ifm electronic

CE

Device manual

UK

Inclination sensor
2 axes

efector410

JN2101
from firmware 2.2.0

Contents

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This document is the original instructions.

1 Preliminary note

This document applies to the device of type "inclination sensor" (art. no.: JN2101). It is part of the device.

This document is intended for specialists. These specialists are people who are qualified by their appropriate training and their experience to see risks and to avoid possible hazards that may be caused during operation or maintenance of the device. The document contains information about the correct handling of the device.

Read this document before use to familiarise yourself with operating conditions, installation and operation. Keep this document during the entire duration of use of the device.

Adhere to the safety instructions.

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

2.1 General

These instructions are an integral part of the device. They contain texts and figures concerning the correct handling of the device and must be read before installation or use.

Observe the operating instructions. Non-observance of the instructions, operation which is not in accordance with use as prescribed below, wrong installation or incorrect handling can seriously affect the safety of operators and machinery.

2.2 Target group

These instructions are intended for authorised persons according to the EMC and low-voltage directives. The device must only be installed, connected and put into operation by a qualified electrician.

2.3 Electrical connection

Disconnect the unit externally before handling it.

The connection terminals may only be supplied with the signals indicated in the technical data and/or on the device label and only the approved accessories from ifm may be connected.

2.4 Tampering with the device

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Contact the manufacturer in case of malfunction of the unit or uncertainties. Any tampering with the device can seriously affect the safety of operators and machinery. In case of tampering with and/or modifying the unit, any liability and warranty is excluded.

3 Functions and features

The 2-axis inclination sensor with CANopen interface enables angle levelling and position detection of mobile machines.

Typical applications are, for example, the position detection of access platforms, levelling of mobile cranes or set-up of mobile machines.

Properties:

● 2-axis inclination sensors with a measuring range of ±45°

● High accuracy and resolution

● CANopen interface to CiA DS-301 and device profile CiA DSP-410

● The module supports "node guarding" and "heartbeat"; "guard time", "life time factor" as well as "heartbeat time" can be configured.

● High sampling rate and band width

● Configurable limit frequency (digital filter) for vibration suppression

● CANopen functions

   – Transmit PDOs (RTR, cyclical, synchronised)

   – SYNC consumer (synchronised transmission of the transmit PDOs after reception of a SYNC telegram)

   – EMCY producer (exceeding of limit value, monitoring of the inside device temperature)

   – Failure monitoring by means of heartbeat or node guarding / life guarding

● Programming key

● Autostart function

4 Installation

4.1 Fixing

► Fasten the device using 4 M5 screws on a flat surface.
Screw material: steel or stainless steel.

4.2 Mounting surface

[!] The housing must not be exposed to any torsional forces or mechanical stress.
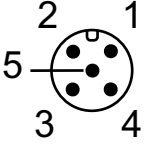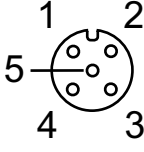
► Use compensating elements if there is no flat mounting surface available.

