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Document structure:

CANopen®

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  - TPDO1 and TPDO2-mapping
  - CAN Object Dictionary Entries (Manufacturer Specific Profile section)

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- Appendix 1: Inclination measurement block diagram

Introduction

This manual is only valid for sensor embedded firmware v4B.x types

DIS inclination/acceleration sensor family overview:

- Three housing types: 60x50mm plastic or aluminium (QG65), 70x60 stainless steel (QG76)
- Three inclination types: Inclination 1-axis (vertical plane): 360° (or ±180°)
  Inclination 2-axis (horizontal plane): 2x ±30°
  Inclination 2-axis (horizontal plane): 2x ±90°
- Various acceleration types: Acceleration 2-axis (horizontal plane): up to 2x ±12G
- Various CAN settings can be configured conform CANopen standard
- Various Sensor-settings can be configured via CANopen
- EDS files available

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Quick Reference Guide:

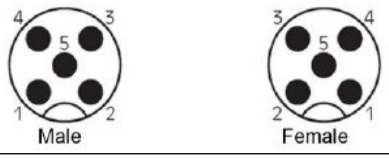
- Hexadecimal figures will have suffix "h" in this manual
- CAN hardware interface: CAN2.0 A and B (complies to ISO11898-1&2)
- CAN communication profile: CANopen (complies to CiA301 version 4.2.0 & EN50325-4)
- Baudrate: default 125 kBit/s (can be set to 125 kBit/s up to 1 MBit/s)
- Node-ID: default 01h (possible range 01h – 7Fh, so max. 127 nodes)
- Event time: default 100ms for TPDO1 and TPDO2 (range 5ms – 32767ms)
- TPDO1 output: 180h + node-ID (181h for node-ID 1)
- TPDO2 output: 280h + node-ID (281h for node-ID 1)
- TPDO-mapping available to select sensor-output values
- 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 on, 2000 msec.
- Vendor-ID DIS: 000001BDh (index 1018h subindex 01h)
- Firmware-version available via CAN Object Dictionary (index 1018h subindex 03h)
- Serial number available via CAN Object Dictionary (index 1018h subindex 04h)
- Center/zero adjustment available via CAN Object Dictionary (index 300Fh subindex 00h)
- Center/zero range limit adj. available via CAN Object Dictionary (index 3012h + 3013h subindex 00h)
- Sample rate g-sensor-chip inclination: 1.25ms. Averaging during event-time TPDO1
- Sample rate g-sensor-chip acceleration: 1.00ms. Peak-detection or averaging during event-time TPDO1
- Input filter: Fixed 2nd order Bessel (low-pass cut off freq. 10Hz). Controlled by CAN object 3014h.
- Output filter: adjustable high- or lowpass 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')

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



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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Signal processing: see Appendices 1 and 2 for schematic overview

Sample rate:
Each axis of the internal G-sensor chip is sampled periodically. The sample rate is fixed.

- inclination: every 1,25ms (800Hz)
- acceleration: every 1.00ms (1000Hz)

Inclination: The averaging period is set to the event time of TPDO1. e.g. if Event time TPDO1 is 10 ms → an average value of 8 samples is calculated.

Acceleration: Sensor outputs are available with averaging, RMS, peak-to-peak, lowest value and highest value within TPDO1 event time. By TPDO-mapping this can be selected, see sensor-specific part.

Input filter:
For inclination the raw values of the g-sensor-chip can be filtered by a 2nd order Bessel digital low-pass filter with a cut-off frequency of 10Hz. This will give a more stable and accurate output value.

There is a drawback when using this filter, it adds an extra phase delay, so the response is slower. When the CAN application will do it's own filtering or when the fastest output response is needed, the internal filter of the sensor can be disabled. This filter can be controlled by CAN object 3014h. See specific part.
Disabling this filter will lead to significant more noise on the sensor output and an increased sensitivity for mechanical vibrations.
For inclination: default enabled
For acceleration: not available

Averaging (inclination only):
The filtered values are averaged during the TPDO1 cycle time. A longer TPDO cycle time results is a smaller bandwidth and therefore a more stable output signal (less noise), but also more phase delay.

Calculation:
Every TPDO1 cycle time a new output value is calculated according to a smart algorithm including calibration settings.

Output filter:
The output of the sensor can be filtered. Default this output filter is disabled.

