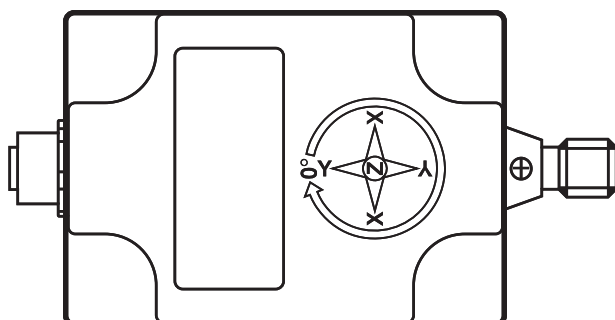




Device manual
Inclination sensor JD
with J1939 interface

UK

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1 Preliminary note

Technical data, approvals, accessories and further information at www.ifm.com.

1.1 Symbols used

- ▶ Instructions
- > Reaction, result
- [...] Designation of keys, buttons or indications
- Cross-reference
-  Important note
Non-compliance may result in malfunction or interference.
-  Information
Supplementary note

2 Safety instructions

- Read this document before setting up the product and keep it during the entire service life.
- The product must be suitable for the corresponding applications and environmental conditions without any restrictions.
- Only use the product for its intended purpose (→ Functions and features).
- If the operating instructions or the technical data are not adhered to, personal injury and/or damage to property may occur.
- The manufacturer assumes no liability or warranty for any consequences caused by tampering with the product or incorrect use by the operator.
- Installation, electrical connection, set-up, operation and maintenance of the unit must be carried out by qualified personnel authorised by the machine operator.
- Protect units and cables against damage.

3 Intended use

Dynamic MEMS inclination sensors detect and measure the angle of tilt (inclination/slope/elevation) of an object in relation to the force of gravity. This is possible while the object stands still (static) or while it is moving (dynamic).

The unit offers integrated linearisation and temperature compensation and ignores external accelerations.

This makes the sensor particularly apt for moving (dynamic) applications and harsh environments.

JD1xxx: Single-axis inclination sensor with an angular range of 0...360°.

JD2xxx: Dual axis inclination sensor with an angular range of $\pm 90^\circ$.

Properties:

- high accuracy also during external accelerations

Typical applications are:

- mobile machines
- agricultural machines
- elevating work platforms
- automated guided transport vehicle (AGV)

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4 Installation

4.1 Fixing

- ▶ Choose a plane mounting surface.
- ▶ Fix the unit using 4 screws, tightening torque 1.5...2.5 Nm.

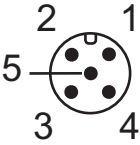
Recommendation:

M6 hex-head screws (steel or stainless steel)

- ▶ Adjust M12 connectors precisely and screw them fully into the unit, tightening torque 1.5 Nm.

5 Electrical connection

The inclination sensor is connected via a 5-pin M12 connector.

	<p>1: CAN_GND Ground 2: CAN_V+ supply voltage 24 V DC (+UB) 3: GND CAN_ supply voltage 0 V DC (+UB) 4: CAN_H High bus cable 5: CAN_L Low bus cable</p>
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5.1 Bus termination

One terminating resistor is required

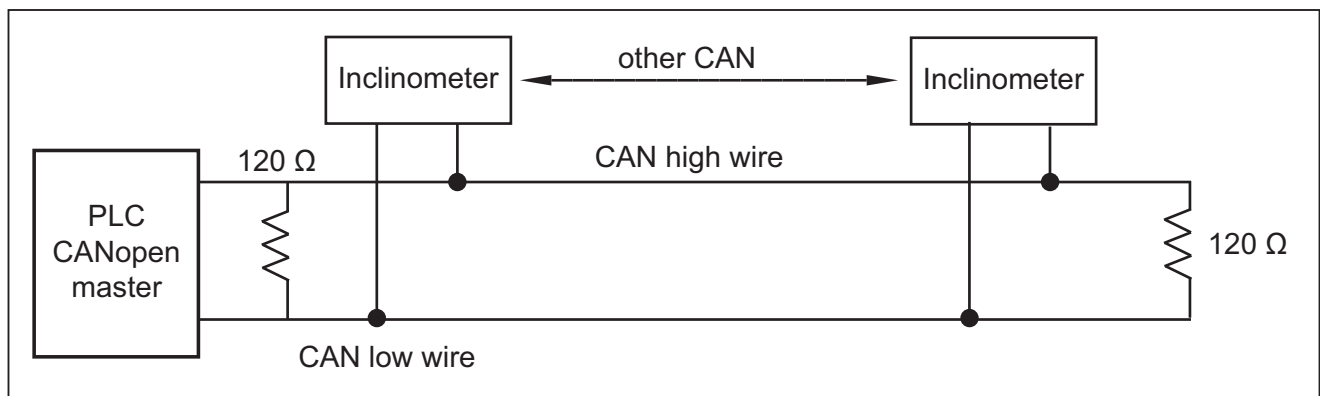
- if the sensor is connected at the end or the beginning of the bus.
- in case of a transmission rate ≥ 50 kBaud.