5 Scale drawing
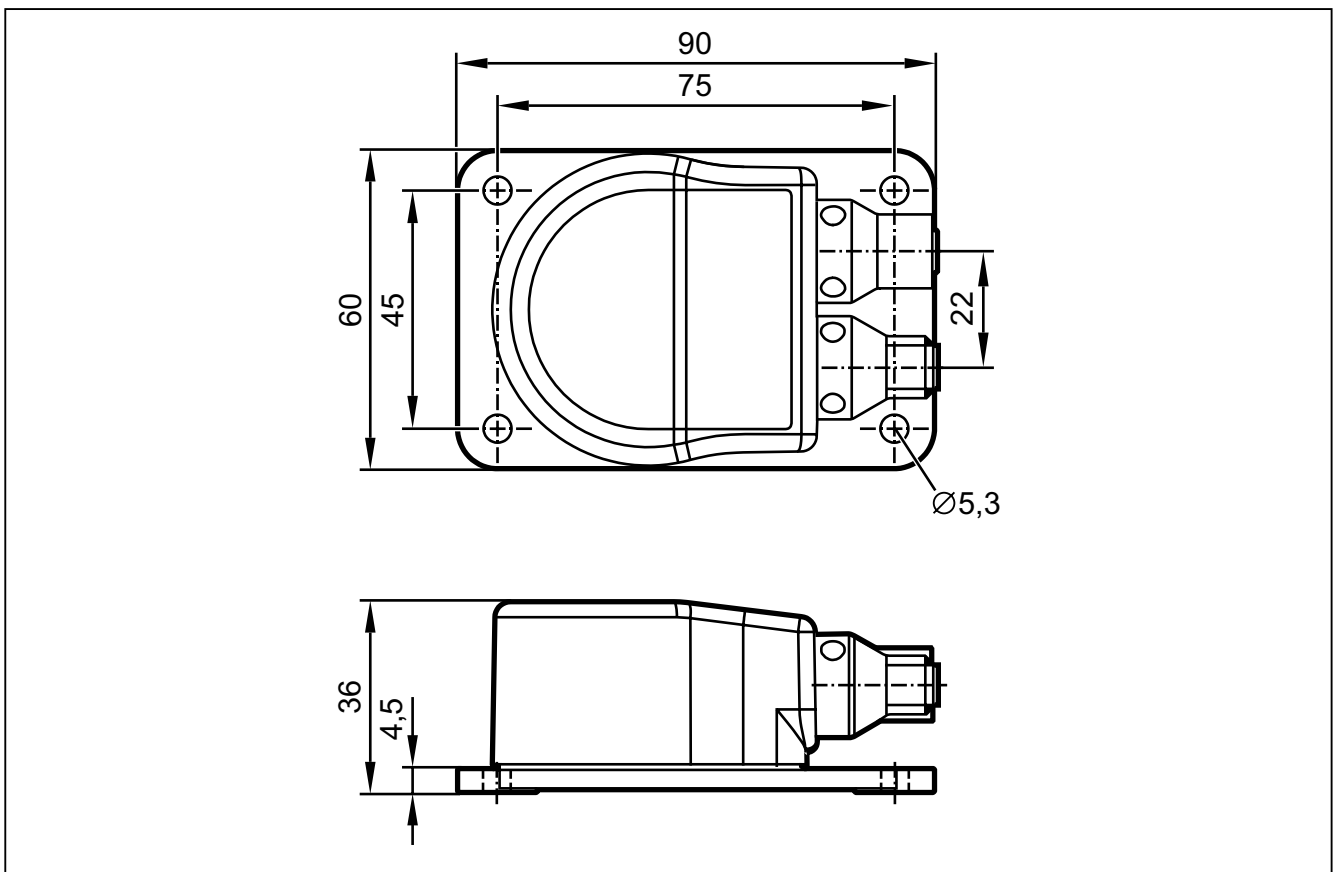
6 Electrical connection

The inclination sensors are fitted with two round 5-pole M12 connectors (A-coded). The pin connection corresponds to the CANopen specification CiA DR-303-1.

2 1 5 ⊙ 3 4	1: CAN_SHLD CAN shield 2: CAN_V+ Supply voltage 24 V DC (+U_B) 3: CAN_GND Ground 4: CAN_H High bus cable 5: CAN_L Low bus cable
M12 connector CAN-In	
1 2 5 ⊙ 4 3	1: CAN_SHLD CAN shield 2: CAN_V+ Supply voltage 24 V DC (+U_B) 3: CAN_GND Ground 4: CAN_H High bus cable 5: CAN_L Low bus cable
M12 socket CAN-Out	

6.1 Bus termination

The inclination sensors have an internal terminating resistor that can be activated via the CANopen interface → SDO register.

7 CANopen interface

The inclination sensors have a standardised CANopen interface to CiA DS-301 and a device profile to CiA DSP-410. All measured values and parameters can be accessed via the object directory (OD). The individual configuration can be saved in the internal permanent memory (flash).

7.1 CANopen functions

The following CANopen functions are available:

● Several transmit data objects (TPDO) in four possible operating modes:
  – individual check via a remote transmit-request telegram (RTR)
  – cyclical transmission per interval time
  – synchronised transmission after reception of a SYNC telegram
  – a service data object (default SDO)
● Error messages per emergency object (EMCY) with support of the:
  – general error register
  – manufacturer-specific register
  – error list (pre-defined error field)
● Monitoring mechanisms heartbeat and node guarding/life guarding

- Status and error indication via LED

- In addition to the basic CANopen functions there are other manufacturer and profile-specific features:

  – setting of the node ID and the baud rate via OD

  – configurable limit frequency (digital filter)

7.2 Set-up

The CANopen standard CiA DS-301 defines three possible states for sensor nodes.

Pre-operational
The pre-operational state is used to set the sensor parameters or as standby mode. In the pre-operational state no process data (PDO messages) can be transmitted.

Operational
The operational state is used to exchange the process data while in operation. In the operational state all communication services are carried out.

Stopped
The stopped state is used for network management; only NMT messages are possible.

The master or network manager can request the sensor via NMT messages to change the state accordingly. This allows almost complete separation of redundant or faulty sensors from the bus.

7.3 NMT start-up (OD index 1F80h)

The sensor has a selectable start performance. The following three options can be selected under the index 1F80h:

7.3.1 Slave Only (default) (OD index 1F80h = 0)

The sensor starts in the pre-operational state (0x00h).

7.3.2 NMT start command (OD index 1F80h = 2)

This command is used for CAN bus networks without NMT master. If the sub-index 0x02h is selected, the sensor starts after a new start as NMT master in the operational state and sets the other network participants from the pre-operational into the operational state.

7.3.3 Autostart (OD index 1F80h = 8)

If this command is written under the sub-index 0x08h, the sensor starts automatically in the operational state after a new start.

7.4 Communication types of process data object (PDO)

The request for process data objects is made by sending a remote transmit request telegram (RTR).

The different transmit PDOs (TPDOx) can be polled in all operating modes of the inclination sensor individually and at any time.

7.5 Cyclical operating mode

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The cyclical transmission of a TPDO is activated when the interval time (e.g. OD index 1800h/05h for TPDO0) contains a value greater than 0. The type of transmission (e.g. OV index 1800h/02h for TPDO0) has to be set to "asynchronous – manufacturer-specific" (value = FEh). In the "operational" state the inclination sensor then cyclically transmits the TPDO0 with the set interval time.