- inclination: 1st order low-pass filter
- acceleration: 1st order high pass filter

Via the CAN object dictionary (index 300Eh) this filter can be controlled, by setting the time-constant in ms, with a maximum of FFFFh = 65536ms.
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.

Center/zero adjustment:
To eliminate mechanical offsets the sensor can be centered/zero-ed by the center/zero adjustment method, so introducing a permanent offset on the output of the sensor.The current position will be regarded as the new center/zero position. This can be done repeatedly.

- Inclination sensor can be centered (center point = middle of measuring range).
- Acceleration sensors can be zero-ed (0G point).

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. This action will update objects 3010h and 3011h. Status information of the result is available from object 300Fh

Also an offset value can be written or read by object 3010h and 3011h.

A center adjustment range limit can be set by object 3012h and 3013h. The value in 3012h and/or 3013h is always positive, but the limited range is always symmetrical around 0.

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Self-test

During sensor start-up the two-axis g-element-chips and the EEPROM in the sensor are submitted to a self-test. The self-test will verify if both axis of the g-element-chip are functional and the main functions are working properly. Additionally the EEPROM for data storage is checked. When an error is detected during the self-test, this is reported on the CAN bus by an emergency message.

When the self-test is passed, an emergency message is sent with all zeroes.
When the self-test fails, an emergency message is sent according to the table below.

The receiving application should ignore the sensor-output when an error is reported.

CAN Connection Object ID: 080h+NODE_ID (emergency message)		
Data-index	Type	Description
00h to 01h	U16	Error-code: 0000h: No error (selftest OK) 5000h: Device hardware error (selftest FAIL) Error simulation (when switched ON via CAN object 3007h): 6200h: Device software error - user
02h	U8	Error-register: 00h: No error (selftest OK) 81h: Manufacturer specific error (selftest FAIL)
03h to 07h	5*U8	Manufacturer specific data: 00h, 00h, 00h, 00h, 00h: No error 00h, 00h, 00h, 00h, 01h: selftest initialization error 00h, 00h, 00h, 00h, 02h: selftest error X-axis 00h, 00h, 00h, 00h, 04h: selftest error Y-axis 00h, 00h, 00h, 00h, 08h: EEPROM error Multiple errors can be indicated (bitwise ORed) simultaneously.
The receiving application should ignore sensor-output when an error is reported		

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CAN Predefined Connection Object ID's

Standard CAN Connection Object ID's (Most used)		
CAN-ID	Data	Description (client = CANmaster, server = sensor)
000h		NMT Network Management
080h		Sync command to sensor
080h + node-ID		Emergency message from sensor
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, bootup-mode Heartbeat from sensor, stopped mode Heartbeat from sensor, operational mode Heartbeat from sensor, pre-operational mode

CAN Object Dictionary Entries (Communication Profile section)

Object Dictionary Communication Profile (Most used)					
Index	Subindex	Data	Type	Read/Write	Description
1000h	00h		U32	R	Device Type
1001h	00h		U8	R	Error Register
1010h	01h	"save" in ASCII 65766173h	U32	W	Save All parameters in EEPROM
	02h				Save Communication parameters in EEPROM
	03h				Save Application Parameters in EEPROM
1017h	00h	Time in ms (hex) e.g. 07D0h e.g. 0000h	U16	R+W	Set event time for heartbeat e.g. 2000ms (default) e.g. 0ms (heartbeat switched off)
1018h	01h		U32	R	Vendor ID (000001BDh)
	02h		U32	R	Product Code 00000001h = Inclination 1-axis (vertical plane): 360° 00000002h = Inclination 2-axis (horizontal plane): 2x ±90° 00000003h = Inclination 2-axis (horizontal plane): 2x ±30° 00000402h = Acceleration 2-axis (horizontal plane): 2x ±0.5g 00000403h = Acceleration 2-axis (horizontal plane): 2x ±1g 00000405h = Acceleration 2-axis (horizontal plane): 2x ±1,7g 00000408h = Acceleration 2-axis (horizontal plane): 2x ±4g 0000040Ch = Acceleration 2-axis (horizontal plane): 2x ±12g
	03h		U32	R	Firmware Version from sensor (000x000yh) e.g. v4B.1 = 004B0001h
	04h		U32	R	Serial Number of the sensor in 32 bit, unique. (between 00000000h and FFFFFFFFh)
1800h	01h	C0000281h 40000281h	U32	R+W	Disable event-mode TPDO1 Enable event-mode TPDO1 (default)
	02h	01h FFh	U8	R+W	Enable sync-mode for TPDO1 Disable sync-mode for TPDO1 (default)
	05h	Time in ms (hex) e.g. 0064h	U16	R+W	Set event time for TPDO1 e.g. 100ms (default)
1801h	01h	C0000281h 40000281h	U32	R+W	Disable event-mode TPDO2 (default) Enable event-mode TPDO2
	02h	01h FFh	U8	R+W	Enable sync-mode for TPDO2 Disable sync-mode for TPDO2 (default)
	05h	Time in ms (hex) e.g. 0064h	U16	R+W	Set event time for TPDO2 e.g. 100ms (default))
1F80h	00h	00000000h 00000004h	U32	R+W	NMT startup: Boot-up in Operational state (default) (= self-starting device) Boot-up in Pre-operational state, waiting . . . .