This prevents that information will be transmitted back to the CAN bus.

Dynamic ifm sensors have an integrated (switchable) 120Ω termination resistor that can be activated (1) or deactivated (0).

The bus wires can be routed in parallel or twisted, with or without shielding in accordance with the electromagnetic compatibility requirements. A single line structure minimises reflection.

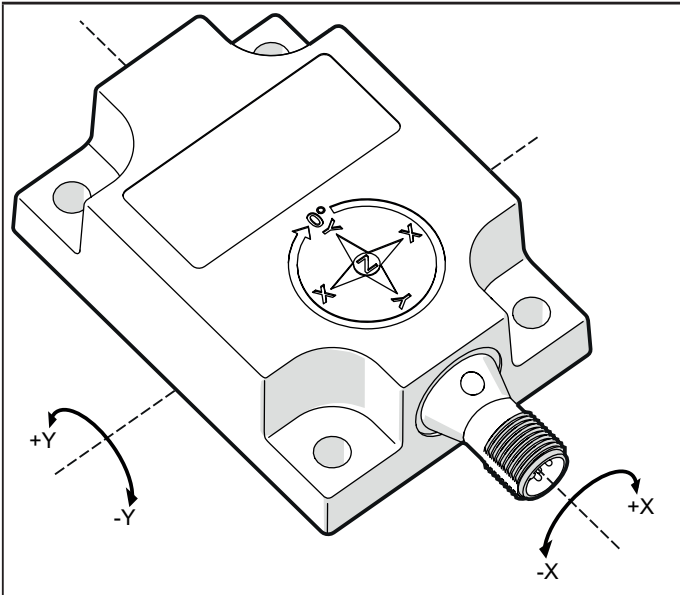
The following diagram shows the components for the physical layer of a two-wire CAN bus.



6 Measurement axes

6.1 Dual axis inclination sensor $\pm 90^\circ$ (JD23xx)

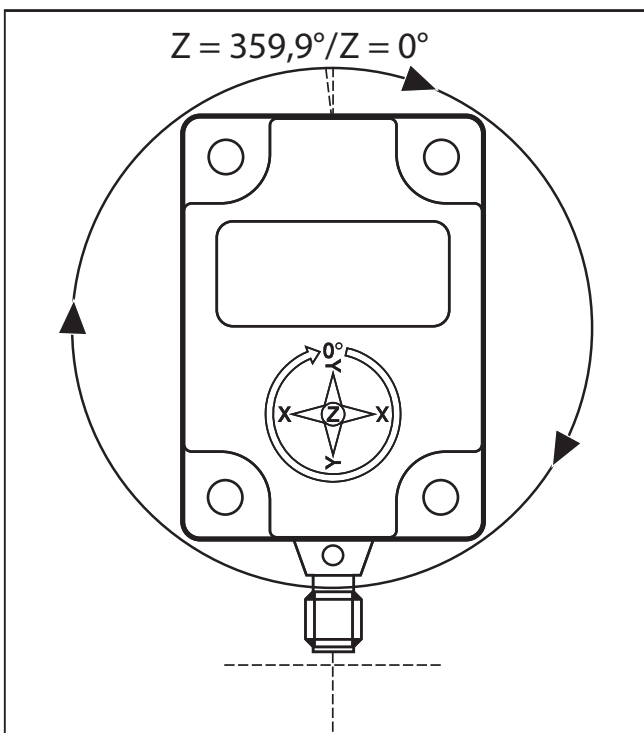
The X-axis (Roll) and the Y-axis (Pitch) measure the angular position relative to the earth vector. Both axes are limited to $\pm 90^\circ$. The sensor is mounted horizontally. The X-axis and the Y-axis provide 0° if the inclination sensor is installed in a horizontal position.



