ifm electronic

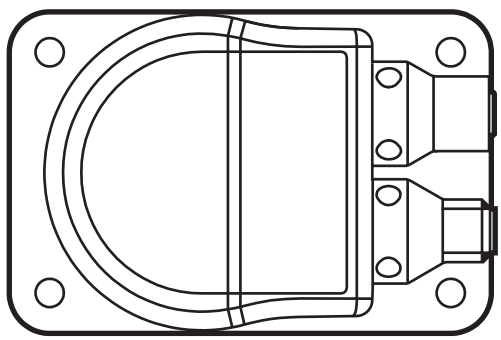
CE

Device manual
Inclination sensor
2 axes

UK

efector410®

JN2100
JN2101



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Contents

This document is the original instructions.

1 Preliminary note

This document applies to devices of the type "inclination sensor" (art. no.: JN210x). 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

► Instruction
> Reaction, result
[…] Designation of pushbuttons, buttons or indications
→ Cross-reference

Important note
Non-compliance can result in malfunction or interference.

Information
Supplementary note

2 Safety instructions

2.1 General

These instructions are part of the device. They contain information and illustrations about 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 of ifm electronic gmbh may be connected.

2.4 Tampering with the device

In case of malfunctions or uncertainties please contact the manufacturer. Any tampering with the device can seriously affect the safety of operators and machinery. This is not permitted and leads to the exclusion of any liability and warranty claims.

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.

- 2-axis inclination sensors with a measuring range of:
  JN2101: ± 45°
  JN2100: ± 360°
- High resolution and precision
- CANopen interface (CiA DS-301, 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 vibration suppression
- Functions
  - A transmit PDO (RTR, cyclical, event-controlled, synchronised)
  - SYNC consumer (synchronised transmission of the transmit PDO 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
  - Freely configurable limit frequency (digital filter)
- Robust metal housing
- Suitable for industrial applications

4 Installation

4.1 Fastening

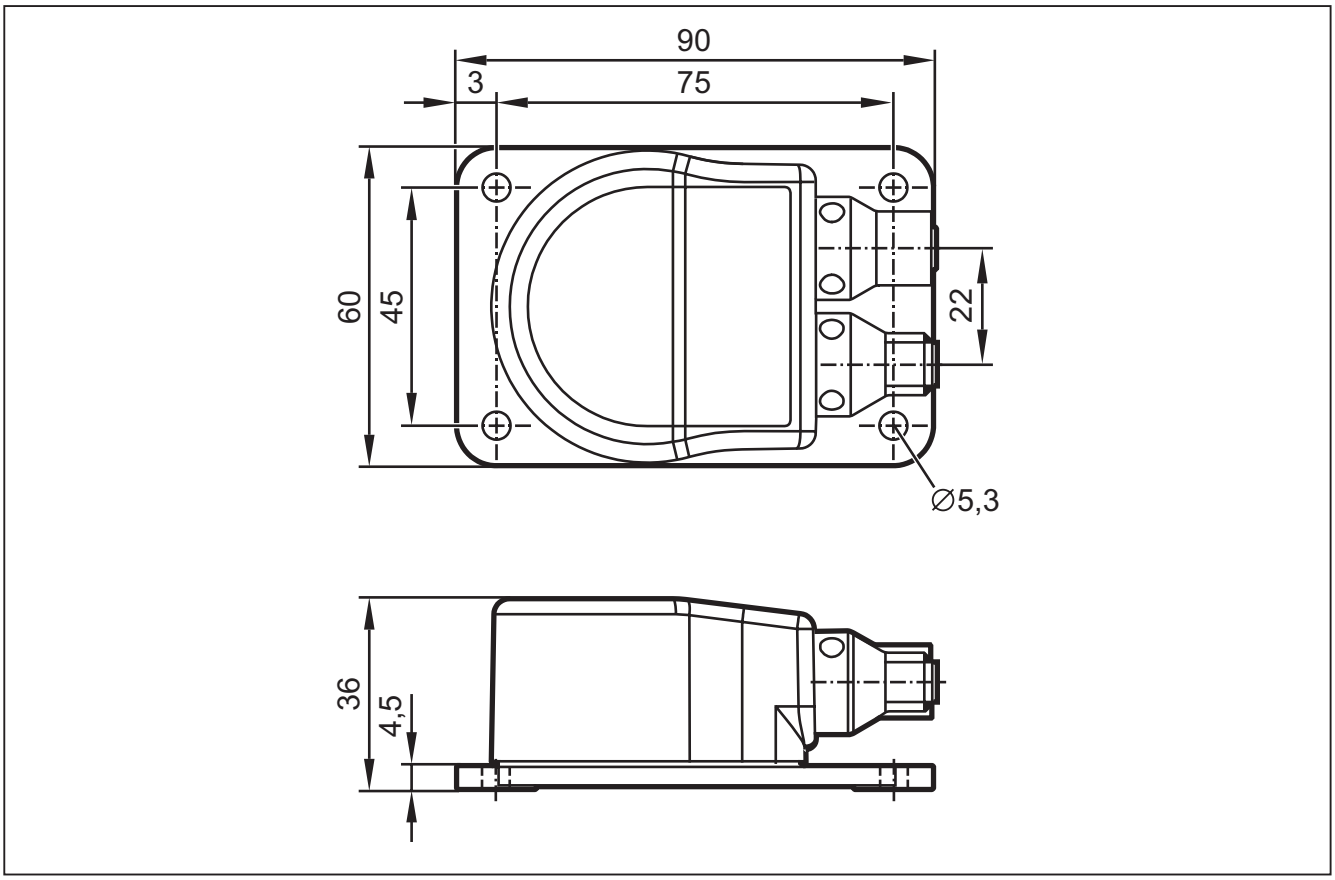
► Fasten the device using 4 M5 screws on a flat surface.
Screw material: steel or stainless steel.

