10 ms	7	0xFF05	Node-ID	Roll: INX		Pitch: INX		Yaw: INX			
Quaternion (PDO 6)	10 ms	7	0xFF06	Node-ID	Quat X		Quat Y		Quat Z		Quat W	
Mics (PDO 7)	10 ms	7	0xFF07	Node-ID	Temp sensor element		Temp mainboard					

Table 4.3

1) Angle: Please note that the data of the respective upright axis is indefinite (e.g. yaw in case of the sensor orientation is horizontal with connector sideways)

4.4 PDO Mapping

The following table describes the allocation of the PDO Output data. Triaxial acceleration sensor and triaxial gyroscope data is provided as raw data and used as input of the sensor fusion algorithm. The sensor fusion algorithm is designed to compensate the measurement errors by combining accelerometer and gyroscope data (Sensor Fusion data). The PDO output data can be defined in the parameter PDO[x].Map of the respective PDO as listed in chapter "Parameter Table".

Mapping ID	Data	Data name	Data description	Data type
0	Acc X	Acceleration X	Acceleration in x direction	Raw data
1	Acc Y	Acceleration Y	Acceleration in y direction	Raw data
2	Acc Z	Acceleration Z	Acceleration in z direction	Raw data
3	Gyro X	Gyroscope X	Rotation rate around the x axis	Raw data
4	Gyro Y	Gyroscope Y	Rotation rate around the y axis	Raw data
5	Gyro Z	Gyroscope Z	Rotation rate around the z axis	Raw data
6	RotAcc X	Rotational Acceleration X	Rotational acceleration around the x axis	Raw data
7	RotAcc Y	Rotational Acceleration Y	Rotational acceleration around the y axis	Raw data
8	RotAcc Z	Rotational Acceleration Z	Rotational acceleration around the z axis	Raw data
9	-	-	Reserved (internal use only)	Raw data
10	-	-	Reserved (internal use only)	Raw data
11	-	-	Reserved (internal use only)	Raw data
12	Grav X	Gravity Vector X	Proportion of the gravity vector in x direction without external acceleration	Sensor Fusion data
13	Grav Y	Gravity Vector Y	Proportion of the gravity vector in y direction without external acceleration	Sensor Fusion data
14	Grav Z	Gravity Vector Z	Proportion of the gravity vector in z direction without external acceleration	Sensor Fusion data
15	LinAcc X	Linear Acceleration X	Acceleration in x direction without gravity vector	Sensor Fusion data
16	LinAcc Y	Linear Acceleration Y	Acceleration in y direction without gravity vector	Sensor Fusion data
17	LinAcc Z	Linear Acceleration Z	Acceleration in z direction without gravity vector	Sensor Fusion data
18	Roll [1)]	Roll	P + F Angle INX/INY: Rotation about y axis	Sensor Fusion data
			Euler Angle: psi	Sensor Fusion data

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Mapping ID	Data	Data name	Data description	Data type
19	Pitch [1]	Pitch	P + F Angle INX/INY: Rotation about x axis	Sensor Fusion data
			Euler Angle: theta	Sensor Fusion data
20	Yaw [1]	Yaw	P + F Angle INX/INY: Rotation about z axis	Sensor Fusion data
			Euler Angle: phi	Sensor Fusion data
21	Quat X	Quaternion X	Quaternion Data X	Sensor Fusion data
22	Quat Y	Quaternion Y	Quaternion Data Y	Sensor Fusion data
23	Quat Z	Quaternion Z	Quaternion Data Z Note: Output value is always "0"	Sensor Fusion data
24	Quat W	Quaternion W	Quaternion Data W	Sensor Fusion data
25	Temp Sens	Temperature sensor	Temperature of the sensor element	Raw data
26	Temp Main	Temperature Mainboard	Temperature of the mainboard	Raw data
27	-	Empty no data	Empty no data	-

Table 4.4

[1] Please note that the data of the respective upright axis is indefinite (e.g. yaw in case of the sensor orientation is horizontal plane and the connector face sideways)

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4.5 SLOT Definition

In the following **SLOT** definition table the **S**caling, **L**imit, **O**ffset and **T**ransfer function of the output data is described. The SLOT definition can be defined in the "SLOT definition" parameters as listed in chapter “Parameter table”.

