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CAN User Manual Inclination Safety Sensor (Type D)

Original instructions

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1 Introduction

This manual is only valid for CAN Open safety inclination sensor (D-type inclination sensors)

DIS CAN Open safety inclination sensor **(**D-type) family overview:

- Three housing types: 60x50mm plastic or aluminium (QG65), 70x60 stainless steel (QG76)
- Three inclination devices: Inclination 1-axis (vertical plane) 1x ±180°
  Inclination 2 axis (horizontal plane) 2x ±30°
  Inclination 2 axis (horizontal plane) 2x ±90°
- Various CAN settings can be configured according to the CAN Open standard
- Various Sensor-settings can be configured via CAN Open
- CAN Device Profile CIA410 V2.0.0 is supported
- EDS files are available
- CRC calculation tool is available (2 different CRC calculations available, check your firmware version first)

2 Quick Reference Guide

- Hexadecimal figures will have suffix “h” in this manual
- CAN hardware interface: CAN2.0 A and B (complies to ISO11898-1&2)
- CAN communication profile: CAN Open (complies to CiA301 version 4.2.0 & EN50325-4)
- CAN device profile: CiA410 DSP 2.0.0 for inclinometers
- Baud-rate: default 125 kbit/s (can be set to 10, 20, 50, 125, 250, 500, 1000 kbit/s)
- Node-ID: default 01h (possible range 01h – 7Fh, so max. 127 nodes)
- Event time: default 50ms for TPDO1 and TPDO2 (range 10ms – 5000ms)
- TPDO1 output: 180h + node-ID (181h for node-ID 1). Default ‘off’
- TPDO2 output: 280h + node-ID (281h for node-ID 1). Default ‘off’
- SRDO1 normal: 0FFh + 2*node-ID (101h for node-ID 1).
- SRDO1 invers: 100h + 2*node-ID (102h for node-ID 1).
- Byte-sequence on CAN-bus: little-endian (least significant byte first)
- Negative values: two’s complement
- Two modes of operation: Event-mode (periodically autonomous messages) & Sync-mode
- Sync-mode: default disabled for TPDO1 and TPDO2
- Heartbeat: default off, 2000 msec.
- Vendor-ID DIS: 000001BDh (index 1018h sub index 01h)
- Firmware-version available via CAN Object Dictionary (index 1018h sub index 03h)
- Serial number available via CAN Object Dictionary (index 1018h sub index 04h)
- Pre-set/zero adjustment available via CAN Object Dictionary (index 300Fh sub index 01h)
- Sample rate g-sensor-chip: 1600Hz. Averaging during event-time TPDO1
- Input filter: Fixed 32 taps 45dB suppression (low-pass cut off freq. 20Hz).
- Output filter: adjustable high- or low-pass filter 1st order. Controlled by CAN object 300Eh.
- Document data-types definition:
  U8 Unsigned 8-bits number (0 - 255)
  U16 Unsigned 16-bit number (0 - 65535)
  U32 Unsigned 32-bit number (0 - 4294967295)
  S8 Signed 8-bits number (-128 - +127) (also known as ‘Integer 8’)
  S16 Signed 16-bits number (-32768 - +32767) (also known as ‘Integer 16’)
  S32 Signed 32-bits number (-2147483648 - +2147483647) (also known as ‘Integer 32’)

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3 Safety, Installation, use & maintenance

- By ignoring the safety instructions the manufacturer cannot be hold responsible for any damage or hazard.
- If any damage is noticed (M12 connector(s) and/or the enclosure) the device must be replaced by a new one in order to avoid hazard.
- Never move the sensor by pulling the cable.
- The device should only be used in situations covered by the datasheet.
- Only a SELV power supply should be used.
- Only the CANopen Safety interface according to EN50325-5 should be used.
- As this device is accelerometer-based the sensor is inherent sensitive for accelerations/vibrations. Application specific testing must be carried out to check whether this sensor will fulfil customer requirements.
- The family of sensors involved will have a variety of types due to different outputs, measuring ranges, enclosures and connection options. Datasheets are available for each specific type. Customer must select and read the datasheet for the product he is using.
- The Safety Related Fault Response Time (SRFRT) of this device is defined as the maximum time the sensor will report a non-safe situation to the outside world, after detecting an internal safety error. Actual value is specified in the datasheet
- Configuration of the device like changing Node-ID, COB-ID's and centring (sensor-offset) can only be done after a new CRC-code is generated separately and written to the device.
- The sensor should be mounted on a stable flat surface with all screws tightened.
- Use only double twisted double shielded CAN cables.
- The proof test interval for this sensor is 10 year. After this interval the sensor should be replaced or checked by comparing the output to a reference sensor, or checked / recalibrated by the manufacturer. This is to check for any non-detectable faults and/or degradation. This check / recalibration is not included in the price.
- The calculated MTTFd of the sensor is specified in the datasheet.
- This sensor does not require any maintenance between proof-test intervals.