4.2 Mounting surface

The housing must not be exposed to any torsional forces or mechanical stress.

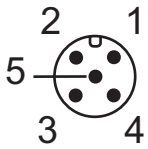
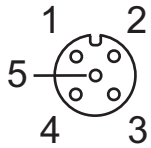
► Use compensating elements if there is no flat mounting surface available.

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 CiA DR-303-1.

	1: CAN_SHLD shield 2: CAN_V+ supply voltage 24 V DC 3: CAN_GND GND 4: CAN_H H bus cable 5: CAN_L L bus cable
M12 connector CAN-In	
	1: CAN_SHLD shield 2: CAN_V+ supply voltage 24 V DC 3: CAN_GND GND 4: CAN_H H bus cable 5: CAN_L L bus cable
M12 socket CAN-Out	

6.1 Bus termination

The inclination sensors have an internal terminating resistor → chapter 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 (EEPROM).

7.1 CANopen functions

The following CANopen functions are available:

- Two transmit data objects (TPDO1, TPDO2) 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 (to CiA DR-303-3)
- In addition to the CiA DS-301 functionality there are more manufacturer and profile-specific characteristics:
  - Setting of the node ID and the baud rate via OD
  - Freely configurable limit frequency (digital filter)

7.2 Set-up

The CANopen standard CiA301 defines three possible states for sensor nodes.

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

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

Stopped
In the stopped state only NMT messages (network management) are possible. This allows almost complete separation of redundant or faulty sensors from the bus.

The master or network manager can request the sensor via NMT messages to change the state accordingly.

Inclination sensors are shipped from ifm electronic with the node ID 10 and a baud rate of 125 Kbits/s.

7.3 Communication types of the process data object (PDO)

Individual check via a remote transmit-request telegram (RTR)

The TPDO can be checked at any time by transmitting a remote transmit-request telegram. This is possible in all operating modes of the inclination sensor.

7.3.1 Cyclical operating mode

The cyclical transmission of the TPDO is activated if the entry 1800h/05h (interval time in milliseconds) contains a value greater than 0. To do so, the entry 1800h/02h (transmission type) must contain the value 254 (asynchronous, manufacturer-specific). In the "operational" state the inclination sensor then cyclically transmits the TPDO1 with the set duration of time.

7.3.2 Synchronised transmission after reception of a SYNC telegram

For the synchronised transmission CANopen provides the SYNC object at which the TPDO1 transmits after every "nth" reception of a SYNC telegram.