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CAN Object Dictionary Entries (Manufacturer Specific Profile section)

Manufacturer specific parameters					
Index	Subindex	Data	Type	Read/Write	Description
3000h	00h	01h up to 7Fh	U8	R+W	set node-ID 01h (default) up to set node-ID 7Fh *(changes are being affected after a power cycle only)*
3001h	00h	04 03 02 00	U8	R+W	set Baudrate 125 kBit/s (default) set Baudrate 250 kBit/s set Baudrate 500 kBit/s set Baudrate 1 MBit/s *(changes are being affected after a power cycle only)*
3007h	00h	00h FFh	U8	R+W	Simulate Error: 00h: No error (or error reset) FFh: Simulate a device error (error-code = 6200h: device software error - user)
300Eh	00h	Time in ms (hex) e.g. 0000h e.g. 0064h e.g. 03E8h	U16	R+W	Output Filter: disabled (default) time constant 100ms time constant 1000ms

To store manufacturer 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 subindices are reserved for factory use only.

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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 baudrate, 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 index2300h subindex 00h to store permanently, see "CAN Object Dictionary Entries".

The EDS-files available for sensors with embedded firmware version v4B.x described in this document should have a version number v4B.x also.

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

- QG_Btype_1_axis_360v_v4B.x
- QG_Btype_2_axis_90_v4B.x
- QG_Btype_2_axis_30_v4B.x
- QG_Btype_2_axis_2g_v4B.x

Document revision control

v4B.01: New document based on Rev. v4.09
Firmware updated to be compliant to CANopen standard CiA301 v4.2.0
Backwards compatible to standard CiA DS301 v4.02 (firmware v4.x) except for baudrate settings
LSS (layer Setting Services) implemented to modify Node ID & baudrate
Error Simulation implemented (index 3007h)
NMT Network management startup implemented (index 1F80h)
v4B.02: Event time down to 5ms, TPDO2 time disable, mechanical vibrations vs filtering
v4B.03: Centering Result Read command needs to be > 1 second after centering write command,
Restore Command 1011h removed, Store with Index 2300h removed
V4B.4 Change EDS file name to standard DIS name

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Sensor-Specific: Inclination 1-axis (vertical plane): 360° (or ±180°)

Sensor output data available for TPDO-mapping:

Index 6401h		**Sensor output data Inclination 1-axis (vertical plane) 360° (or ±180°)**
Subindex	Type	Description
00h	U8	Number of parameters in this object (9)
01h	U16	Angle normal (0 to +35999)
02h	U16	Angle reversed (+35999 to 0)
03h	S16	Angle normal (-17999 to +18000)
04h	S16	Angle reversed (+17999 to -18000)
05h	U16	Raw counts X-sensor (0 to 2047) (*)
06h	U16	Raw counts Y-sensor (0 to 2047) (*)
07h	S16	Sensor chip temperature (°C)
08h	S16	Environment Temperature indication (°C) = Sensor temperature - 8 (°C) Sensor stabilized at operating temperature, normal environmental conditions
09h	U16	Cross Z-axis displacement, indication (0 to 9000) e.g. 0 = 0° (sensor mounting surface parallel to gravity) e.g. 9000 = 90° (sensor mounting surface horizontal) Note: should be <10° for max. accuracy