<u>The user of this safety device shall only use this device when:</u>

- he is educated to design in / use functional safety sensors.
- he has taken knowledge of both the datasheet and the user manual.
- the zeroing / centering function is only performed in the right position by an authorized person.
- the redundancy compare parameters (both Redundancy Compare Time and Redundancy Compare Angle) are set by the customer according the application demands. The actual values used by the customer should fit the application involved. Before using this sensor and with the settings chosen the customer should evaluate risks in order to check whether the chosen settings satisfies his safety requirements. Manufacturer is not responsible for any damage caused by these customer-setting, even when the manufacturer defaults are used.
- the bandwidth settings are according to the application demand
- the device is used inside the specified environmental situation

<u>The user of this safety device shall consider its output as 'defective' in the following situations:</u>

- the device is not responding
- the device is not running in operational state
- the device is not running in the desired mode of operation. To be checked at installation/start-up.
- the device is sending an emergency message
- the device switches to NMT stop state
- the safeguard cycle time (SCT) exceeds the limit
- the safety related validation time (SRVT) exceeds the limit
- the angle output is 200°

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4 Certification

EC Type examination by DEKRA EXAM GmbH Reg. no: ZP/C015/16
Certified level: SIL CL2 (claim limit 2 according to IEC 62061) & PLd (according to EN ISO 13849)
Architecture: HFT=0 (according to IEC 62061) & CAT2 (according to EN ISO 13849)

5 Inclination sensor explained

An inclinometer measures the angle(s) of the device with respect to earth gravity, using earth gravity vector as external reference. The inclinometer involved is based on an accelerometer. The acceleration values are used to calculate the angle(s). The device takes both the static component (100%) and the dynamic component (partial, depending on frequency and bandwidth-setting) into account. The device will periodically send a CAN message on the CAN-bus containing the angle(s) in degrees.

6 Safety function

The safety function of the inclinometer sensor is to generate angle information based on acceleration values (caused by gravitation) measured by a MEMS acceleration sensor chip. Based on this angle information the safety controller of the application can switch the machine to safe-mode in order to prevent for a dangerous situation.

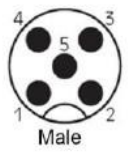
Example: a crane having a maximum tilt angle of the chassis. If the tilt angle of the chassis exceeds a certain critical value, the crane will fall over. To prevent for this an inclinometer can be mounted on the chassis, measuring the X- and Y tilt of the chassis. The safety controller of the application should monitor the X- and Y tilt angles and should switch the crane to safe-mode as soon as a certain tilt angle for X and/or Y exceeds the limits for the application. This will significantly reduce the risk of a dangerous situation to happen.

7 Hardware setup

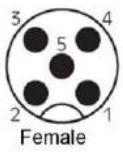
Connection:

Default: 2x 5-pins M12 connector (A-coding), female & male, loop-through.
According to CiA303 V1.8.0

Pin 1:	Shield
Pin 2:	Vcc
Pin 3:	Gnd & CAN_GND
Pin 4:	CAN_H
Pin 5:	CAN_L



Male



Female

Figure 1: Layout CAN bus connector

Optional: 1x 5-pins M12 connector (A-coding) male only
CAN-Cable with 5-pins M12 connector (A-coding) male
CAN-Cable 5-wire

CAN-bus termination 120Ω

Default: no CAN-bus termination inside
Optional: CAN-bus termination inside

Tip: the last CAN-device in the chain should be terminated. For this purpose you can use the M12 male 5-pin termination resistor' (DIS article number 10217) or the M12 female 5-pin termination resistor' (DIS article number 10194).

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8 Signal processing

The Safety sensor transmits SRDO messages. These message must be used to check the data and timing. In this SRDO message the angle information is available in normal and in invers format. Customer should compare these messages in order to check the sensor output is safe. It is also possible to send the data via the TPDO message according to CiA410 but in this case the sensor should be treated as a non-safety sensor. An output filter is available for a stable signal. To compensate for mounting tolerances a pre-set/zero adjustment option is available. When pre-set/zero values are changed a CRC must be calculated off-line (CRC calculate tool available) and written to the sensor. The settings of the SRDO messages are also protected with a CRC code. When these are changed also new CRC code must be determined. When the sensor detects a failure an emergency message is generated and a safe state is activated. In the safe state no communication is possible, only reset restarts the communication.

8.1 Sample rate:

The internal g-sensor chip is sampled every 10ms. Each sample of the element consists of 16 samples for each axis. Resulting in sample rate of 1600 Hz. These samples are input for a 32 tabs FIR input low pass filter. Each 10ms new data is available for the CAN bus.