Every inclination sensor has two transmit process data objects (TPDO1/2). 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: 6010h		Inclination value lateral (y axis) OD: 6020h	

The second transmit process data object TPDO2 contains the inclination values as 32-bit values.

Byte 0 to	Byte 3	Byte 4 to	Byte 6
Inclination value longitudinal (x axis) OD: 6110h		Inclination value lateral (y axis) OD: 6120h	

The resolution (6000h) of the inclination information can be configured accordingly. For the settings see the device profile for inclination sensors 410 0x6000 – 0x9FFF. See the object directory below.

7.4 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	
100Ah	0	Software version ("xyy")	const	VSTR	Typical	
1008h	0	Product designation	const	VSTR	JN2100	
1009h	0	Hardware version	const	VSTR	1.0	
100Ch	0	Guard time (multiple of 1 ms)	rw	u16	0	Yes
100Dh	0	Life time factor	rw	u8	0	Yes
1010h	Save parameters					
	0	Highest supported sub-index	r0	u32	1	
	1	Save all parameters (command: "save" 65766173h)	rw	u32	0	
1011h	Restore factory parameters			u32		
	0	Highest supported sub-index	r0	u32	1	
	1	Restore all factory parameters (command: "load" 64616F6Ch)	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	159h	
	2	Product code	ro	u32	Typical	
	3	Revision number	ro	u32	Typical	
	4	Serial number	ro	u32	Typical	
1029h	Error behaviour object					
	0	Number of error classes	ro	u8		No
	1	Error behaviour	rw	u8		0x0

Index	Sub-index	Name (parameter)	Type		Default value	Save
1800h	Transmit PDO1 communication parameters					
	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	0	Yes
	3	Disable time between two TPDO messages (multiple of 100 µm)	rw	u16	0	
	4	Compatibility entry	rw	u8	0	Yes
	5	Interval time for cycl. transmission (multiple of 1 ms, 0 deactivated)	rw	u16	0	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, manufacturer-specific)	rw	u8	0	Yes
	3	Disable time between two TPDO messages (multiple of 100 µs)	rw	u16	0	
	4	Compatibility entry	rw	u8	0	Yes
	5	Interval time for cycl. transmission (multiple of 1 ms, 0 deactivated)	rw	u16	0	Yes
1A00h	Transmit PDO1 mapping parameters (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 PDO2 mapping parameters (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	

Values for error behaviour

0 = pre-operational (only if current state is operational)
1 = no change of state
2 = stopped
3 .. 127 = reserved

7.4.1 Communication parameters (to CiA DS-301)

Error register (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 EMCY message.

Error groups

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

Pre-defined error field (1003h)

Every inclination sensor keeps an error list of the last five errors occurred. The entry 1003h/00h contains the number of error entries in the error field.
All other sub-indices contain all error states occurred in chronological order with the error last occurred being always found under sub-index 01h.

The oldest error is in the highest available sub-index (value of 1003h/00h) and is the first to be removed from the list in the case of more than five errors. If an error occurs, a new error entry is added to 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 (hex)	Description
00xx	Error reset or no error
10xx	Generic error
31xx	Mains voltage
32xx	Voltage inside the device
41xx	Ambient temperature
42xx	Device temperature
80xx	Monitoring
81xx	Communication
8110	CAN overrun (objects lost)

8120	CAN in error passive mode
8130	Life guard error or heartbeat error
8140	Recovered from bus off
8150	Transmit COB ID
82xx	Protocol error
8210	PDO not processed due to length error
8220	PDO length exceeded
90xx	External error
F0xx	Additional functions

7.4.2 Save (1010h) and restore (1011h) parameters

Changes of parameters in the object directory are immediately active except for the node ID (2000h) and the baud rate (2001h). To ensure that the changed parameters of the communication profile DS301 are active even after a reset, they must be saved in the internal EEPROM.

By writing the command "save" (65766173h) in the entry 1010h/01h all current parameters of the object directory DS301 are transferred to the permanent memory. The object directory 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 command) or a hardware reset the changes become effective. If only a "reset communication" (NMT command) is transmitted, only the factory settings of the communication parameters become effective.