7.5.1 Synchronised transmission after reception of a SYNC telegram

For the synchronised transmission CANopen provides the SYNC object at which the TPDOs are transmitted after every "nth" reception of a SYNC telegram.

Each inclination sensor has several transmit process data objects (TPDO0). The TPDO1 contains the current inclination values (longitudinal and lateral) as 16-bit values.

Byte 0	Byte 1	Byte 2	Byte 3
Inclination value longitudinal (X axis) OD index: 6010h		Inclination value lateral (y axis) OD index: 6020h	

The second transmit process data object TPDO1 contains the inclination values as 32-bit values.

Byte 0 to byte 3	Byte 4 to byte 7
Inclination value longitudinal (X axis) OD index: 6110h	Inclination value lateral (y axis) OD index: 6120h

The resolution of the inclination information (SDO index 6000h) can be configured accordingly. For the settings see the device profile for inclination sensors (CiA DSP-410: SDO index 0x6000 – 0x9FFF).
A list with the individual values can be found in chapter "7.6.5 Profile-specific part".

7.6 Object directory (OD)

Index	Sub-index	Name (parameter)	Type		Default value	Save
1000h	0	Device type (device profile 410, 2 axes)	const	u32	4019Ah	
1001h	0	Error register	ro	u8	0	
1003h		Pre-defined error field				
	0	Number of error entries	rw	u32	0	
	1...50	Error code (oldest error at highest index)	ro	u32	0	
1005h	0	COB ID sync message	rw	u32	80h	
1008h	0	Product designation	const	VSTR	JN2101	
1009h	0	Hardware version	const	VSTR	X.Y.Z	
100Ah	0	Software version ("XYY")	const	VSTR	X.Y.Z	
100C h	0	Guard time (multiple of 1 ms)	rw	u16	0	Yes
100D h	0	Life time factor	rw	u8	0	Yes
1010h		Save parameters				
	0	Highest supported sub-index	r0	u32	1	
	1	Save all parameters (signature: "save" 65766173h)	rw	u32	0	
1011h		Restore factory parameters		u32		
	0	Highest supported sub-index	r0	u32	1	
	1	Restore all factory parameters (signature: "load" - 64616F6 Ch)	rw	u32	0	
1014h	0	COB ID EMCY (emergency message)	ro	u32	80h + node ID	
1015h	0	Disable time between EMCY messages (multiple of 100 µs)	rw	u16	0	Yes
1017h	0	Heartbeat interval time (multiple of 1 ms, 0 deactivated)	rw	u16	0	Yes
1018h		Identity object				
	0	Highest supported sub-index	ro	u8	4	
	1	Vendor ID	ro	u32	6D666900	
	2	Product code	ro	u32	01	
	3	Revision number	ro	u32	AA	
	4	Serial number	ro	u32	Typical	
1029h		Error behaviour object				
	0	Number of error classes	ro	u8	1	No
	1	Error behaviour	rw	u8	0	0x0

Index	Sub-index	Name (parameter)	Type		Default value	Save
1200h		Server SDO parameter				
	0	Highest supported sub-index	ro	u8	2	
	1	COB ID client to server	ro	u32	600h + node ID	
	2	COB ID server to client	ro	u32	580h + node ID	
1800h		Transmit PDO0 communication parameter				
	0	Highest supported sub-index	ro	u8	5	
	1	COB ID	ro	u32	180h + node ID	
	2	Type of transmission (synchronous + asynchronous, manufacturer-specific)	rw	u8	1	Yes
	3	Disable time between two TPDO messages (multiple of 100 μm)	rw	u16	0	
	5	Interval time for cycl. transmission (multiple of 1 ms, 0 deactivated)	rw	u16	10	Yes
1801h		Transmit PDO1 communication parameters				
	0	Highest supported sub-index	ro	u8	5	
	1	COB ID	ro	u32	280h + node ID	
	2	Type of transmission (synchronous/asynchronous)	rw	u8	1	Yes
	3	Disable time between two TPDO messages (multiple of 100 μs)	rw	u16	0	
	5	Interval time for cycl. transmission (multiple of 1 ms, 0 deactivated)	rw	u16	10	Yes
1A00h		Transmit PDO0 mapping parameter (fixed mapping)				
	0	Highest supported sub-index	ro	u8	2	Yes
	1	Inclination value longitudinal (X axis)	ro	u32	60100010h	
	2	Inclination value lateral (Y axis)	ro	u32	60200010h	
1A01h		Transmit PDO1 mapping parameter (fixed mapping)				
	0	Highest supported sub-index	ro	u8	2	Yes
	1	Inclination value longitudinal (X axis)	ro	u32	61100020h	
	2	Inclination value lateral (Y axis)	ro	u32	61200020h	

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Index	Sub-index	Name (parameter)	Type	Default value	Save
1F80h	NMT start-up				
	0	Slave only	rw		
	2	Start-up capable device NMT start command	rw		
	8	Start-up capable device autostart feature only	rw		

Values for error behaviour (see 1029h)

0 = pre-operational (only if current state is operational)

1 = no change of state

2 = stopped

3 .. 127 = reserved

7.6.1 Communication parameters (to CiA DS-301)

Error register (OD index 1001h)

The error register indicates the general error status of the device. Every bit stands for an error group. If a bit is set (= 1), at least one error of this group is active at the moment. The contents of this register are transmitted in every emergency message (EMCY).