SLOT Definition	Acceleration (Acc)/ Gravity Vector (Grav)/ Linear Acceleration (LinAcc)	Rotational Acceleration (RotAcc)	Rotation Rate (Gyro)	Euler Angles (EUl) zy'x'', ZXZ	P + F Angles INX/INY	Quaternion (Quat)	Temperature (temp)
Data Length	2 Bytes signed	2 Bytes signed	2 Bytes signed	2 Bytes signed	2 Bytes unsigned	2 Bytes signed	2 Bytes signed
Basic Unit	g	$°/s^2$	°/s	°	°	-	°C
Range	+/- 2 g	± 2500 $°/s^2$	± 250 °/s	Roll, Pitch, Yaw -180 ° ... + 180 °	Roll, Pitch, Yaw 0 ° ... 360 °	± 1	-40 °C ... +85 °C
Offset	0 mg	0 $°/s^2$	0 °/s	0 °	0 °	0	0 °C
Default Factor	1000	1	100	100	100	1000	10
Transfer Function	= ((Data - Offset)/Factor) [basic unit]						

Table 4.5

All signed data is 16 bit (two's complement). The abbreviation "g" is equivalent with the acceleration of gravity factor 9,81 m/s^2.

Example

AccX data = 987 Dez; Offset value = 0; Factor = 1000 >> Acceleration in x direction = (987 - 0)/ 1000 g = 0,987 g

4.6 Filter Settings

The following filter types can be used to enable filters in the signal path in order to adapt the device to special applications. For the allocation of the different filters, please see the signal graph above. The filter settings can be defined in the parameters "Filter Settings" as listed in chapter "Parameter Table".

Filter Types	ID
Butterworth lowpass	0
Butterworth highpass	1
Bessel lowpass	2
Bessel highpass	3
Tschebyscheff lowpass	4
Tschebyscheff highpass	5

Table 4.6

Filter Order	ID
Off	0
1^{st}	1
2^{nd}	2
3^{rd}	3

Table 4.7

Cut-off frequency	ID
1 ... 65000 mHz	1 ... 65000

Table 4.8

5 J1939 Interface Description

5.1 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" equates to the destination address. A value of "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. Details see chapter "J1939 Interface Description", section "Address claiming".

5.2 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 5.1

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
	Extended data page (1 bit)	Data page (1 bit)	PDU format (8 Bit)	Destination address (8 bit)		Requested PGN							
0x07	0x00	0x00	0xEA	0x80	0x32	LSB	MSB	00	xx	xx	xx	xx	xx
0x1CEA8032													

Table 5.2

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 5.3

5.3 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 J1939 name (Parameter index 0x02) should be set to zero.

The sensor starts the claiming with the default node address 128 (0x80) (Parameter Index 0x01). 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. After a conflict the new claimed address 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.

5.4 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 0x00EAnn.

Example Request PGN 0x FF 01:

Identifier			Data Bytes							
Priority	PGN	Source address	1	2	3	4	5	6	7	8
			Requested PGN							
*	0x00EAnn	rr	01	FF	00	xx	xx	xx	xx	xx

Table 5.4

*: placeholder, necessary

nn: destination address -> sensor node adress

rr: source address

xx: unused, bytes optional

Note!

Requested PGN: LSB first!

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5.5 Parameter Mode

The parameter mode uses the "Proprietary A" PGN 0x00EFnn for a peer-to-peer communication. Therefore the PGN includes the sensor node address in the last byte.

To read and write the parameters the eight data bytes have to contain the following commands. The written parameter values are saved permanently when the parameter mode is left. Then the sensor starts with a complete reset and the new parameter set.

5.6 Starting Parameter Mode

To send parameters to the device and to read out the actual parameters start the parameter Mode by using the following sequence.

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

Table 5.5

*: placeholder, necessary

nn: destination address -> sensor node address

rr: source address

xx: unused, bytes optional

Note!

Please note that during the device is in the parameter mode no PDOs are sent. The answer message should be D0 (see also chapter "J1939 Interface Description", section "Answer message").

5.7 Reading Parameters

To read out the actual parameters use the following message.

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

Table 5.6

*: placeholder, necessary

pp: the index of the parameter (see chapter "Parameter Table")

nn: destination address -> sensor node address

rr: source address

xx: unused, bytes optional

5.8 Writing Parameters

To write parameters to the device use the following message.

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

Table 5.7

*: placeholder, necessary

dd: data to write, LSB in Byte 3

pp: the index of the parameter (see chapter "Parameter table")

nn: destination address -> sensor node address

rr: source address

Note!