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6.2 Single axis inclination sensor $0...360^\circ$ (JD13xx)

The sensor is mounted vertically. A clockwise rotation around the Z-axis of the sensor increases the angle value from $0...360^\circ$. When the male connector is pointing downwards, the output is 0° .



7 J1939 interface

7.1 Parameters

Node ID	In the network, each device has a Node ID that is used to address the device and to define the priority (default: 25d; 19h).
Baud rate	Baud rate setting 125 kbaud, 250 kbaud or 500 kbaud (default: 250 kbaud)
Preset value	The preset parameter is used to predefine a position value that is to be reached at a specific physical position.
Terminating resistor	The 120 Ω termination resistor can be activated using the software (default: deactivated).
Direction	The counting direction is adjustable.
Cycle time	The cycle time is adjustable.

8 PGN configuration

8.1 Default PGNs

The JD sensor transmits 2 PGNs by default according to the following table.

	PGN 1	PGN2
JD23xx	65280	65281
JD13xx	65282	65281

8.1.1 PGN 65280 (dual axis): angle information + acceleration x, y



Roll angle - x angle rotation
Pitch angle - y angle rotation

Pitch/x angle	0...15	16	0.01°	-	-90...90°	Pitch angle data (Range $\pm 90^\circ$)
Roll/y angle	16-31	16	0.01°	-	-90...90°	Roll angle data (Range $\pm 90^\circ$)
Acceleration x	32...47	16	1 mg	-	-4000... 4000 mg	x axis acceleration (± 4 g range)
Acceleration y	48...63	16	1 mg	-	-4000... 4000 mg	y axis acceleration (± 4 g range)

8.1.2 PGN 65281 acceleration z + gyro x, y, z

SPN name	SPN position (bit)	SPN size (bit)	Resolution	Offset	Data zone	Description
Acceleration z	0...15	16	1 mg	-	-4000... 4000 mg	z axis acceleration (± 4 g range)
Gyro x	16...31	16	0.1 s	-	-500.0... 500.0 °/s	x axis Vehicle yaw rage (± 500°/s range)
Gyro y	32...47	16	0.1 s	-	-500.0... 500.0 °/s	y axis Vehicle yaw rate (± 500°/s range)
Gyro z	48...63	16	0.1 s	-	-500.0... 500.0 °/s	Z axis Vehicle yaw rate (± 500°/s range)

8.1.3 PGN 65282 (1 axis): angle information + acceleration x, y

SPN name	SPN position (bit)	SPN size (bit)	Resolution	Offset	Data range	Description
Pitch/x angle	0...15	16	0.01°	-	0 to 360°	Pitch angle data (0°-360° range)
Not used	16...31	16	-	-	-	fixed: 0x00
Acceleration x	32...47	16	1 mg	-	-4000... 4000 mg	x axis acceleration (± 4 g range)
Acceleration y	48...63	16	1 mg	-	-4000... 4000 mg	y axis acceleration (± 4 g range)

8.2 PGN 61481

Position of the inclination sensor	Broadcast communication
Transmission repetition rate	10 ms (default)
Data length	8 bytes
PDU Format PF	0xF0
PDU specific PS	0x29
Default priority	3
Parameter Group Number (PGN	61481

8.3 PGN 61481: Slope Sensor Information (extended range)



Roll angle - x-angle rotation
Pitch angle - y-angle rotation

SPN name	SPN position (bit)	SPN size (bit)	Resolution	Offset	Data zone	Description
Pitch angle (extended range)	0...23	24	1/32768°/ bit	-250°	-250...252°	Pitch angle data (range ± 90°)
Roll angle (extended range)	24...47	24	1/32768°/ bit	-250°	-250...252°	Roll angle data (range ± 90°)
Pitch angle compensation	48...49	2	4 states	0	0...3	00b: ON (it is always ON) 01b: OFF
Figure of merit Pitch angle (extended range)	50...51	2	4 states	0	0...3	00b: Pitch angle fully functional (is always 00b since the entire 360° range is covered) 01b: Pitch angle not fully functional
Roll angle compensation	52...53	2	4 states	0	0...3	00b: ON (it is always ON) 01b: OFF
Figure of merit Roll angle (extended range)	54...55	2	4 states	0	0...3	00b: Roll angle fully functional (it is always 00b since the entire 360° range is covered) 01b: Roll angle not fully functional
Measurement latency Roll and pitch angle (extended range)	56...63	8	0.5 ms / bit	0	0...125 ms	Estimated measurement latency (0.5 ms / bit fixed @ 10 ms right now) (UINT8)