Error groups

Bit 5...7	bit 4 = 0	bit 3 = 0	bit 2 = 0	bit 1 = 0	Bit 0
Not used	Communication error (overrun)	Temperature	Voltage	Not used	At least one error active

Pre-defined error field (OD index 1003h)

Each inclination sensor has an error list with the 50 most recent errors. The pre-defined error field (OD index 1003h) contains the number of error entries (OD index 1003h/00h).

The other sub-indices contain the saved error states in chronological order with the error occurred last being always found under the lowest sub-index (OD index 1003h/01h).

The oldest error is in the highest available sub-index and is the first to be removed from the list in the case of more than 50 errors.
If an error occurs, a new error entry is added to the error field (OD index 1003h) and also communicated via an EMCY message.

Structure of an error entry

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Emergency error Code		Error register (object 1001h)	Manufacturer-specific error field				

Emergency error code	Meaning
00xxh	Error reset or no error
10xxh	Generic error
31xxh	Mains voltage
32xxh	Voltage inside the device
41xxh	Ambient temperature
42xxh	Device temperature
80xxh	Monitoring
81xxh	Communication
8110h	CAN overrun (objects lost)
8120h	CAN in error passive mode
8130h	Life guard error or heartbeat error
8140h	Recovered from bus off
8150h	Transmit COB ID
82xxh	Protocol error
8210h	PDO not processed due to length error
8220h	PDO length exceeded
90xxh	External error
F0xxh	Additional functions

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7.7 Service data object (SDO) mapping

7.7.1 System settings 0x2000 - 0x203F

SDO index	Sub-index	Type	Value	Unit	r/w	Reset
0x2000	0x0	u8	Node ID		rw	x
0x2001	0x0	u16	Baud rate	Kbit	rw	x
0x2002	0x0	u8	Flag to reset the sensor Flag = 1 sensor reset	0	rw	

7.7.2 Applicative 0x2040 - 0x207F

SDO index	Sub-index	Type	Value	Unit	r/w	Reset
0x2040	0x0	u8	Flag for quadrant correction 0: off 1: on ± 180 2: on ± 0 360°		rw	
0x2041	0x0	u8	Flag for heating Flag = 0 heating off Flag = 1 heating on		rw	
0x2042	0x0	u8	Index teach values of the X/Y/Z axes 0: no change 1: set teach, relative measurement 2: reset teach, absolute measurement		rw	
0x2043	0x0	u8	FIR filter for angle measurement 0: FIR deactivated 1: FIR 10 Hz 2: FIR 5 Hz 3: FIR 1 Hz 4: FIR 0.5 Hz		rw	
0x2044	0x00	u8	Angle calculation 0: perpendicular 1: Euler 2: gimbal 1X 3: gimbal 1Y		rw	
0x2045	0x00	u8	CAN 120 Ω terminating resistor 0: resistor deactivated 1: resistor activated		rw	
0x2046	0x0	u8	Set zero point of the X / Y axes 0: unchanged 1: set zero (corresponds to the relative measurement) 2. reset set zero (corresponds to the absolute measurement)		rw	
0x207F	0x0	u8	Factory reset 1: make factory reset			
0x3000	0x0		Programming key		rw	

7.7.3 System settings 0x4000 - 0x403F

SDO index	Sub-index	Type	Value	Unit	r/w	Reset
0x4004	0x0	u8	MEMS self-test Number sub-indices		r	
0x4004	0x01	u8	Flag to activate the self-test Flag = 1 → start self-test		rw	

SDO index	Sub-index	Type	Value	Unit	r/w	Reset
0x4004	0x02	u8	Self-test register X axis pass → bit 2 = 1 X axis fail → bit 2 = 0 Y axis pass → bit 1 = 1 Y axis fail → bit 1 = 0		r	

7.7.4 Informative 0x4080 - 0x40BF

SDO index	Sub-index	Type	Value	Unit	r/w	Reset
0x4080	0x0	Integer 32	MEMS temperature	1/10 °C	r	
0x4081	0x0	u16	Heating power	mW	r	

7.7.5 Profile-specific part (to CiA DSP-410)

SDO index	Sub-index	Type	Value	Unit	r/w	Reset
0x6000	0x0	u16	Resolution 1d = 0.001° 10d = 0.01° 100d = 0.1° 1000d = 1.0°		rw	
0x6010	0x0	Integer 16	Longitudinal X axis	Angle [°]	r	
0x6011	0x0	u8	Slope long16 operating parameter		r	
0x6020	0x0	Integer 16	Lateral Y axis	Angle [°]	r	
0x6021	0x0	u8	Slope lateral16 operating parameter		r	
0x6110	0x0	Integer 32	Longitudinal X axis	Angle [°]	r	
0x6111	0x0	u8	Slope long32 operating parameter		r	
0x6120	0x0	Integer 32	Lateral Y axis	Angle [°]	r	
0x6121	0x0	u8	Slope lateral32 lateral operating parameter		r	

8 Angle definition (SDO index 2044h)

To be able to adapt the inclination sensor to the different applications as easily as possible, the measured inclination information is converted into different angle indications. The requested angle indication is set by selecting the respective option.