TPDO1-mapping:

Index 1A00h		**Default TPDO1-mapping**
Subindex	Type	Description
00h	U8	Number of parameters in this object (2)
01h	U32	64010110h (Index: 6401h, Subindex: 01h, length in bits:10h) e.g. default = Angle normal (0 to 35999)
02h	U32	64010710h (Index: 6401h, Subindex: 07h, length in bits:10h) e.g. default = Sensor chip temperature (°C)

TPDO2-mapping:

Index 1A01h		**Default TPDO2-mapping**
Subindex	Type	Description
00h	U8	Number of parameters in this object (2)
01h	U32	64010510h (Index: 6401h, Subindex: 05h, length in bits:10h) e.g. default = Raw counts X-sensor (0 to 2047)
02h	U32	64010610h (Index: 6401h, Subindex: 06h, length in bits:10h) e.g. default = Raw counts Y-sensor (0 to 2047)

To store TPDO-mapping permanent into the EEPROM of the sensor CAN-object 1010h should be used.
Otherwise the changes will be lost after a power cycle.

(*) Raw counts are uncalibrated sensor-chip values direct proportional to the g-force (no offset/gain compensation, no temperature compensation and no non-linearity calibration).
Ideal 0g offset = 1024. Ideal sensitivity = 819 counts/g

CAN Object Dictionary Entries (Manufacturer Specific Profile section):

Manufacturer specific parameters Inclination 1-axis (vertical plane) 360° (or ±180°)					
Index	Subindex	Data	Type	Read/Write	Description
300Fh	00h	01h 00h FFh	U8	W R R	Start center adjustment, allow 1 second before read Center adjustment successful. Center adjustment failed
3010h	00h	 e.g. 0063h	U16	 R+W	Offset after center adjustment (1LSB=0.01°) e.g. offset = 0.99°
3014h	00h	00h 01h	U8	R+W	Input filter disabled Input filter enabled (default)

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Sensor-Specific: Inclination 2-axis (horizontal plane): 2x ±30°

Sensor output data available for TPDO-mapping:

Index 6401h		**Sensor output data Inclination 2-axis (horizontal plane) ±30°**
Subindex	Type	Description
00h	U8	Number of parameters in this object (8)
01h	S16	X-angle normal (-3000 to +3000)
02h	S16	Y-angle normal (-3000 to +3000)
03h	S16	X-angle reversed (+3000 to -3000)
04h	S16	Y-angle reversed (+3000 to -3000)
05h	U16	Raw counts X-sensor (0 to 2047) (*)
06h	U16	Raw counts Y-sensor (0 to 2047) (*)
07h	S16	Sensor chip temperature (°C)
08h	S16	Environment Temperature indication (°C) = Sensor temperature - 8 (°C) Sensor stabilized at operating temperature, normal environmental conditions

TPDO1-mapping:

Index 1A00h		**Default TPDO1-mapping**
Subindex	Type	Description
00h	U8	Number of parameters in this object (2)
01h	U32	64010110h (Index: 6401h, Subindex: 01h, length in bits:10h) e.g. default = X-angle normal (-3000 to +3000)
02h	U32	64010210h (Index: 6401h, Subindex: 02h, length in bits:10h) e.g. default = Y-angle normal (-3000 to +3000)

TPDO2-mapping:

Index 1A01h		**Default TPDO2-mapping**
Subindex	Type	Description
00h	U8	Number of parameters in this object (2)
01h	U32	64010510h (Index: 6401h, Subindex: 05h, length in bits:10h) e.g. default = Raw counts X-sensor (0 to 2047)
02h	U32	64010610h (Index: 6401h, Subindex: 06h, length in bits:10h) e.g. default = Raw counts Y-sensor (0 to 2047)

To store TPDO-mapping permanent into the EEPROM of the sensor CAN-object 1010h should be used.
Otherwise the changes will be lost after a power cycle.