8.4 Configuration Write Parameter

Identifier	CAN data	Meaning	Data type
0x0CEF19xx	01 00 xx xx xx xx xx xx	Index 0x01: Pitch direction (0: SAE J670, 1: opposite direction)	UINT8
0x0CEF19xx	02 00 xx xx xx xx xx xx	Index 0x02: Roll direction (0: SAE J670, 1: opposite direction)	UINT8
0x0CEF19xx	03 xx xx xx xx xx xx xx	Index 0x03: Pitch resolution (default: 327.68 (0.01°))	-
0x0CEF19xx	04 xx xx xx xx xx xx xx	Index 0x04: Roll resolution (default: 327.68 (0.01°))	-
0x0CEF19xx	05 0A 00 xx xx xx xx xx	Index 0x05: Cycle time 1st PGN (1 ms / count, default: 10)	UINT16
0x0CEF19xx	06 0A 00 xx xx xx xx xx	Index 0x06: Cycle time 2nd PGN (1 ms / count, default: 10)	UINT16
0x0CEF19xx	07 19 xx xx xx xx xx xx	Index 0x07: Address (0...253 allowed, default: 25d; 19h)	UINT8
0x0CEF19xx	08 04 xx xx xx xx xx xx	Index 0x08: Baud rate (default: 04: 250 kbaud)	UINT8
0x0CEF19xx	09 00 xx xx xx xx xx xx	Index 0x09: Fast Bootup Enable (0: disabled, 1: enabled; (default 0)	UINT8
0x0CEF19xx	0A 00 00 00 00 xx xx xx	Index 0x0A: Pitch default setting	INT32
0x0CEF19xx	0B 00 00 00 00 xx xx xx	Index 0x0B: Roll default setting	INT32
0x0CEF19xx	0E 00 xx xx xx xx xx xx	Index 0x0E: Termination resistor (0: off; 1: on; (default: 0)	UINT8
0x0CEF19xx	FA 73 61 76 65 xx xx xx	Index 0xFA: Save all parameter with reset (non-volatile)	UINT32
0x0CEF19xx	FC 6C 6F 61 64 xx xx xx	Index 0xFC: Restore all parameter to factory default with reset	UINT32
xx: source/destination address			

8.5 Resolution of pitch/x angle and roll/y angle

These settings change the visualisation of the corresponding angle.

Value	Resolution
1	1°
10	0.1°
100	0.01°

8.5.1 Cycle time

By programming an unsigned 16 bit integer value (0...65535), the cycle time can be set in milliseconds.

8.5.2 Baud rate

The Baud rate can be changed by writing the following values

Value	Baud rate
3	125 kbaud
4	250 kbaud
5	500 kbaud

8.5.3 Pitch and roll default setting

Writing this parameter sets the current pitch and roll position of the sensor to the required value.

Limitation for PGN 61481

In order to not exceed the pitch/roll 24 bit data value and to prevent any roll-over effects, the preset value needs to follow the following limitation:

$$\text{Preset Value} - \text{Physical Value} \leq 155^\circ$$

The equation will be checked automatically if a default setting is programmed. If the equation does not work, the default setting will not be applied.

8.6 Fast Bootup Enable

This write parameter changes the time duration from the moment power is applied until position data is send via the communication interface. After the power supply is switched on, it takes about 1200 ms before the sensor provides the position data.

For some applications it is important, that the sensor sends the data earlier. By setting the fast bootup enable parameter to 1, the fast bootup can be enabled. In this case, the sensor transmits the position data after 600 ms, but the position data for the following 600 ms is incorrect.