With this angle definition a sensor coordinate system is used which is defined as follows:

– The mounting plane corresponds to the XY plane.
– The Z axis is perpendicular to the mounting plane (according to the right-hand rule).
– The X axis is represented by an edge of the mounting plate which shows in direction of the printed X arrow.
– The Y axis is then perpendicular to the plane spanned by the Z and X axes.

8.1 Perpendicular angle (SDO index 2044h = 0)

Using the indication of the two perpendicular angles the inclination of the sensor coordinate system towards the direction of gravitation is described.

The first provided value corresponds to a rotation about the Y axis of the sensor and is called "longitudinal inclination value" (SDO index 6010h or 6110h). The value corresponds to the angle [°] between the gravitation vector and the YZ plane of the sensor.

The second provided value corresponds to a rotation about the X axis of the sensor and is called "lateral inclination value" (SDO index 6020h or 6120h). The value corresponds to the angle [°] between the gravitation vector and the XZ plane of the sensor.

In the case of an inclination in a plane (rotation of an axis with the second axis remaining perpendicular) the perpendicular angle and gimbal angle are always identical.

8.2 Euler angle (SDO index 2044h = 1)

In this setting the two provided angle values are to be interpreted as Euler angle.

The current sensor orientation is determined by two successive rotations from the horizontal position.
The "inclination value longitudinal" indicates the angle [°] at which the Z axis of the sensor is inclined. The "inclination value lateral" corresponds to the angle [°] at which the sensor was then rotated about the (inclined) Z axis.

Interpretation
The first angle value corresponds to the angle between the gravitation vector and the sensor's Z axis (slope inclination, gradient angle) whereas the second angle value indicates the direction in which the slope inclination matches the coordinate system.

Value range for this option

– Inclination value longitudinal (gradient angle): -45°…+45°
– Inclination value lateral (angle of direction): 0°…360°

Critical point
With a gradient angle of 0° the sensor is in a horizontal position. In this position the second angle (angle of direction) is useless. In practice, it is to be expected that the value of the second angle will vary very strongly even if the sensor is virtually motionless.

8.3 Gimbal angle X (SDO index 2044 = 2)

As with the Euler angle the current orientation of the sensor is described by two successive rotations from the horizontal position.

But the current orientation now arises from a rotation about the Y axis with the angle value [°] indicated by the "inclination value longitudinal" as well as from a rotation which then follows about the (now rotated) X axis with the angle [°] "inclination value lateral".

Interpretation
If you imagine the sensor as a plane whose body shows in X direction and whose wings in Y direction, the "inclination value longitudinal" corresponds to the longitudinal inclination of the plane (pitch angle) and the "inclination value lateral" to the bank angle (roll angle) of the plane.

Value range

– Inclination value longitudinal: -45°…45°

– Inclination value lateral: -45°…45°

Critical point
With a longitudinal inclination of ± 90° ("plane" flies vertically downwards or upwards) the roll angle makes a rotation about the gravitational axis which cannot be detected by the inclination sensor. In this condition the "inclination value lateral" is insignificant. In practice, the "inclination value lateral" will vary very strongly when it is close to this condition even if there is only little movement.

## 8.4 Gimbal angle Y (SDO index 2044 = 3)

This setting corresponds to the setting described in 8.3 with the difference that the order of the two rotations is now inverted.
In this option the measured object is first rotated about its X axis with the angle [°] "inclination value lateral". The measured object is then rotated about the Y axis (which is now inclined) with the angle value [°] indicated by the "inclination value longitudinal" of the sensor.

As a result of this the measured values of the gimbal angle X and the gimbal angle Y are identical as long as the measured object is only rotated about one of the sensor's axes. The measured values of the two options do not differ until a general rotation is made about the two sensitivity axes.

8.5 Explanatory example

The different angle definitions will be illustrated using a simple example. An excavator moves up and down an embankment (illustration). The embankment is angled at 30°. The inclination sensor is installed so that the y axis of the sensor shows in driving direction of the excavator.
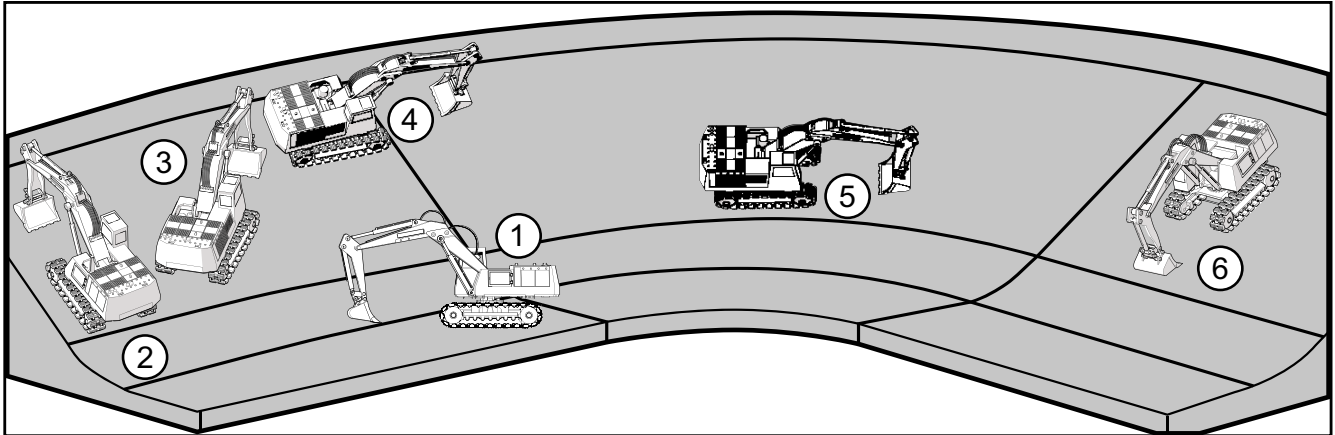
Excavator position	Perpendicular angle		Euler		Gimbal X		Gimbal Y	
	Longitudinal	Lateral	Longitudinal	Lateral	Longitudinal	Lateral	Longitudinal	Lateral
1	0°	0°	0°	Undefined	0°	0°	0°	0°
2	0°	-30°	30°	0°	0°	-30°	0°	-30°
3	20°	-20°	30°	45°	20°	-22°	22°	-20°
4	30°	0°	30°	90°	30°	0°	30°	0°
5	30°	0°	30°	90°	30°	0°	30°	0°
6	0°	30°	30°	180°	0°	30°	0°	30°