The manufacturer-specific parameters (see chapter 6.5) are automatically saved when entered provided they differ from the current value.

After the "save" and "load" command no reset is allowed for about 1 s so that the parameters are correctly saved in the EEPROM.
Saving device parameters in the internal EEPROM can take relatively long. For this reason the "save" and "load" commands are immediately replied to but saving is carried out subsequently.

Type of transmission	Description
1...240	Synchronous (cyclical) Only "synchronised transmission" is possible via SYNC
254	Asynchronous, manufacturer-specific "Cyclical operating mode" and/or "transmit if angle is changed" can be activated via a respective configuration

7.5 Service data object (SDO) mapping

7.5.1 System settings 0x2000 - 0x203F

SDO index	Sub-index	Type	Value	Unit	r/w	Reset
0x2000	0x00	u8	Node ID		rw	x
0x2001	0x00	u16	Baud rate	Kbit	rw	x
0x2002	0x00	u8	Flag to reset the sensor Flag = 1 sensor reset	0	rw	

7.5.2 Applicative 0x2040 - 0x207F

SDO index	Sub-index	Type	Value	Unit	r/w	Reset
0x2040	0x00	u8	Flag for quadrant correction 0: off 1: on ± 180° 2: on 0...360°		rw	
0x2041	0x00	u8	Flag for heating Flag = 0: heating off Flag = 1: heating on		rw	
0x2042	0x00	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	0x00	u8	FIR filter step 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: no change 1: set zero (corresponds to the relative measurement) 2. reset set zero (corresponds to the absolute measurement)		rw	

7.5.3 System settings 0x4000 - 0x403F

SDO index	Sub-index	Type	Value	Unit	r/w	Reset
0x4004	0x00	u8	MEMS self-test Number of sub-indices		r	
0x4004	0x01	u8	Flag to activate the self-test Flag = 1 ⟶ start self-test		rw	
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 z axis pass ⟶ bit 0 = 1 z axis fail ⟶ bit 0 = 0		r	
0x2045	0x00	u8	CAN 120 Ω terminating resistor 0: resistor deactivated 1: resistor activated		rw	

7.5.4 Informative 0x4080 - 0x40BF

SDO index	Sub-index	Type	Value	Unit	r/w	Reset
0x4080	0x00	Integer 32	MEMS temperature	1/10 °C	r	
0x4081	0x00	u16	Heating power	mW	r	

7.5.5 Profile-specific part (to CiA DSP-410) 0x6000 – 0x9FFF

SDO index	Sub-index	Type	Value	Unit	r/w	Reset
0x6000	0x00	u16	Resolution 1d = 0.001° 10d = 0.01° 100d = 0.1° 1000d = 1.0°		rw	
0x6010	0x00	Integer 16	Longitudinal x axis	Angle 1/100 °	r	
0x6020	0x00	Integer 16	Lateral y axis	Angle 1/100 °	r	
0x6110	0x00	Integer 32	Longitudinal x axis	Angle 1/100 °	r	
0x6120	0x00	Integer 32	Lateral x axis	Angle 1/100 °	r	

7.6 Angle definition (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
- The x direction 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.

7.6.1 Perpendicular angle (0x2044 = 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 (inclination value longitudinal; OD: 6010h) indicates the angle [°] which the gravitation vector spans with the yz plane. The second provided value (inclination value lateral; OD 6020h) indicates the angle [°] between the gravitation vector and the xz plane.

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.

7.6.2 Euler angle (0x2044 = 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 sensor was first rotated about the sensor's x axis. 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): -90°…+90°
- Inclination value lateral (angle of direction): 0°…360°

Critical point
With a gradient angle of 0° or 180° 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.

7.6.3 Gimbal angle X (0x2044 = 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: -90°…90°
- Inclination value lateral: -180°…180°

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.