The answer message should be D0 see also chapter "J1939 Interface Description", section "Answer Messages".

5.9 Leaving Parameter Mode

To leave the parameter mode use the following sequence.

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

Table 5.8

*: placeholder, necessary

nn: destination address -> sensor node address

rr: source address

xx: unused, bytes optional

5.10 Answer Messages

In the answer message the source address is the address of the sensor (default value 0x80).The destination address (in this case 0x32) is the node ID of the node that has sent the request. The priority is always 7 (0x07).

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

Below an example for an "Answer Message" with node ID 0x80.

<table>
<tr><th colspan="5">Identifier (29 Bit)</th><th colspan="8">Data Bytes</th></tr>
<tr><td rowspan="2">Priority (3 bit)</td><td colspan="3">PGN</td><td rowspan="2">Source address (8 bit)</td><td rowspan="2">1</td><td rowspan="2">2</td><td rowspan="2">3</td><td rowspan="2">4</td><td rowspan="2">5</td><td rowspan="2">6</td><td rowspan="2">7</td><td rowspan="2">8</td></tr>
<tr><td>Data page (2 bit)</td><td>PDU format (8 Bit)</td><td>Destination address (8 bit)</td></tr>
<tr><td>0x07 = 0111_2</td><td>0x00 = 00_2</td><td>0xEF</td><td>0x32</td><td>0x80</td><td>Code</td><td>optional Parameter Number</td><td colspan="6">optional read Parameter Data</td></tr>
<tr><td colspan="5">0x1CEF3280</td><td colspan="8"></td></tr>
</table>

Table 5.9

The following table describes the content of data byte 1 "Code"

Code	Descripiton
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 5.10

6 Example

6.1 Set Node ID

Assumption:

- Device node ID: 0x80 (default)
- Master node ID: 0x01

Step 1: Starting Parameter Mode

See also chapter "Starting Parameter Mode"

Identifier			Data Bytes							
Priority	PGN	Source address	1 CMD	2 Password	3	4	5	6	7	8
0x00	0xEF80	0x01	0xEB (CMD: Start parameter mode)	0x55	xx	xx	xx	xx	xx	xx

Table 6.1

xx: unused, bytes optional

Effect

Parameter Mode is started.

- Message: D0 = Password accepted (see also chapter "J1939 Interface Description", section "Answer Messages").
- Yellow LED blinks
- No more PDOs are sent

Step 2: Writing Parameter Index 1

See also chapter "J1939 Interface Description", section "Writing Parameters"

Identifier			Data Bytes							
Priority	PGN	Source address	1 CMD	2 Index	3	4	5	6	7	8
0x00	0xEF80	0x01	0xE1 (CMD: Write parameter)	0x01 (Parameter Index 1: Node ID)	0xC8 New address = 200 dez	xx	xx	xx	xx	xx

Table 6.2

xx: unused, bytes optional

Effect

New parameter is acknowledged.

- Message: D0 = parameter successfully written or read (see also chapter "J1939 Interface Description", section "Answer Messages").
- Yellow LED blinks
- No more PDOs are sent

Note!

The sensor answers with the old Node-ID. New Node-ID is valid when the parameter mode is left!

Step 3: Leaving Parameter Mode

See also chapter "Leaving Parameter Mode"

Identifier			Data Bytes							
Priority	PGN	Source address	1 CMD	2 Password	3	4	5	6	7	8
0x00	0xEF80	0x01	0xEB	0x00	xx	xx	xx	xx	xx	xx

Table 6.3

xx: unused, bytes optional

Effect

Parameter Mode is left.

- Sensor restarts.
- New node ID is claimed (see also chapter "J1939 Interface Description", section "Adress Claiming").
- Yellow LED blinks
- PDOs are sent

6.2 Factory reset

The following steps describe how to reset the sensor to the factory default settings:

Step 1: Starting Parameter Mode

See also chapter "Starting Parameter Mode"

Identifier			Data Bytes							
Priority	PGN	Source address	1 CMD	2 Password	3	4	5	6	7	8
0x00	0xEF80	0x01	0xEB (CMD: Start parameter mode)	0x55	xx	xx	xx	xx	xx	xx

Table 6.4

xx: unused, bytes optional

Effect

Parameter Mode is started.