(*) Raw counts are uncalibrated sensor-chip values direct proportional to the g-force (no offset/gain compensation, no temperature compensation and no non-linearity calibration).
Ideal 0g offset = 1024. Ideal sensitivity = 1638 counts/g

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CAN Object Dictionary Entries (Manufacturer Specific Profile section):

Manufacturer specific parameters Inclination 2-axis (horizontal plane) ±30°					
Index	Subindex	Data	Type	Read/Write	Description
300Fh	00h	01h 02h 03h 00h FFh FEh FDh	S8	W W W R R R R	Start center adjustment X-axis Start center adjustment Y-axis Start center adjustment X- AND Y-axis → allow 1 second before read Center adjustment successful. Center adjustment X-axis failed Center adjustment Y-axis failed Center adjustment X- AND Y-axis failed
3010h	00h	e.g. 0063h	S16	R+W	Offset X-axis after center adjustment (1LSB=0.01°) e.g. offset = 0.99°
3011h	00h	e.g. FF9Dh	S16	R+W	Offset Y-axis after center adjustment (1LSB=0.01°) e.g. offset = -0.99°
3012h	00h	e.g. 01F4h	U16	R+W	Center adjustment range limit X-axis e.g. limit = 5° (valid centering range -5° to +5°) (default)
3013h	00h	e.g. 01F4h	U16	R+W	Center adjustment range limit Y-axis e.g. limit = 5° (valid centering range -5° to +5°) (default)
3014h	00h	00h 01h	U8	R+W	Input filter disabled Input filter enabled (default)

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Sensor-Specific: Inclination 2-axis (horizontal plane): 2x ±90°

Sensor output data available for TPDO-mapping:

Index 6401h		**Sensor output data Inclination 2-axis (horizontal plane) ±90°**
Subindex	Type	Description
00h	U8	Number of parameters in this object (8)
01h	S16	X-angle normal (-9000 to +9000)
02h	S16	Y-angle normal (-9000 to +9000)
03h	S16	X-angle reversed (+9000 to -9000)
04h	S16	Y-angle reversed (+9000 to -9000)
05h	U16	Raw counts X-sensor (0 to 2047) (*)
06h	U16	Raw counts Y-sensor (0 to 2047) (*)
07h	S16	Sensor chip temperature (°C)
08h	S16	Environment Temperature indication (°C) = Sensor temperature - 8 (°C) Sensor stabilized at operating temperature, normal environmental conditions

TPDO1-mapping:

Index 1A00h		**Default TPDO1-mapping**
Subindex	Type	Description
00h	U8	Number of parameters in this object (2)
01h	U32	64010110h (Index: 6401h, Subindex: 01h, length in bits:10h) e.g. default = X-angle normal (-9000 to +9000)
02h	U32	64010210h (Index: 6401h, Subindex: 02h, length in bits:10h) e.g. default = Y-angle normal (-9000 to +9000)

TPDO2-mapping:

Index 1A01h		**Default TPDO2-mapping**
Subindex	Type	Description
00h	U8	Number of parameters in this object (2)
01h	U32	64010510h (Index: 6401h, Subindex: 05h, length in bits:10h) e.g. default = Raw counts X-sensor (0 to 2047)
02h	U32	64010610h (Index: 6401h, Subindex: 06h, length in bits:10h) e.g. default = Raw counts Y-sensor (0 to 2047)

To store TPDO-mapping permanent into the EEPROM of the sensor CAN-object 1010h should be used.
Otherwise the changes will be lost after a power cycle.

(*) Raw counts are uncalibrated sensor-chip values direct proportional to the g-force (no offset/gain compensation, no temperature compensation and no non-linearity calibration).
Ideal 0g offset = 1024. Ideal sensitivity = 819 counts/g

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CAN Object Dictionary Entries (Manufacturer Specific Profile section):

Manufacturer specific parameters Inclination 2-axis (horizontal plane) ±90°					
Index	Subindex	Data	Type	Read/Write	Description
300Fh	00h	01h 02h 03h 00h FFh FEh FDh	S8	W W W R R R R	Start center adjustment X-axis Start center adjustment Y-axis Start center adjustment X- AND Y-axis → allow 1 second before read Center adjustment successful. Center adjustment X-axis failed Center adjustment Y-axis failed Center adjustment X- AND Y-axis failed
3010h	00h	e.g. 0063h	S16	R+W	Offset X-axis after center adjustment (1LSB=0.01°) e.g. offset = 0.99°
3011h	00h	e.g. FF9Dh	S16	R+W	Offset Y-axis after center adjustment (1LSB=0.01°) e.g. offset = -0.99°
3012h	00h	e.g. 01F4h	U16	R+W	Center adjustment range limit X-axis e.g. limit = 5° (valid centering range -5° to +5°) (default)
3013h	00h	e.g. 01F4h	U16	R+W	Center adjustment range limit Y-axis e.g. limit = 5° (valid centering range -5° to +5°) (default)
3014h	00h	00h 01h	U8	R+W	Input filter disabled Input filter enabled (default)