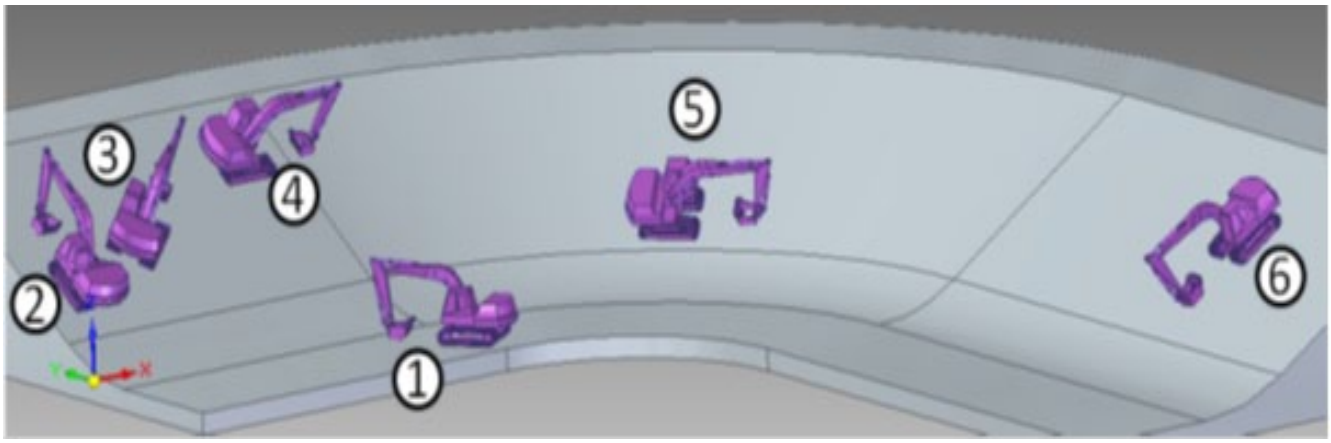
7.6.4 Gimbal angle Y (0x2044 = 3)

This setting corresponds to the setting described in 7.6.3 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.

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 x 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°	undefined	0°	0°	0°	0°	0°
2	-30°	0°	0°	30°	-30°	0°	0°	-30°
3	-20°	20°	45°	30°	-20°	22°	-22°	20°
4	0°	30°	90°	30°	0°	30°	30°	0°
5	0°	30°	90°	30°	0°	30°	0°	30°
6	30°	0°	180°	30°	30°	0°	30°	0°

7.7 Node ID (2000h) and baud rate (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).

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

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

7.8 Limit frequency digital filter (2043h)

With the sensor it is possible to make continuously arising angle values insensitive to external interfering vibrations.
Using a configurable filter interfering vibrations can be suppressed. The limit frequency is individually adjustable between 0.5...25 Hz (25 Hz corresponds to a deactivated FIR filter). The digital filter which is implemented in the sensor is an eighth-order Butterworth low pass filter.

Values of 0 (deactivate filter) up to 4 (0.5 Hz) are allowed.

7.8.1 Set zero point (2046h)

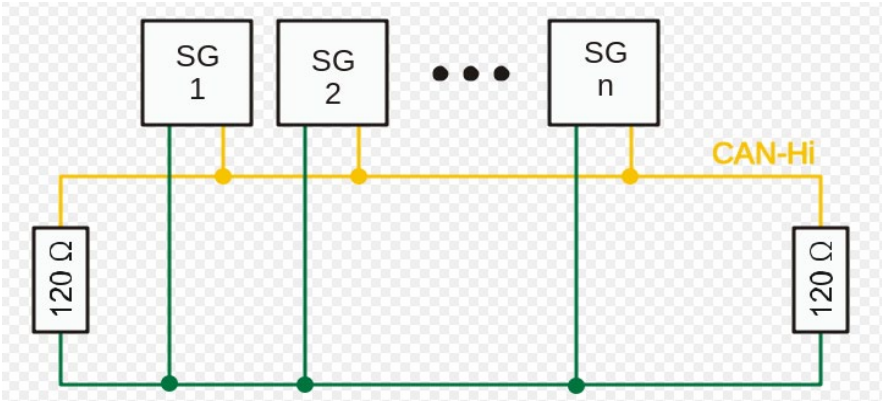
To set the zero point the sensor is rotated in the requested position.

► Write the value 1 (activate set zero point) to the object 2046h (zero point x and y axis).

> The sensor calculates the offset to the zero point shift and saves it in the EEPROM. From now on the offset is added to the angle.