- Message: D0 = Password accepted (see also chapter "J1939 Interface Description", section "Answer Messages").
- Yellow LED blinks
- No more PDOs are sent

Step 2: Send command factory reset

Identifier			Data Bytes							
Priority	PGN	Source address	1 CMD	2 Index	3	4	5	6	7	8
0x00	0xEF80	0x01	0xE2 (CMD: Factory reset)	0x00 (CMD: Factory reset)	xx	xx	xx	xx	xx	xx

Table 6.5

xx: unused, bytes optional

Effect

New parameter is acknowledged.

- Message: D0 = parameter successfully written or read (see also chapter "J1939 Interface Description", section "Answer Messages").
- Yellow LED blinks
- No more PDOs are sent

Step 3: Leaving Parameter Mode

See also chapter "Leaving Parameter Mode"

Identifier			Data Bytes							
Priority	PGN	Source address	1 CMD	2 Password	3	4	5	6	7	8
0x00	0xEF80	0x01	0xEB	0x00	xx	xx	xx	xx	xx	xx

Table 6.6

xx: unused, bytes optional

Effect

Parameter Mode is left.

- Sensor restarts.
- Factory default values are set again.
- Yellow LED blinks
- PDOs are sent

7 Parameter Table

The following table describes the allocation, range, default values and description of the accessible parameters

Index	Name	Valid values	Default value	Size [bytes]	Description
J1939 Interface					
0x00	Baud rate	0 ... 8	5	1	Index equals 10,20,50,100,125,250,500,800, 1000kBaud
0x01	Node ID	0 ... 253	128	1	Actual respectively last valid node ID
J1939 Name					
0x02	Arbitrary Address Capable	0, 1	1	1	Part of the J1939 Name ■ 0 = Address Claiming deactivated ■ 1 = Address Claiming activated
0x03	Industry Group	0 ... 7	0	1	Part of the J1939 Name
0x04	Vehicle System Instance	0 ... 15	0	1	Part of the J1939 Name
0x05	Vehicle System	0 ... 127	0	1	Part of the J1939 Name
0x06	Function	0 ... 255	0	1	Part of the J1939 Name
0x07	Function Instance	0 ... 31	0	1	Part of the J1939 Name
0x08	ECU Instance	0 ... 7	0	1	Part of the J1939 Name
J1939 Messages					
0x09	PDO[0].PGN	0x00000 ... 0x3FFFF	0x0FF00	4	Process data PGN
0x0A	PDO[0].Map	je Byte 0 ... 27 [1)]	0, 1, 2, 27	4	Defines the mapping of the process data
0x0B	PDO[0].Interval	0 … 65535	1	2	0 = no message is send 1...65535 = multiple of 10ms
0x0C	PDO[0].Offset	0 ... 255	0	1	Offset for PDO interval to equalize traffic demand temporally. Value = multiple of 10ms
0x0D	PDO[0].Priority	0 ... 7	7	1	Priority of the PDO
0x0E	PDO[1].PGN	0x00000 ... 0x3FFFF	0x0FF01	4	Process data PGN
0x0F	PDO[1].Map	je Byte 0 ... 27 [1)]	3, 4, 5, 27	4	Defines the mapping of the process data
0x10	PDO[1].Interval	0 … 65535	1	2	0 = no message is send 1...65535 = multiple of 10ms
0x11	PDO[1].Offset	0 ... 255	0	1	Offset for PDO interval to equalize traffic demand temporally. Value = multiple of 10ms
0x12	PDO[1].Priority	0 ... 7	7	1	Priority of the PDO
0x13	PDO[2].PGN	0x00000 ... 0x3FFFF	0x0FF02	4	Process data PGN