9 Other sensor functions

9.1 Node ID (SDO index 2000h) and baud rate (SDO index 2001h)

In the case of a change node ID and baud rate do not become effective until after a reset (reset application, reset communication or hardware reset).

> ℹ The inclination sensor from ifm is delivered with the node ID 10 and a baud rate of 125 Kbits/s.

> ℹ After a reset all COB IDs are recalculated and set according to the pre-defined connection set.

> ℹ The following baud rates [Kbits/s] are supported: 10, 20, 50, 125, 250, 500, 800, 1000.

9.2 Limit frequency digital filter (SDO index 2043h)

With the sensor it is possible to make continuously arising angle values insensitive to external interfering vibrations.
Using a configurable filter (digital FIR filter) interfering vibrations can be suppressed. The limit frequency of the filter is set via the FIR filter step (SDO index 2043h.

9.3 Set zero point (SDO index 2046h)

To set the zero point the sensor is rotated to the requested position and the current position is set as "0". The value of the parameter "set zero point and y axis" (SDO index 2046h) is to be set to 1.

The sensor then calculates the offset to the zero point shift and saves it in the permanent memory. From then on the offset is subtracted from the angle.

9.4 Terminating resistor (SDO index 2045h)

In bus topology a CANopen system is terminated with terminating resistors (120 Ω) at the beginning and end. If the sensor is at the beginning or end, the terminating resistor (SDO index 2045h) integrated in the sensor can be activated by writing the value 1.
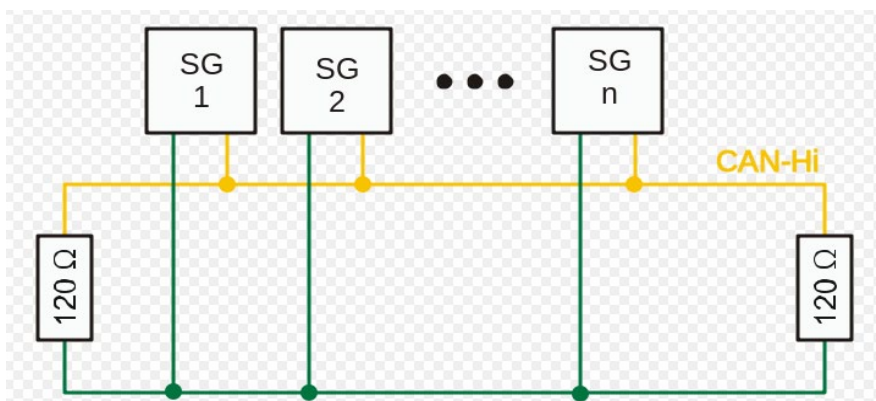
9.5 Set teach (SDO index 2042h)

Should it not be possible to integrate the inclination sensor into the measured object so that the coordinate system of the sensor and object match, the teach function enables the creation of a new reference system.
The new reference system X_b, Y_b, Z_b is defined so that its Z_b direction corresponds to the direction of gravitation at the teach moment. The X_b direction of the reference system results from the projection of the X_s axis of the sensor to the X_bY_b plane of the reference system.
The Y_b axis then corresponds to the direction which is perpendicular to both the Z_b and the $X_b$axis.
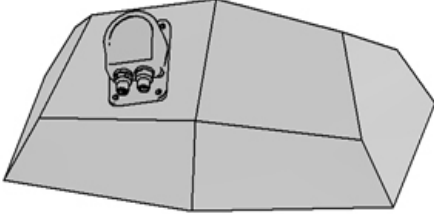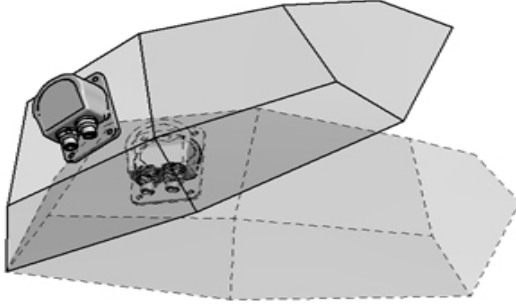
ℹ️ The result of this is that at the teach moment the Xs axis must not be parallel to the direction of gravitation. As long as the value for the SDO index 2042h is 1, all angle indications are converted into the new reference system.