8.2 Averaging:

The FIR filtered values are averaged during the TPDO1 cycle time set by the customer. A longer TPDO cycle time results is a smaller bandwidth and therefore a more stable output signal (less noise), but also more phase delay.
e.g. if Event time TPDO1 is 10 ms (fastest time) → a filtered value of 16 samples is available.
e.g. if Event time TPDO1 is 100 ms → an average value of 10*16 samples is available.

8.3 Output filter:

The output of the sensor can be extra filtered by a 1st order low-pass filter. Default this output filter is disabled.
Via the CAN object dictionary (index 300Eh) this filter can be controlled, by setting the time-constant in ms, with a maximum of the redundancy compare time (set by index 40006h subindex 02h) .
The time constant is defined as the time in which the output changes to 70% of the step after a step response.
The -3dB frequency can be calculated by the formula f = 1 / (2*pi*time-constant). This -3dB frequency is independent of a change in TPDO1 event time. But when the output filter time-constant is set < TPDO1 event time the output filter is disabled.

8.4 Pre-set/zero adjustment:

To eliminate mechanical offsets a pre-set/ zero value can be added. This can be done with the pre-set/zero adjustment method, so introducing a permanent offset on the output of the sensor (centre point = middle of measuring range). The current position will be regarded as the new pre-set/zero position. This can be done limited to 100.000x. (The value is written in EEPROM. The write actions for EEPROM is limited to 100.000x)
Via CAN object 300Fh (see sensor specific part) the centering/zeroing can be done for each axis separate or for both axis at the same time. Status information of the result is available from the same object 300Fh
Since the offset has direct influence on the output angle, the pre-set/zero value is protected with a CRC code. This CRC code must be set via object 63FFh. When the CRC code is written it must be validated with object 63FE sub id 0 writing data A5h.
The polynomial of the CRC code is:

$$g(x) = x^{16} + x^{12} + x^5 + 1$$

Table 1 Object fields for zero value (pre-set) CRC calculation

Order	Index	Sub index	Value	Size	Data
1	6200h	00h	Highest sub index supported	1 octet	a_7 *to* a_0
2		01h	Sub index number	1 octet	b_7^1 *to* b_0^1
3			Safety slope longitudinal offset (pre-set) value	2 octets	c_{15} *to* c_0
4		02h	Sub index number	1 octet	b_7^2 *to* b_0^2
5			Safety slope lateral offset(pre-set) value	2 octets	d_{15} *to* d_0

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For CRC calculation a PC tool is developed and can be found on the DIS web site www.dis-sensors.com
We have implemented two different CRC-calculations. Please check your firmware version number first, and then select the right Firmware version when using the PC-tool.
A CRC code is also oblige for SRDO1 messages. For detailed information about generating see EN 50325-5. This CRC code can also be calculated with the same PC tool.

8.5 Accelerator element tolerance

The sensor consists of two accelerator elements. The acceleration values of these elements are converted to angles. These angles are compared and a safe state is set when the elements differ too much. To prevent for false alarms, a tolerance can be configured. The tolerance consists of allowing an angle deviation during a certain time.
These values are adjustable via object 4006h sub- index 01h and 02h. The default values are 300d and 200d (3° during 2000 ms). The actual values used by the customer should fit the application involved. Before using this sensor and with the settings chosen the customer should evaluate risks in order to check whether the chosen settings satisfies his safety requirements. Manufacturer is not responsible for any damage caused by these customer-setting, even when the manufacturer defaults are used.
Definitions for the Redundancy error:
'Redundancy Compare time' (user programmable, default 2000ms)
'Redundancy Compare angle' (user programmable, default 3°)

8.6 Output invalid

A vertical device measures the angle relative to the gravity. When a device is tilted towards the horizontal plane for more than 45 degree, the angle can't be accurately measure because the gravitation vectors become shorter. In this case the output is set to 200 degree. This value indicates that the output is invalid.

For horizontal devices the same principle is valid. When the longitudinal axis is greater than 45 degree the output for lateral axis is set to 200 degree. When the lateral axis is greater than 45 degree the longitudinal is set to 200 degree. The output is also invalid when the range limits are reached. Example when angle is 32 degree for a ±30 device the output is limit to ±30 degree. For a ±90 device the angle is limited to ±90 degree.