8.7 Configuration of read parameters

Direction	Identifier	CAN data	Meaning	Data type
Enquiry	0x0CEA19xx	00 EF 00	Read request	-
Reply	0x0CEFxx19	01 00 FF FF FF FF FF FF	Index 0x01: Pitch direction (default: 0)	UINT8
Enquiry	0x0CEA19xx	00 EF 00	Read request	-
Reply	0x0CEFxx19	02 00 FF FF FF FF FF FF	Index 0x02: Roll direction (default: 0)	UINT8
Enquiry	0x0CEA19xx	00 EF 00	Read request	-
Reply	0x0CEFxx19	03 64 00 FF FF FF FF FF	Index 0x03: Pitch resolution (default: 0.01°)	UINT16
Enquiry	0x0CEA19xx	00 EF 00	Read request	-
Reply	0x0CEFxx19	04 64 00 FF FF FF FF FF	Index 0x04: Roll resolution (default: 0.01°)	UINT16
Enquiry	0x0CEA19xx	00 EF 00	Read request	-
Reply	0x0CEFxx19	05 0A 00 FF FF FF FF FF	Index 0x05: Cycle time 1st PGN in ms (default: 10 ms)	UINT16
Enquiry	0x0CEA19xx	00 EF 00	Read request	-
Reply	0x0CEFxx19	06 0A 00 FF FF FF FF FF	Index 0x06: Cycle time 2nd PGN in ms (default: 10 ms)	
Enquiry	0x0CEA19xx	00 EF 00	Read request	-
Reply	0x0CEFxx19	07 19 FF FF FF FF FF FF	Index 0x07: Address (default: 25)	UINT8
Enquiry	0x0CEA19xx	00 EF 00	Read request	-
Reply	0x0CEFxx19	08 04 FF FF FF FF FF FF	Index 0x08: Baud rate (default: 250 kbaud)	UINT8
Enquiry	0x0CEA19xx	00 EF 00	Read request	-
Reply	0x0CEFxx19	09 00 FF FF FF FF FF FF	Index 0x09: Fast Bootup Enable (default: 0 deactivated)	UINT8
Enquiry	0x0CEA19xx	00 EF 00	Read request	-
Reply	0x0CEFxx19	0A 00 00 00 00 FF FF FF	Index 0x0A: Pitch preset (default: 0)	INT32
Enquiry	0x0CEA19xx	00 EF 00	Read request	-

Direction	Identifier	CAN data	Meaning	Data type
Reply	0x0CEFxx19	0B 00 00 00 00 FF FF FF	Index 0x0B: Roll preset (default: 0)	INT32
Enquiry	0x0CEA19xx	00 EF 00	Read request	-
Reply	0x0CEFxx19	0C 00 00 00 00 FF FF FF	Index 0x0C: Pitch offset (default: 0)	INT32
Enquiry	0x0CEA19xx	00 EF 00	Read request	-
Reply	0x0CEFxx19	0D 00 00 00 00 FF FF FF	Index 0x0D: Roll offset (default: 0)	INT32
Enquiry	0x0CEA19xx	00 EF 00	Read request	-
Reply	0x0CEFxx19	0E 00 FF FF FF FF FF FF	Index 0x0E: Termination resistor (default: 0...off)	UINT8
Enquiry	0x0CEA19xx	00 EF 00	Read request	
Reply	0x0CEFxx19	0F 02 FF FF FF FF FF FF	Index 0x0F: Angle mode (2 = JD23xx; 3 = JD13xx)	UINT8
Enquiry	0x0CEA19xx	00 EF 00	Read request	
Reply	0x0CEFxx19	10 31 2E 32 31 FF FF FF	Index 0x10: Software version	5 bytes (ASCII)
Enquiry	0x0CEA19xx	00 EF 00	Read request	
Reply	0x0CEFxx19	11 50 4F 53 31 30 37 FF	Index 0x11: Hardware version (default: POS107)	6 bytes (ASCII)
Enquiry	0x0CEA19xx	00 EF 00	Read request	
Reply	0x0CEFxx19	12 FF FF FF FF FF FF FF	Index 0x12: Serial number (default: "FF FF FF FF")	UINT32
Enquiry	0x0CEA19xx	00 EF 00	Read request	
Reply	0x0CEFxx19	13 32 53 4B 41 FF FF FF	Index 0x13: Product code (1 = JD13xx; 2 = JD23xx)	UINT32
Enquiry	0x0CEA19xx	00 EF 00	Read request	
Reply	0x0CEFxx19	JD1xxx: 14 4A 44 31 33 31 31 FF JD2xxx: 14 4A 44 32 33 31 30 FF	Index 0x14: Device name (default: JD1xxxx / JD2xxxx)	3 bytes (ASCII)

8.8 Changing the device address

Original address: 0x19 (25d)

New address: 0xC1 (193d)

Identifier	DLC	Data
0x0CEF19xx	8	06 C1 00 00 00 00 00 00
0x0CEF19xx	8	FA 73 61 76 65 xx xx xx

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Row 1:

- Set address to C1 → Configuration write parameter

Note: The Address will be changed after store and reset.