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Sensor-Specific: Acceleration 2-axis (horizontal plane): up to 2x ±12G

Acceleration sensors can have various ranges. The example below is for ±12G range

for ±0.5G range: replace '12000' by '500', '-12000' by '-500', '24000' to '1000'

for ±1G range: replace '12000' by '1000', '-12000' by '-1000', '24000' to '2000'

for ±1.7G range: replace '12000' by '1700', '-12000' by '-1700', '24000' to '3400'

for ±4G range: replace '12000' by '4000', '-12000' by '-4000', '24000' to '8000'

Sensor output data available for TPDO-mapping:

Index 6401h		**Sensor output data Acceleration 2-axis (horizontal plane) ± 12 G**
Subindex	Type	Description
00h	U8	Number of parameters in this object (0Bh)
01h	S16	X-acceleration average within interval* (-12000 to +12000)
02h	S16	Y-acceleration average within interval* (-12000 to +12000)
03h	U16	X-acceleration RMS** value within interval* (to +12000)
04h	U16	Y-acceleration RMS** value within interval* (to +12000)
05h	U16	X-acceleration peak-to-peak within interval* (0 to +24000)
06h	U16	Y-acceleration peak-to-peak within interval* (0 to +24000)
07h	S16	X-acceleration lowest value within interval* (-12000 to +12000)
08h	S16	Y-acceleration lowest value within interval* (-12000 to +12000)
09h	S16	X-acceleration highest value within interval* (-12000 to +12000)
0Ah	S16	Y-acceleration highest value within interval* (-12000 to +12000)
0Bh	S16	Sensor chip temperature (°C)

* note: interval is TPDO1 event-time

** note: RMS means Root Mean Square, also known as the quadratic mean.

TPDO1-mapping:

Index 1A00h		**Default TPDO1-mapping**
Subindex	Type	Description
00h	U8	Number of parameters in this object (2)
01h	U32	64010110h (Index: 6401h, Subindex: 01h, length in bits:10h) e.g. default = X-acceleration average within interval (-12000 to +12000)
02h	U32	64010210h (Index: 6401h, Subindex: 02h, length in bits:10h) e.g. default = Y-acceleration average within interval (-12000 to +12000)

TPDO2-mapping:

Index 1A01h		**Default TPDO2-mapping**
Subindex	Type	Description
00h	U8	Number of parameters in this object (2)
01h	U32	64010510h (Index: 6401h, Subindex: 05h, length in bits:10h) e.g. default = X-acceleration peak-to-peak within interval (0 to +24000)
02h	U32	64010610h (Index: 6401h, Subindex: 06h, length in bits:10h) e.g. default = Y-acceleration peak-to-peak within interval (0 to +24000)

To store TPDO-mapping permanent into the EEPROM of the sensor CAN-object 1010h should be used. Otherwise the changes will be lost after a power cycle.

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CAN Object Dictionary Entries (Manufacturer Specific Profile section):

Manufacturer specific parameters Acceleration 2-axis (horizontal plane) ± 12 G					
Index	Subindex	Data	Type	Read/Write	Description
300Fh	00h	01h 02h 03h 00h FFh FEh FDh	S8	W W W R R R R	Start zero adjustment X-axis Start zero adjustment Y-axis Start zero adjustment X- AND Y-axis → allow 1 second before read Zero adjustment successful. Zero adjustment X-axis failed Zero adjustment Y-axis failed Zero adjustment X- AND Y-axis failed
3010h	00h	e.g. 0063h	S16	R+W	Offset X-axis after zero adjustment (1LSB=1 mg) e.g. offset = 99 mg
3011h	00h	e.g. FF9Dh	S16	R+W	Offset Y-axis after zero adjustment (1LSB=1 mg) e.g. offset = -99 mg
3012h	00h	e.g. 01F4h	U16	R+W	Zero adjustment range limit X-axis e.g. limit = 500 mg (valid zeroing range -500 to +500 mg (default)
3013h	00h	e.g. 01F4h	U16	R+W	Zero adjustment range limit Y-axis e.g. limit = 500 mg (valid zeroing range -500 to +500 mg) (default)