8.7 Writing objects

When writing an object it can have a major influence on the output. To prevent unauthorized changes most write action can only be executed when the device is in pre-operational state. According to EN 50325-5

8.8 Changing SRDO1 settings

When changing an SRDO1 setting the sensor must be in pre-operating state.
The direction 1301h sub id 01h must be disabled by writing 00h to object 1301h sub id 01h.
When the SRDO setting is changed the CRC code must also be changed and activated. Finally the data must be stored in EEPROM

Example to change safety guard cycle SCT

Load object:	1301h sub id 01h with:	00h	disable SRDO1 communication.
Load object:	1301h sub id 02h with:	0064h	new safety guard cycle time.
Load object:	1301h sub id 01h with:	01h	enable transmit SRDO1 communication.
Load object:	13FFh sub id 01h with:	xxxxh	code from CRC calculation tool.
Load object:	13FEh sub id 00h with:	A5h	validate new CRC.
Load object:	1010h sub id 01h with:	"save" or 65766173h	write new SCT, CRC and validation to EEPROM.

After a power reset and when the device is set to operational, the transmission time is equal to the desired time.

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9 Internal diagnostic tests

To ensure safety the hard- and software of the safety sensor is continue checked. When a failure is detected an emergency message is sent. After sending this message the device is goes to a safe state. No communication is possible in this state To restart the communication is to solve the error and give a power cycle.

The receiving application should detect that no communication is possible and shall set the system to a safe state.

Table 2: Emergency code

CAN Connection Object ID: 080h+NODE_ID (emergency message)		
Byte number	Type	Description
01h and 00h	U16	Error-code: 0000h: no error FF00h: CAN Open device specific error code
02h	U8	Error-register: 00h: no error 01h: error register object 1001h
04h and 03h	U8	Diagnose error CAN stack: 0000h: No error 0001h: Reset state 0002h: Can driver has to be reset 0004h: Safety cycle is ready 0008h: reserved 0010h: Timeout by watchdog diagnose 0020h: Overvoltage 0040h: Unknown interrupt occurs 0080h: CSC stack has entered safety stop 0100h: Initialization error 0200h: Can error 0400h: CAN NMT state error 0800h: Diagnose error 1000h: Safety cycle error 2000h: SRDO error 4001h: RAM error 8000h: Unknown error -multiple errors can be indicated (bitwise OR-ed) simultaneously. -when an overvoltage occur the device stays permanent in safe state
05h		reserved
06h		Diagnose error
	00h	Start CRC calculation ROM
	01h	Check register
	02h	Check stack
	03h	Check addressing part unit 1
	04h	Check addressing part unit 2
	05h	Check conditional jumps
	06h	Check opcode
	07h	Check CRC for SRDO's
	09h	Check time stamp
	0Ah	Wait for end of CRC calculation for CSC main
	0Bh	Start CRC calculation ROM for application
	0Ch	Wait for end of CRC calculation for application
	0Dh	Start CRC calculation ROM for start-up monitor
	0Eh	Wait for end of CRC calculation for start-up monitor
	0Fh	Check RAM with GALPAT algorithm
	10h	Check software interrupt
	11h	Check software interrupt was ok
	12h	Check undefined instruction interrupt

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	19h 7Fh	Check undefined instruction interrupt was ok Idle state
07h	 00h 01h 02h 04h 08h 10h 20h 40h 80h 	Application error No application error Unknown interrupt occurs Safety RAM error SRDO error 3V3 monitor error Sensor element error (Redundancy Error) RAM error EEPROM error Watchdog or 5V under voltage error multiple errors can be indicated (bitwise OR-ed) simultaneously.
Sensor goes to safe state (stop state) when an error is reported. Sensor must be power cycled to restart.		

Example:
Receive COB-id 81h with data 00h FFh 01h 80h 00h 00h 0Eh 08h
81 emergency message of node id 01h

00h FFh-> FF00h	CAN Open device specific error code
01h->	error register object 1001h
80h 00h ->0080h	CSC stack has entered safety stop
00h	reserved
0Eh	Wait for end of CRC calculation for start-up monitor
08h.	3V3 monitor error

10 CAN Predefined Connection Object ID's

Table 3: COB id's

Standard CAN Connection Object ID's (Most used)		
CAN-ID	Data	Description (client = CAN master, server = sensor)
000h		NMT Network Management
080h		Sync command to sensor
080h + node-ID		Emergency message from sensor
0FFh + 2 * node-ID		SRDO1
100h + 2 * node-ID		SRDO1 invers
180h + node-ID		TPDO1 message from sensor
280h + node-ID		TPDO2 message from sensor
580h + node-ID		SDO Download Request: Feedback from sensor (server to client)
600h + node-ID		SDO Upload Request: Write to sensor (client to server)
700h + node-ID	00h 04h 05h 7Fh	heartbeat from sensor, boot-up mode heartbeat from sensor, stopped mode heartbeat from sensor, operational mode heartbeat from sensor, pre-operational mode

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11 CAN Object Dictionary Entries (Communication Profile section)