Index	Name	Valid values	Default value	Size [bytes]	Description
0x14	PDO[2].Map	je Byte 0 ... 27 [1)]	6, 7, 8, 27	4	Defines the mapping of the process data
0x15	PDO[2].Interval	0 … 65535	1	2	0 = no message is send 1...65535 = multiple of 10ms
0x16	PDO[2].Offset	0 ... 255	0	1	Offset for PDO interval to equalize traffic demand temporally. Value = multiple of 10ms
0x17	PDO[2].Priority	0 ... 7	7	1	Priority of the PDO
0x18	PDO[3].PGN	0x00000 ... 0x3FFFF	0x0FF03	4	Process data PGN
0x19	PDO[3].Map	je Byte 0 ... 27 [1)]	12, 13, 14, 27		Defines the mapping of the process data
0x1A	PDO[3].Interval	0 … 65535	1	2	0 = no message is send 1...65535 = multiple of 10ms
0x1B	PDO[3].Offset	0 ... 255	0	1	Offset for PDO interval to equalize traffic demand temporally. Value = multiple of 10ms
0x1C	PDO[3].Priority	0 ... 7	7	1	Priority of the PDO
0x1D	PDO[4].PGN	0x00000 ... 0x3FFFF	0x0FF04	4	Process data PGN
0x1E	PDO[4].MAP	je Byte 0 ... 27 [1)]	15, 16, 17, 27	4	Defines the mapping of the process data
0x1F	PDO[4].Interval	0 … 65535	1	2	0 = no message is send 1...65535 = multiple of 10ms
0x20	PDO[4].Offset	0 ... 255	0	1	Offset for PDO interval to equalize traffic demand temporally. Value = multiple of 10ms
0x21	PDO[4].Priority	0 ... 7	7	1	Priority of the PDO
0x22	PDO[5].PGN	0x00000 ... 0x3FFFF	0x0FF05	4	Process data PGN
0x23	PDO[5].Map	je Byte 0 ... 27 [1)]	18, 19, 20, 27	4	Defines the mapping of the process data
0x24	PDO[5].Interval	0 … 65535	1	2	0 = no message is send 1...65535 = multiple of 10ms
0x25	PDO[5].Offset	0 ... 255	0	1	Offset for PDO interval to equalize traffic demand temporally. Value = multiple of 10ms
0x26	PDO[5].Priority	0 ... 7	7	1	Priority of the PDO
0x27	PDO[6].PGN	0x00000 ... 0x3FFFF	0x0FF06	4	Process data PGN
0x28	PDO[6].Map	je Byte 0 ... 27 [1)]	21, 22, 23, 24	4	Defines the mapping of the process data
0x29	PDO[6].Interval	0 … 65535	1	2	0 = no message is send 1...65535 = multiple of 10ms
0x2A	PDO[6].Offset	0 ... 255	0	1	Offset for PDO interval to equalize traffic demand temporally. Value = multiple of 10ms

Index	Name	Valid values	Default value	Size [bytes]	Description
0x2B	PDO[6].Priority	0 ... 7	7	1	Priority of the PDO
0x2C	PDO[7].PGN	0x00000 ... 0x3FFFF	0x0FF07	4	Process data PGN
0x2D	PDO[7].Map	je Byte 0 ... 27 [1)]	25, 26, 27, 27	4	Defines the mapping of the process data
0x2E	PDO[7].Interval	0 … 65535	1	2	0 = no message is send 1...65535 = multiple of 10ms
0x2F	PDO[7].Offset	0 ... 255	0	1	Offset for PDO interval to equalize traffic demand temporally. Value = multiple of 10ms
0x30	PDO[7].Priority	0 ... 7	7	1	Priority of the PDO
SLOT Definition					
0x31	Acc_SLOT[0].Factor	no limit	1000	2	Acceleration (Acc) SLOT value: Factor
0x32	Acc_SLOT[0].Offset	no limit	0	2	Acceleration (Acc) SLOT value: Offset
0x33	Reserved	-	-	-	Internal use only
0x34	Reserved	-	-	-	Internal use only
0x35	Gyro_SLOT[1].Factor	no limit	100	2	Rotation rate (Gyro) SLOT value: Factor
0x36	Gyro_SLOT[1].Offset	no limit	0	2	Rotation rate (Gyro) SLOT value: Offset
0x37	Reserved	-	-	-	Internal use only
0x38	Reserved	-	-	-	Internal use only
0x39	RotAcc_SLOT[2].Factor	no limit	1	2	Rotational Acceleration (RotAcc) SLOT value: Factor
0x3A	RotAcc_SLOT[2].Offset	no limit	0	2	Rotational Acceleration (RotAcc) SLOT value: Offset
0x3B ... 0x40	Reserved	-	-	-	Internal use only
0x41	Grav_SLOT[4].Factor	no limit	1000	2	Gravity Vector (Grav) SLOT value: Factor
0x42	Grav_SLOT[4].Offset	no limit	0	2	Gravity Vector (Grav) SLOT value: Offset
0x43	Reserved	-	-	-	Internal use only
0x44	Reserved	-	-	-	Internal use only
0x45	LinAcc_SLOT[5].Factor	no limit	1000	2	Linear Acceleration (LinAcc) SLOT value: Factor
0x46	LinAcc_SLOT[5].Offset	no limit	0	2	Linear Acceleration (LinAcc) SLOT value: Offset
0x47	Reserved	-	-	-	Internal use only
0x48	Reserved	-	-	-	Internal use only
0x49	Eul_SLOT[6].Factor	no limit	100	2	Euler angle (Eul) SLOT value: Factor
0x4A	Eul_SLOT[6].Offset	no limit	0	2	Euler angle (Eul) SLOT value: Offset