► Row 2:

Execute the command save and reset.

9 Status LED

Two-color status LED	Flashing frequency	Meaning
Green	off	No power supply
	on	Normal operation mode
Red	off	Normal operation mode
	single flash	At least one of the error counters of the CAN controller has reached or exceeded the warning level (too many error frames).
	flashes	General configuration error (e.g. wrong baud rate)
	on	The CAN controller is in the state bus off. No communication is possible anymore. Too many errorframes in the network.

The two-color LED will only light up red in cases where both the green and red LEDs would light up.

10 Maintenance, repair and disposal

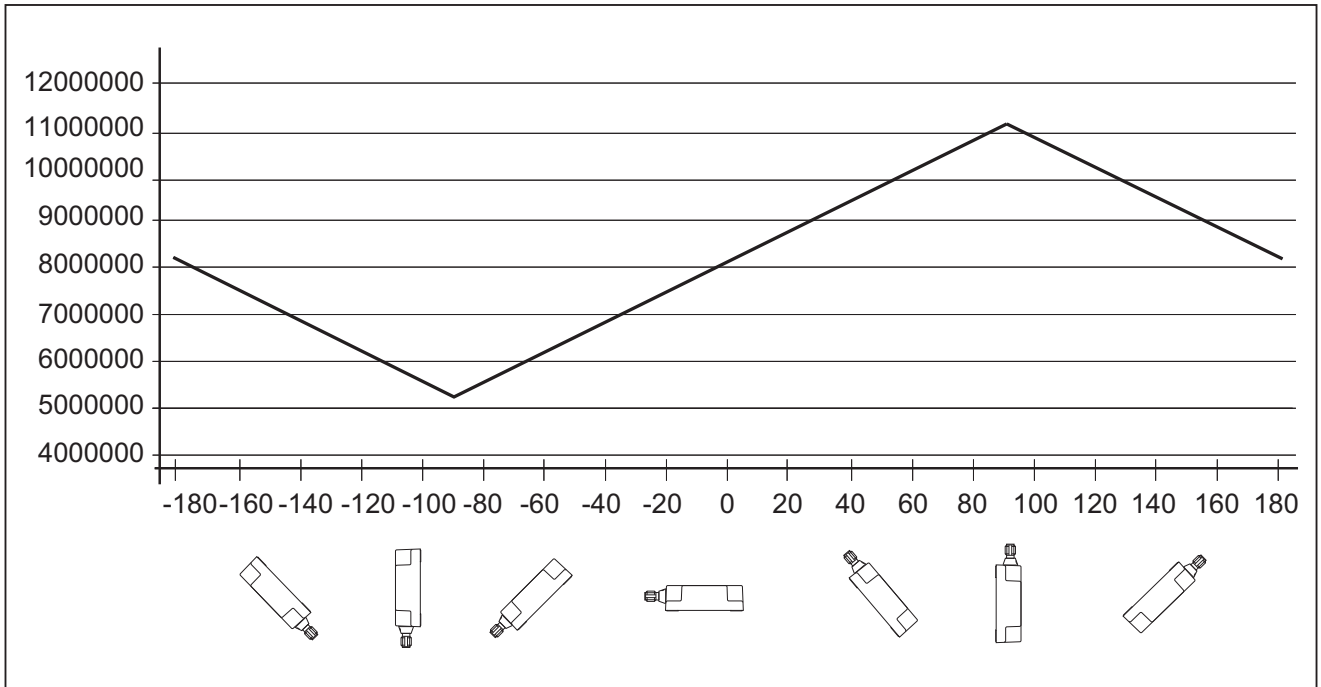
The device is maintenance-free.

- Dispose of the device in accordance with the national environmental regulations.