The teach operation can, for example, be as follows:

The measured object with the non-aligned inclination sensor is brought into a known horizontal position. In this position the teach function is carried out, thus defining the new reference system. All provided angle values then refer to this new reference system.

ℹ️ Even with an inclination sensor which is installed at an angle note that the X axis (Xs axis) of the sensor is parallel to the XBZB plane of the requested reference system.

Explanatory example
Inclination sensor installed at an angle in the coordinate system of the workpiece. The coordinate system of the sensor is transferred to the coordinate system of the workpiece by teaching the sensor when the workpiece is horizontally aligned.
The raw data of the sensor is indicated in the coordinate system of the sensor. In teach mode the data is converted into the coordinate system of the workpiece.

The example shows a rotation of 30° about the y axis of the coordinate system of the workpiece.

Perpendicular angle without teach		Teach mode			Perpendicular angle without teach		Teach mode	
Longitudinal angle value	Lateral angle value	Longitudinal angle value	Lateral angle value		Longitudinal angle value	Lateral angle value	Longitudinal angle value	Lateral angle value
-13.2°	-29.3°	0°	0°		-45.5°	-29.5°	-30°	0°

9.6 Quadrant correction (SDO index 2040h)

Quadrant correction means for JN2101 only an extension of the lateral Euler angle to the measuring ranges ± 180° (corresponds to 2040h = 1) or 0...360° (corresponds to 2040h = 2).

9.7 Heating (SDO index 2041h)

To ensure good temperature stability over the whole temperature range, the measuring cell is regulated to a constant temperature using a PID controller. The regulation of the heating is set by the factory and can be deactivated by writing the value 0 to the parameter of the heating (SDO index 2041h).

This has the following effects:

> Reduction of temperature stability

> Current consumption decreases when operating

> Accuracies deviate from the indications in the data sheet

9.8 MEMS self-test (SDO index 4004h)

To check the function of the measurement axes a self-test of the measuring cell can be carried out. The MEMS self-test (SDO index 4004/01h) has to be activated by writing the value 1. The self-test takes about 2 s; when the self-test has ended, the flag (SDO index 4004/01h) is reset to 0.

The test result is coded in a byte and can be read from the self-test register (SDO index 4004/02h).

00000110: The 2 indicated least significant bits code the internal X, Y measurement axes

bit 1 = 0: axis faulty / bit 1: axis functional

9.9 Temperature of the measuring cell (SDO index 4080h)

The temperature of the measuring cell is determined every 200 ms and updated in the object directory. It can be read via SDO access to the object directory (in every device state) and via TPDO. The signed 32-bit value (two's complement) indicates the temperature in °C.

9.10 Inclination values longitudinal and lateral (SDO index 6010h and SDO index 6020h)

The current angle values of the inclination axes can be accessed via SDO access to the object directory (in every device state) and via TPDO. The conversion of the 100-fold, signed 16-bit inclination value (two's complement) is as follows:

Value of the SDO index 6010h = -2370, thus the angle is -2370 / 100 = -23.70°

9.11 Programming key (SDO index 3000h)

The sensor can convert the parameter setting unambiguously into a Base64-coded key. By means of this key sensors with the same parameter setting can be duplicated in an easy way.

The programming key can be read from and written to SDO index 3000h sub-index 0. To ensure that only valid keys are accepted by the firmware a 2-byte checksum (CRC) is calculated and added to the end of the key.

The following parameters are coded by the key

Parameter	SDO index	SDO sub-index
Node ID	0x2000	0x00
Baud rate	0x2001	0x00
Quadrant correction	0x2040	0x00
Heating on	0x2041	0x00
Teach index	0x2042	0x00
FIR filter angle	0x2043	0x00
Angle calculation	0x2044	0x00
CAN 120 Ohm resistor	0x2045	0x00
Set zero point	0x2046	0x00
Resolution	0x6000	0x00

The default setting of the programming key is: D0UfZEgRKHAl5Ag=

10 Parameter (connection set) handling

The CAN identifiers (COB IDs) of the communication objects are determined according to the pre-defined connection set with every reset (communication, application and hardware reset) depending on the set node ID (SDO index 2000h). Always make sure that the current parameters (connection set) always match the current node ID.

The connection set always refers to the current node ID. Therefore set the node ID to the requested value before saving the connection set.

If the node ID is changed after the connection set was saved, the connection set first has to be reset to the factory settings. After saving the connection set again, all COB IDs that are calculated with the node ID are mapped again correctly.

10.1 Save the connection set (OD index 1010h)

Changes of parameters in the object directory are immediately active except for the node ID (SDO index 2000h) and the baud rate (SDO index 2001h). To ensure that the changed parameters of the communication profile (CiA DS-301) are active even after a reset, they must be saved in the internal permanent memory (flash).

By writing the command "save" (65766173h) to save the parameters (OD index 1010h/01h) all current parameters of the object directory referring to the communication are transferred to the flash memory. The saved communication profile is called pre-defined connection set.

10.2 Reset the connection set (OD index 1011h)

The saved communication profile (OD index 1000h - 1FFFh) can be reset to the factory settings via the entry 1011h/01h by writing the command "load" (64616F6Ch) in this entry. After a "reset application" (NMT comand) or a hardware reset the changes will become effective. If only a "reset communication" (NMT command) is transmitted, only the factory settings of the communication parameters become effective.