Table 4: Communication profile section

Object Dictionary Communication Profile (Most used)						
Index	Sub-index	Data	Type	Read/ Write	Description	Pre-operational
1000h	00h	3001019A h 3002019Ah	U32	R	Device Type -Inclination, C1 (360 degree) normal TPDO -Inclination, C2 (±90 or ±30 degree) normal TPDO	No
1001h	00h	e.g. 00h e.g. 81h	U8	R	Error Register - normal operation - device error	No
1003h	00h		U32	R	Predefined error field	No
1005h	00h		U32	R+W	Sync cob-id	No
100Ch	00h		U16	R	Guard time	No
100Dh	00h		U8	R	Life time factor	No
1010h	00h	3	U8	R	Number of entrees	No
	01h	“save” in ASCII Or “65766173h”	U32	R+W	Save all parameters in EEPROM	Yes
	02h	“save” in ASCII Or “65766173h”	U32	R+W	Save communication parameters in EEPROM	Yes
	03h	“save” in ASCII Or “65766173h”	U32	R+W	Save application parameters in EEPROM	Yes
1011h	00h	3	U8	R	Number of entrees	No
	01h	“load” in ASCII Or “64616F6Ch”	U32	R+W	Restore all parameters from EEPROM	Yes
	02h	“load” in ASCII Or “64616F6Ch”	U32	R+W	Restore communication parameters from EEPROM	Yes
	03h	“load” in ASCII Or “64616F6C h”	U32	R+W	Restore application parameters from EEPROM	Yes
1017h	00h	time in ms (hex) e.g. 07D0h e.g. 0000h	U16	R+W	Heartbeat time (ms) -2000ms (default) -0ms (heartbeat switched off)	No
1018h	01h	4	U32	R	Vendor ID (000001BDh)	No
	02h	e.g.04000001h e.g.04000002h e.g.04000003h	U32	R	Product Code Inclination 1-axis (vertical plane): 360° Inclination 2-axis (horizontal plane): 2x ±90° Inclination 2-axis (horizontal plane): 2x ±30°	No
	03h		U32	R	Firmware version sensor (000x000yh) e.g. v2.1 = 00020001h	No
	04h		U32	R	Serial number sensor (32 bit, unique) 00000000h up to FFFFFFFFh	No
1300h	00h	e.g. 00h e.g. 01h	U8	R+W	GFC parameter -invalid -valid	No
1301h	00h	6	U8	R	Number of entrees SRDO1	No
	01h	00h 01h	U8	R+W	SRDO1 direction -Disabled -tx/SRDO producer (default)	Yes
	02h	e.g. 50h	U16	R+W	SRDO1 refresh time - 80 ms default	Yes
	03h	e.g. 14h	U8	R+W	safety-relevant validation time (SRVT) - 20 ms default	Yes
	04h	e.g. 254 (FEh)	U8	R+W	Transmission type asynchronous (default)	Yes
	05h		U32	R+W	COB ID1 0xFFh + Node ID *2 (default)	Yes

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	06h		U32	R+W	COB_ID2 0x100h + Node ID *2 (default)	Yes
13FEh	00h	 e.g. A5h Other value	U8	R+W	SRDO configuration SRDO configuration signature valid SRDO configuration signature not valid	Yes
13FFh	00h	4	U8	R	Number of entrees	No
	01h		U16	R+W	CRC of SRDO1	Yes
1400h	00h	2	U8	R	Number of entrees Receive PDO 1	No
	01h		U32	R+W	COB_ID used by PDO 0xC0000201 (default)	No
	02h		U8	R+W	Transmission type FFh default	No
1401h	00h	2	U8	R	Number of entrees Receive PDO 2	No
	01h		U32	R+W	COB_ID used by PDO 0xC0000201 (default)	No
	02h		U8	R+W	Transmission type FFh default	No
1600h	00h	8	U8	R	Number of entrees Receive PDO mapping	No
	01h-08h		U32	R	Disabled 00000000h	No
1601h	00h	8	U8	R	Number of entrees Receive PDO mapping	No
	01h-08h		U32	R	Disabled 00000000h	No
1800h	00h	5	U8	R	Number of entrees	No
	01h	 e.g. 40000181h e.g. C0000181h	U32	R+W	TPDO1 event-mode -enable -disable (default TPDO1)	No
	02h	 e.g. 01h e.g. FFh	U8	R+W	TPDO1 sync-mode -enable - disable (default)	No
	05h	time in ms (max 5000ms) e.g. 0032h e.g. 0000h	U16	R+W	TPDO1 event-time -50ms (default) -0ms (disable TPDO1)	No
1801h	00h	5		U8	Number of entrees	No
	01h	 e.g. 40000281h e.g. C0000281h	U32	R+W	TPDO2 event-mode -enable -disable (default TPDO2)	No
	02h	 e.g. 01h e.g. FFh	U8	R+W	TPDO2 sync-mode -enable -disable (default)	No
	05h	time in ms (max 5000ms) e.g. 0032h e.g. 0000h	U16	R+W	TPDO2 event-time -50ms (default) -0ms (disable TPDO2)	No