Index	Name	Valid values	Default value	Size [bytes]	Description
0x4B	Reserved	-	-	-	Internal use only
0x4C	Reserved	-	-	-	Internal use only
0x4D	Quat_SLOT[7].Factor	no limit	1000	2	Quaternion (Quat) SLOT value: Factor
0x4E	Quat_SLOT[7].Offset	no limit	0	2	Quaternion (Quat) SLOT value: Offset
0x4F	Reserved	-	--	2	Internal use only
0x50	Reserved	-	-	-	Internal use only
0x51	Temp_SLOT[8].Factor	no limit	10	2	Temperature (temp) SLOT value: Factor
0x52	Temp_SLOT[8].Offset	no limit	0	2	Temperature (temp) SLOT value: Offset
0x53	Reserved	-	-	-	Internal use only
0x54	Reserved	-	-	-	Internal use only
Filter Settings					
0x55	Acc_Filter[0].Type	0… 5 [2)]	0	1	Filter type of Filter No.0 >> Acceleration (Acc)
0x56	Acc_Filter[0].Order	0… 3 [2)]	1	1	Filter order of Filter No.0 >> Acceleration (Acc) 0 = off
0x57	Acc_Filter[0].Frequency	1000…65000 [2)]	20000	2	Cut-off frequency of Filter No.0 >> Acceleration (Acc) in mHz
0x58	Gyro_Filter[1].Type	0… 5 [2)]	1	1	Filter type of Filter No.1 >> Rotation rate (Gyro)
0x59	Gyro_Filter[1].Order	0… 3 [2)]	0	1	Filter order of Filter No.1 >> Rotation rate (Gyro) 0 = off
0x5A	Gyro_Filter[1].Frequency	1000…65000 [2)]	50000	2	Cut-off frequency of Filter No.1 >> Rotation rate (Gyro) in mHz
0x5B	RotAcc_Filter[2].Type	0… 5 [2)]	0	1	Filter type of Filter No.2 >> Rotational acceleration (RotAcc)
0x5C	RotAcc_Filter[2].Order	0… 3 [2)]	1	1	Filter order of Filter No.2 >> Rotational acceleration (RotAcc) 0=off
0x5D	RotAcc_Filter[2].Frequency	1000…65000 [2)]	10000	2	Cut-off frequency of Filter No.2 -> Rotational acceleration (RotAcc) in mHz
0x5E … 0x60	reserved	-	-	-	Internal use only
0x61	Grav_Filter[4].Type	0… 5 [2)]	0	1	Filter type of Filter No.4 >> Gravity vector (Grav)
0x62	Grav_Filter[4].Order	0… 3 [2)]	0	1	Filter order of Filter No.4 >> Gravity vector (Grav) 0 = off
0x63	Grav_Filter[4].Frequency	1000…65000 [2)]	50000	2	Cut-off frequency of Filter No.4 >> Gravity vector (Grav) in mHz
0x64	LinAcc_Filter[5].Type	0… 5 [2)]	0	1	Filter type of Filter No.5 >> Linear acceleration (LinAcc)
0x65	LinAcc_Filter[5].Order	0… 3 [2)]	0	1	Filter order of Filter No.5 >> Linear acceleration (LinAcc) 0 = off

Index	Name	Valid values	Default value	Size [bytes]	Description
0x66	LinAcc_Filter[5].Frequency	1000…65000 [2]	50000	2	Cut-off frequency of Filter No.5 >> Linear acceleration (LinAcc) in mHz
Angle_Definition					
0x67	Eul_Ang_Def	0 .. 3	2	1	Euler Angles definition: ■ 0 = z,y',x'' [DIN 9300;DIN 70000] ■ 1 = ZXZ P +F Angles definition: ■ 2 = INX [Pepperl + Fuchs] ■ 3 = INY [Pepperl + Fuchs]

Table 7.1

[1] PDO according to table in chapter "PDO Mapping"

[2] Filter Type according to table in chapter "Filter Settings"

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