10.3 Factory reset (SDO index 207Fh)

To reset the manufacturer-specific parameters of the inclination sensor (SDO index 2000h – 5FFFh) to the factory settings the value 1 has to be written to the respective parameter (SDO index 207Fh). If the value 1 is read when this parameter is read, the factory reset was successful. If the value 0 is read, the factory reset failed.

The factory reset also applies to some settings of the communication protocol (CiA DS-301) such as the node ID or the baud rate. If the node ID or the baud rate was changed, the changes will, however, only become effective after a reset of the device. The data of the factory setting (node ID = 10, baud rate = 125 Kbits) are only valid again after this reset.

11 Emergency messages

Every inclination sensor supports EMCY messages which are transmitted in the event of sensor, temperature, hardware or guarding errors.
If one of these errors occurs, the error register (OD index 1001h) and the pre-defined error field (OD index 1003h) are updated.

After rectification of the error the device transmits an EMCY message with the "error reset" code (0h) and the current state of the error and manufacturer status register. The current device state ("pre-operational, operational or stopped") is not influenced by the error states (except for guarding errors).

11.1 Failure monitoring

As in a CANopen network the nodes do not respond regularly in the case of an event-controlled transmission, heartbeat and node guarding/life guarding mechanisms are available for failure monitoring.

Only one of the two monitoring methods can be used.

11.1.1 Node guarding / life guarding

Node guarding is the monitoring of one or several nodes by the NMT master. The NMT master periodically transmits an RTR telegram to the slave to be monitored which responds with its own status and a toggle bit.

If the status or toggle bit do not correspond to the response expected from the guarding master or no response is given, the master assumes a slave error.
With this mechanism the node to be monitored can detect even the failure of the guarding master.
To do so, two parameters are used. The interval time used by the guarding master to check the sensor to be monitored is the "guard time" (100Ch).

The second parameter, the "life time factor (100D h), defines a multiplier.

The product of guard time and life time factor defines the life time of the node (node life time). This life time indicates the time after which the connection is considered as interrupted.

Node life time = guard time × life time factor

If the sensor receives no guarding request from the master within this configured time, it assumes a master failure. It transmits an emergency telegram and returns to the "pre-operational" state. If one of the two parameters is "0" (default setting), the master is not monitored (no lifeguarding).

11.1.2 Heartbeat

Heartbeat is a failure monitoring mechanism which needs no RTR telegrams. The sensor cyclically transmits a heartbeat message which contains the device status and can be monitored by the master. Heartbeat is activated as soon as a value greater than "0" is entered in the register heartbeat interval time (OD index 1017h).

> Heartbeat function has a considerable influence on the bus load of the CANopen network - but generates a bus load which is only half as high as node guarding / life guarding.

11.2 COB IDs

The CAN identifiers of the communication objects are determined according to the pre-defined connection set with every reset (communication, application and hardware reset) depending on the set node ID (SDO index 2000h).

Communication object	Calculation of the COB ID	Default value (node ID = 10)
NMT0 h	0h	
SYNC	80h	80h
EMCY	80h + node ID	8Ah
TPDO0	180h + node ID	18Ah
TPDO1	280h + node ID	28Ah
Standard SDO (client →server)	580h + node ID	58Ah

Communication object	Calculation of the COB ID	Default value (node ID = 10)
Heartbeat	700h + node ID	70Ah

11.3 Status LED

The integrated LEDs indicate the current device status (run LED, green) and CAN communication errors (error LED, red).

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LED colour	Flashing frequency	Description
Green	Permanently off	The device is in the state "reset" or no power supply is available
	Permanently on	The device is in the "pre-operational" state
	Flashes	The device is in the "operational" state
	Brief lighting once	The device is in the "stopped" state
Red	Permanently off	No error
	Permanently on	The device is in the "bus off" state
	Brief lighting once	Error counter: The CAN controller has reached or exceeded its warning limit
	Brief lighting twice	The device has detected the failure of the guarding master (node guard event)

12 Maintenance, repair and disposal

The unit is maintenance-free.

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

13 Approvals/standards

The CE declarations of conformity and approvals can be found at:
www.ifm.com → Data sheet search → JN2101.

14 Factory setting

SDO index	Sub-index	Type	Value	Delivery
0x2000	0x0	u8	Node ID	10
0x2001	0x0	u16	Baud rate	125 Kbits
0x2040	0x0	u8	Flag for quadrant correction	1: corresponds to "± 180°"
0x2041	0x0	u8	Flag for heating	1: corresponds to "heating on"
0x2042	0x0	u8	Index teach value of the X/Y/Z axes	2: corresponds to "absolute measurement"
0x2043	0x0	u8	FIR filter angle	2: corresponds to "FIR lowpass 5Hz"
0x2044	0x0	u8	Angle calculation	0: corresponds to "perpendicular"
0x2045	0x0	u8	CAN 120 Ω terminating resistor 0	1: corresponds to "activated"
0x2046	0x0	u8	Set zero point of the X/Y axes	2: corresponds to "absolute measurement"
0x6000	0x0	u16	Resolution	10d: corresponds to "0.01°"