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12 CAN Object Dictionary Entries 360v device(Application Specific Profile section)

Table 5 Application specific profile section for 360 degree device

Application specific parameters						
Index	Sub index	Data	Type	Read/ Write	Description	Pre-operational
1381h	00h	4	U8	R	Number of entrees	No
	01h		U32	R	Mapping object SRDO1 62100108h	No
	02h		U32	R	Mapping object SRDO 1 invers 62110108h	No
	03h		U32	R	Mapping object SRDO 1 62100208h	No
	04h		U32	R	Mapping object SRDO 1 invers 62110208h	No
3000h	00h	1	U8	R	Number of entrees	No
	01h	01h up to 7Fh	U8	R+W	Node-ID 01h (default) up to 7Fh (when Node-ID >3Fh non-standard COB-ID of SRDO1 must be used) *(changes are being affected after a power cycle only)*	Yes
3001h	00h	1	U8	R	Number of entrees	No
	01h	e.g.06 e.g.05 e.g.04 e.g.03 e.g.02 e.g.01 e.g.00	U8	R+W	Baud rate (kbit/s) -50 -100 -125 (default) -250 -500 -800 -1000 *(changes are being affected after a power cycle only)*	Yes
300Eh	00h	1	U8	R	Number of entrees	No
	01h	Time in ms (max = 'redundancy compare time') e.g. 0000h e.g. 0064h	U16	R+W	Output filter (1st order low pass): -disabled (default) -enabled, 100ms (f=1.59Hz)	Yes
300Fh	00h	1	U8	R	Number of entrees	No
	01h	e.g. 01h	S8	R+W	Pre-set adjustment angle. -Write: start zero longitudinal -Read 00h= zero successful, -Read FFh= zero unsuccessful	Yes
4006h	00h	2	U8	R	Number of entrees	No
	01h	e.g. 012Ch/300d e.g. 001Eh/30d	U16	R+W	Redundancy Compare Angle Maximal angle deviation between two elements -3,00 degree -0,3 degree	Yes
	02h	e.g. 0014h/20d e.g. 00C8h/200d	U16	R+W	Redundancy Compare Time Time within maximal deviation is allowed. [*10ms] -200 ms. -2000 ms (default) Max = 10sec (1000d)	Yes
6000h	00h	2	U8	R	Resolution in 0,01 degree	No
6010h	00h		S16	R	Longitudinal slope	No

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6011h	00h	e.g. Bit0 = 0 e.g. Bit0 = 1 e.g. Bit1 = 0 e.g. Bit1 = 1 Other bits	U8	R+W	Operating parameter longitudinal slope -Slope normal -Slope invers -Pre-set enable -Pre-set disable -No function	Yes
6200h	00h	2	U8	R	Number of entrees	No
	01h		S16	R+W	Pre-set value longitudinal	Yes
	02h		S16	R+W	Pre-set value lateral	Yes
6210h	00h	2	U8	R	Number of entrees	No
	01h		U8	R	Bit 0-7 of normal SRDO longitudinal slope	No
	02h		U8	R	Bit 8-15 of normal SRDO longitudinal slope	No
6211h	00h	2	U8	R	Number of entrees	No
	01		U8	R	Bit 0-7 of invers SRDO longitudinal slope	No
	02h		U8	R	Bit 8-15 of invers SRDO longitudinal slope	No
63FEh	00h	e.g. A5h e.g. 00h	U8	R+W	Pre-set configuration field -Signature valid -Signature not valid	Yes
63FFh	00	1	U8	R	Number of entrees	No
	01h		U16	R+W	Pre-set value signature	Yes
To store application specific parameters permanent into the EEPROM of the sensor CAN Object 1010h should be used, otherwise the changes will be lost after a power cycle.						
All not-specified indices and/or sub-indices are reserved for factory use only.						

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13 CAN Object Dictionary Entries ±30h and ±90h devices (Application Specific Profile section)