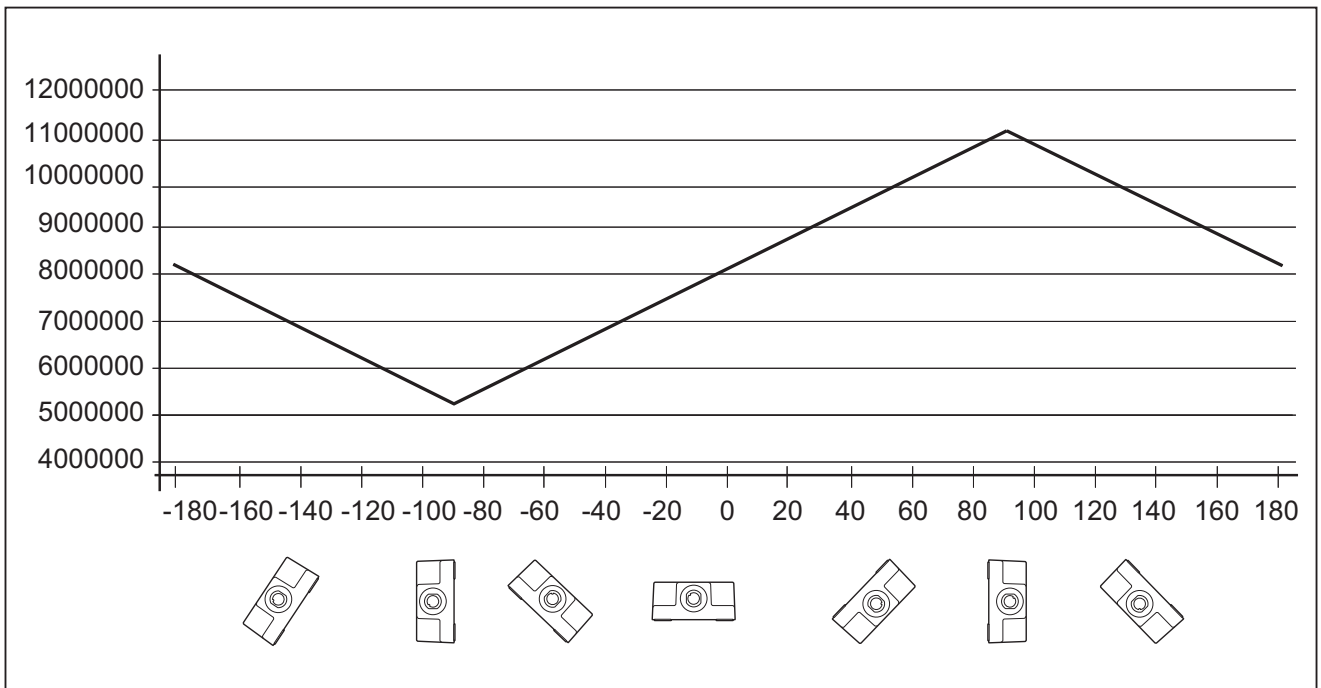
11 Graphic representation of the output functions