7.8.2 Terminating resistor (2045h)

In bus topology the CANopen system is terminated with terminating resistors (120 Ω) at the beginning and end. The terminating resistor integrated into the sensor can be activated by writing the value 1 to the object 2045h.



7.8.3 Set teach (2042h)

In principle, all provided inclination values refer to the sensor's coordinate system x_s,y_s,z_s which is described in chapter 7.6.

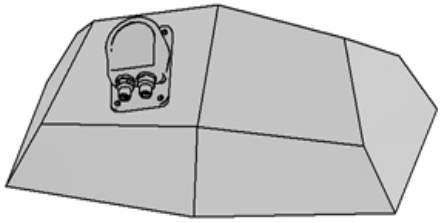
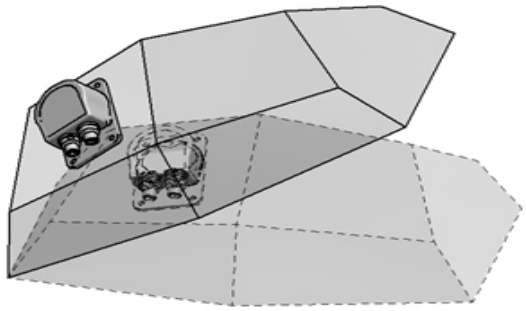
Should it not be possible to integrate the inclination sensor into the measured object so that the coordinate system of the sensor and object match, the teach function enables the creation of a new reference system. The new reference system $x_{b,}y_{b,}z_b$ is defined so that its z_b direction corresponds 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.

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.

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°

7.8.4 Quadrant correction (2040h)

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

The following conditions apply to the different angle calculations:

Perpendicular angle: longitudinal (x) and lateral (y) are corrected

Euler: only lateral (y) is corrected

For the gimbal angle the roll angle is corrected.

Gimbal X: longitudinal x (pitch angle), lateral y (roll angle)

Gimbal Y: longitudinal x (roll angle), lateral y (pitch angle)

7.9 Heating (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 can be deactivated by writing the value 0 to the object 2014h.

> Reduction of temperature stability

> In the operational state the current consumption drops

7.10 MEMS self-test (4004h)

To check the function of the measurement axes a self-test can be carried out. To activate the self-test the value 1 is written to the object 0x4004/01h. The self-test takes about 2 s. After the self-test has been carried out the object 0x4004/01h contains the value 0.

The test result is coded in a byte and can be read from the object 0x4004/02h (self-test register).

JN2100
00000111: The 3 least significant bits code the internal x, y, z measurement axes

JN2101
00000011: The 2 least significant bits code the internal x, y measurement axes

Bit 0: axis faulty
Bit 1: axis functional

7.11 Temperature of the measuring cell (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.

7.12 Inclination values longitudinal and lateral (6010h and 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 6010h = -2370 / 100 = -23.70°

7.13 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 entries in the object directory

- 1001h (error register)
- 1003h (pre-defined error field)

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).

7.14 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.

7.14.1 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 is the life time factor (100Dh). It defines a multiplicator after which the connection is considered as interrupted.
This time is called node life time.

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 state "pre-operational". If one of the two parameters is "0" (default setting), the master is not monitored (no lifeguarding).

7.14.2 Heartbeat

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

Heartbeat 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.

7.15 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 (2000h).

Communication object	Calculation of the COB ID	Default value (node ID = 10)
NMT0 h	0h	
SYNC	80h	80h
EMCY	80h + node ID	8Ah
TPDO1	180h + node ID	18Ah
Default SDO (Client ⟶ server)	580h + node ID	58Ah
Heartbeat	700h + node ID	70Ah

7.16 Status LED (to CiA DR-303-3)

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

LED	Description
Green	
Off	The device is in the state "reset" or no power supply is available
Flashing	The device is in the state "pre-operational"
Brief lighting once	The device is in the state "stopped"
On	The device is in the state "operational"
Red	
Off	No error
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)
On	The device is in the state "bus off"

8 Maintenance, repair and disposal

The unit is maintenance-free.

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

9 Approvals/standards

The EC declaration of conformity and approvals can be found at:
www.ifm.com → Data sheet search → JN210x.