Table 6: Application specific profile section for ±30h and ±90h devices

Application specific parameters						
Index	Sub index	Data	Type	Read/ Write	Description	Pre-operational
1381h	00h	8	U8	R	Number of entrees	No
	01h		U32	R	Mapping object SRDO1 62100108h	No
	02h		U32	R	Mapping object SRDO 1 invers 62110108h	No
	03h		U32	R	Mapping object SRDO 1 62100208h	No
	04h		U32	R	Mapping object SRDO 1 invers 62110208h	No
	05h		U32	R	Mapping object SRDO 1 62200108h	No
	06h		U32	R	Mapping object SRDO 1 invers 62210108h	No
	07h		U32	R	Mapping object SRDO 1 62200208h	No
	08h		U32	R	Mapping object SRDO 1 invers 62210208h	No
3000h	00h	1	U8	R	Number of entrees	No
	01h	01h up to 7Fh	U8	R+W	Node-ID 01h (default) up to 7Fh (when Node Id >3Fh non-standard COB-ID of SRDO1 must be used) *(changes are being affected after a power cycle only)*	Yes
3001h	00h	1	U8	R	Number of entrees	No
	01h	e.g. 06 e.g. 05 e.g. 04 e.g. 03 e.g. 02 e.g. 01 e.g. 00	U8	R+W	Baud rate (kbit/s) -50 -100 -125 (default) -250 -500 -800 -1000 *(changes are being affected after a power cycle only)*	Yes
300Eh	00h	1	U8	R	Number of entrees	No
	01h	Time in ms (max = 'redundancy compare time')e.g. 0000h e.g. 0064h	U8	R+W	Output filter (1st order low pass): -disabled (default) -enabled, 100ms (f=1.59Hz)	Yes
300Fh	00h	1	U8	R	Number of entrees	No
	01h	e.g. 01h e.g. 02h e.g. 03h	S8	R+W	Pre-set adjustment -Write: start zero longitudinal -Write: start zero lateral -Write start longitudinal and lateral -Read 00h=adjustment successful, -Read FFh=fail longitudinal adjustment -Read FEh=fail lateral adjustment	Yes
4006h	00h	1	U8	R	Number of entrees	No
	01h		U16	R+W	Maximal angle deviation between two elements	Yes
	02h	e.g. 20 e.g. 200	U16	R+W	Time within maximal deviation is allowed [10ms]. -200 ms. -2000 ms (default) Max = 10sec (1000d)	Yes
6000h	00h	2	U8	R	Resolution in 0,01 degree	No
6010h	00h		S16	R	Longitudinal slope	No

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6011h	00h	e.g. Bit0 = 0 e.g. Bit0 = 1 e.g. Bit1 = 0 e.g. Bit1 = 1 e.g. Other bits	U8	R+W	Operating parameter longitudinal slope -Slope normal -Slope invers -Pre-set enable -Pre-set disable -No function	Yes
6020h	00h		S16	R	Lateral slope	No
6021h	00h	e.g. Bit0 = 0 e.g. Bit0 = 1 e.g. Bit1 = 0 e.g. Bit1 = 1 e.g. Other bits	U8	R+W	Operating parameter lateral slope -Slope normal -Slope invers -Pre-set enable -Pre-set disable -No function	Yes
6200h	00h	2	U8	R	Pre-set value	No
	01h		S16	R+W	Pre-set value longitudinal	Yes
	02h		S16	R+W	Pre-set value lateral	Yes
6210h	00h	2	U8	R	Number of entrees	No
	01h		U8	R	Bit 0-7 of normal SRDO longitudinal slope	No
	02h		U8	R	Bit 8-15 of normal SRDO longitudinal slope	No
6211h	00h	2	U8	R	Number of entrees	No
	01		U8	R	Bit 0-7 of invers SRDO longitudinal slope	No
	02h		U8	R	Bit 8-15 of invers SRDO longitudinal slope	No
6220h	00h	2	U8	R	Number of entrees	No
	01h		U8	R	Bit 0-7 of normal SRDO lateral slope	No
	02h		U8	R	Bit 8-15 of normal SRDO lateral slope	No
6221h	00h	2	U8	R	Number of entrees	No
	01		U8	R	Bit 0-7 of invers SRDO lateral slope	No
	02h		U8	R	Bit 8-15 of invers SRDO lateral slope	No
63FEh	00h	A5h 00h	U8	R+W	Pre-set configuration field -Signature valid -Signature not valid	Yes
63FFh	00	1	U8	R	Number of entrees	No
	01h		U16	R+W	Pre-set value signature	Yes
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14 EDS files

The “Electronic Data Sheet” (EDS file) is a file format that describes the communication behavior and the object dictionary entries of a device. In fact it’s a template. This allows tools such as CAN configuration tools to handle the device properly. The file format is described in CiA306 V1.3.0

The EDS-file contains all possible settings and functions for the device by describing the CAN object dictionary for the device to be set by CAN commands.

The EDS-file does not contain a customer specific configuration description (the values of the object dictionary, like i.e. the chosen baud rate, TPDO1 event time, Node ID etc.). For this purpose the customer can generate a so called DCF-file (Device Configuration File) with all customer specific settings out of the EDS-file. The DCF file is in fact the incarnation of the EDS-file.
After loading the DCF-file into the device you have to store the settings into EEPROM by index 1010h sub index 01h to store permanently, see “CAN Object Dictionary Entries”.

The EDS-files available for sensors with embedded firmware version D-type described in this document should have a version D-type also.