11.1 Output Values JD23xx

PGN 65280 pitch



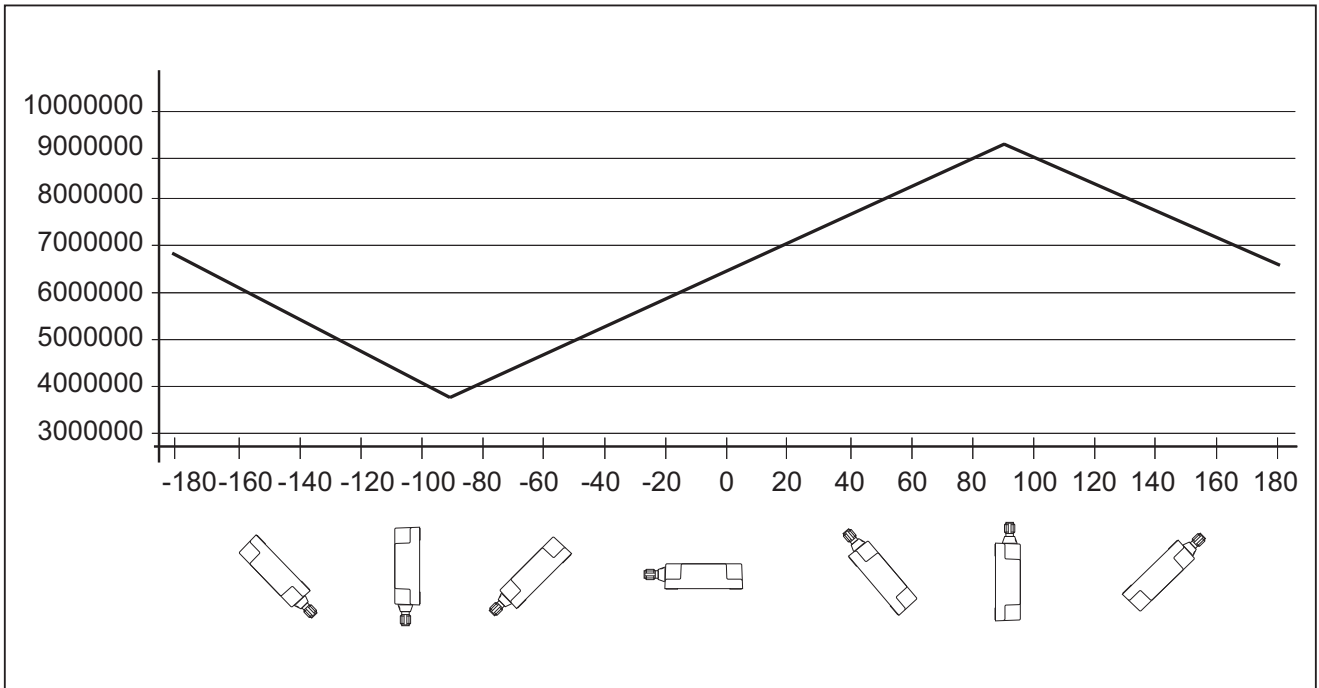
PGN 65280 roll



11.2 Output Graphs with Preset and Offset

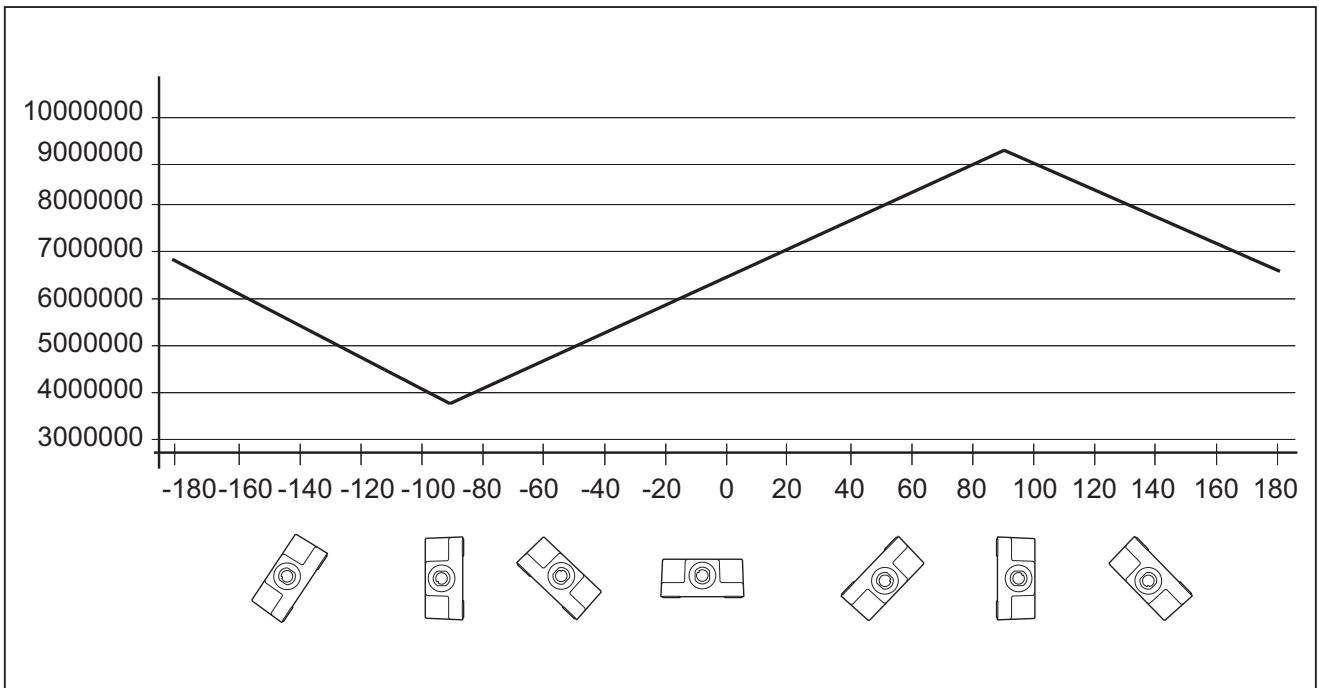
JD23xx with a programmed pitch and roll offset of 50°

PGN 65280 pitch (offset 50°)



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PGN 65280 roll (offset 50°)



Note: The turning point where the graph switches from positive to negative slope stay at the physical position of $\pm 90^\circ$.