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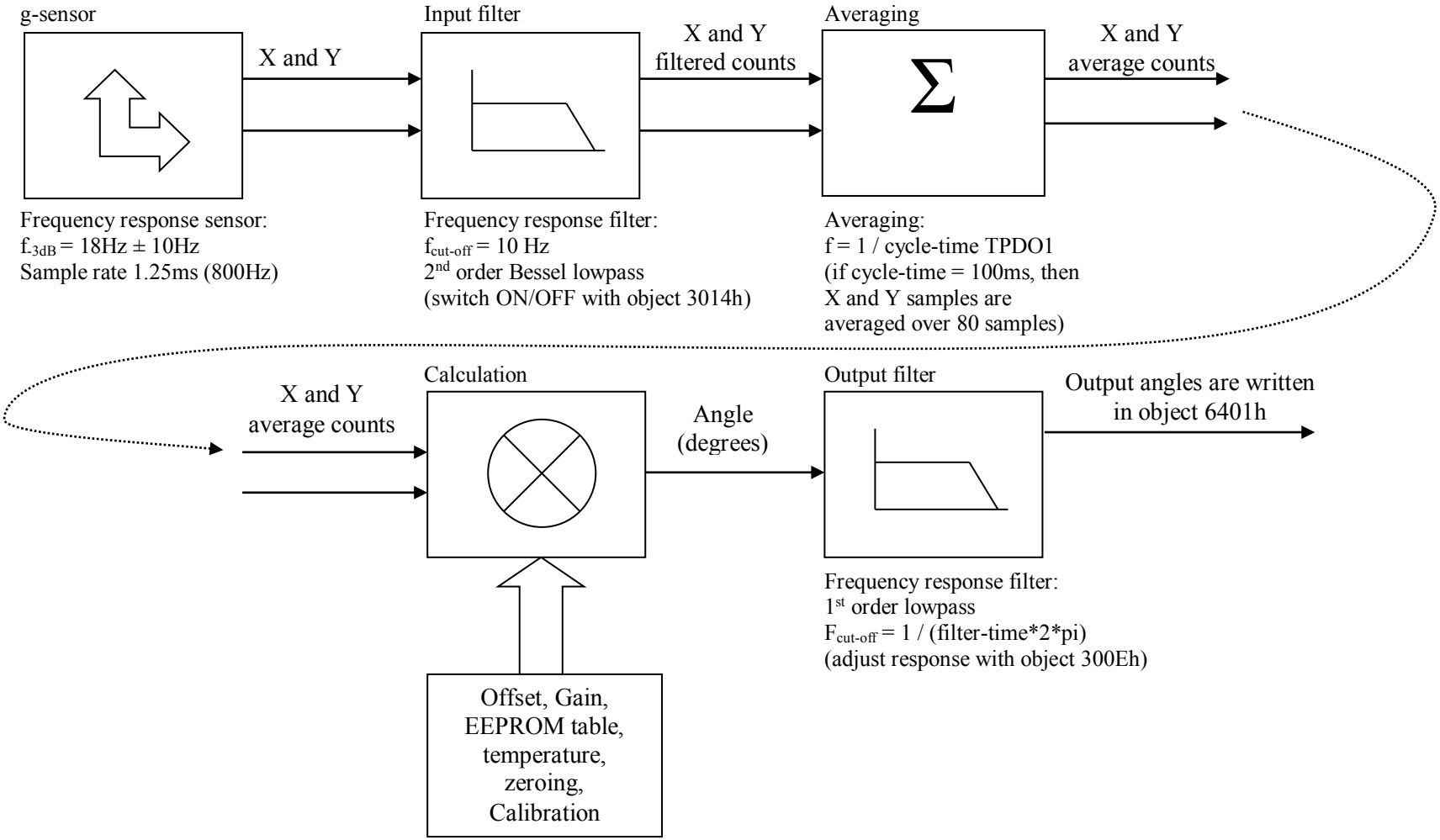
APPENDIX 1: Schematic overview inclination measurement



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APPENDIX 2: Schematic overview acceleration measurement