The next EDS-files are available at www.dis-sensors.com under ‘downloads’:

- QG_Dtype_1_axis_360v_v*.*
- QG_Dtype_2_axis_30h_v*.*
- QG_Dtype_2_axis_90h_v*.*

15 Document revision control

V1.0 first release
V1.1 Add SRD1 objects programming. Add Writing objects in pre-operating state. Major text additions
V1.2 Add commend after review JK
V1.3 Safety information added (MvA)
V1.4 Layout changed (RMo), safety chapters modified (MvA)
V1.5 Change mapping object 1381h for 1 axis and 2 axis according to profile (RMo)
V1.6 20190725 Various more accurate descriptions, some parameters maximized, see release notes firmware v2.9 & v2.5.3

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A. Appendixes1 Schematic overview inclination measurement

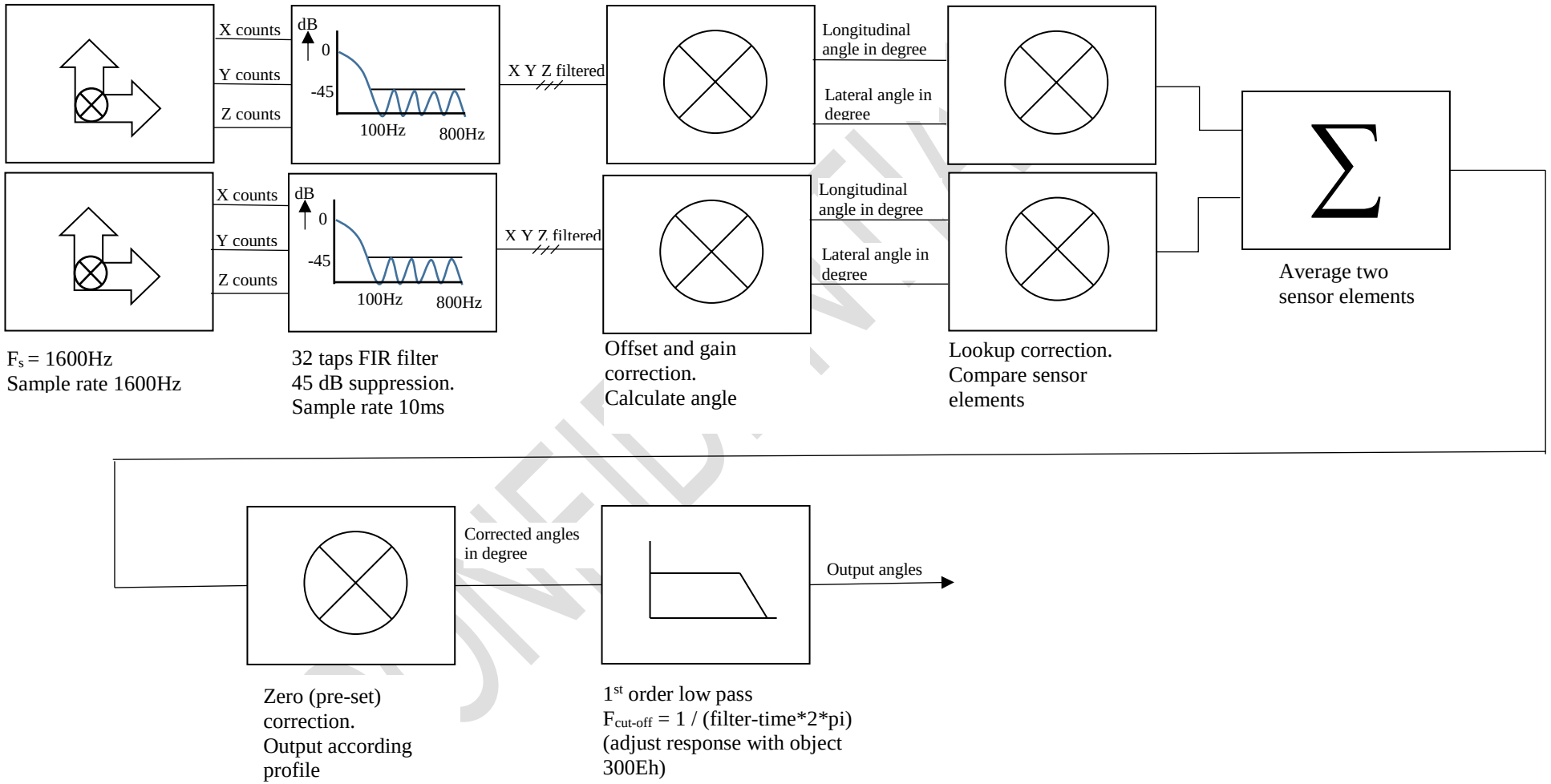

Figure 2: Schematic overview inclination measurement.