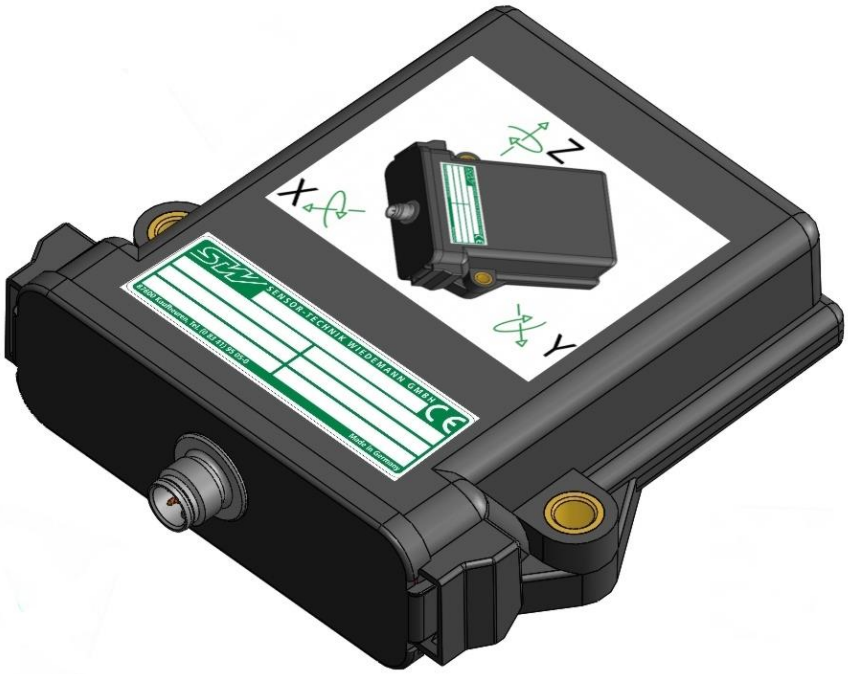
NGS2-CAN

3-Axis Gyroscope/Inclination Sensor

with

CANopen Interface



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1 History

Version	Date	Name	Change
1.00	16.09.08	STW / SZ	Document created
1.01	12.04.10	STW / SZ	Added pin assignment for M12 connector (CiA DR303-1) and “auto-zero” SubIndex for angle X,Y,Z
1.02	11.01.11	STW / SZ	Added technical information (sensor-specification, coordinate-system) and pin assignment of house-grounding GGND
2.00	25.10.13	STW / SZ	Document completely revised and updated to “NGS2”

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2 General

The “NGS2” is a combined sensor for measurement of angular velocity and inclination in 3 axes. The acceleration in each axis is also available. The measured value is transmitted on the CAN-Bus with the CANopen protocol. The transmitter takes more than 300 samples per second of each sensor signal, does filtering and converts the raw value into the physical output format.

The CAN2.0B interface is able to run up to a speed of 1 Mbit/sec with 11-bit and 29-bit identifiers.

The CAN protocol complies with the CANopen specification DS301, the “NGS2” function is presented by the CANopen device profile DS404. The possible configurations can be set with the object dictionary. Heartbeat and emergency messages guarantee high reliability.

3 CAN Interface

The device includes a Full CAN controller specified to CAN 2.0B. The physical layer of the 2-wire interface is specified according to ISO 11898. The wires are protected against short-circuit. By adjusting the rise and fall times of the CAN signals, the noise emission is minimized. The bus termination resistor is *not* included in the device.

4 NGS2-CAN Specification

4.1 Supply Voltage

Supply voltage:	9…36 VDC, protected against reverse polarity
Current consumption:	120 mA@12V, 60mA@24V

4.2 CAN Interface

Physical layer:	2-wire interface, 5 V level according to ISO 11898-2 Protected against short-circuit
max. Bitrate:	1 Mbit/sec
Bus termination:	external
Protocol:	CANopen DS301, Device Profile DS404

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4.3 Sensor

Gyro:	bandwidth 3dB	40Hz
	measurement range	50°/s (typ. 75°/s)
	resolution	0,25°/s
	accuracy offset	±0,5°/s
	accuracy gain	±0,5%FS
	nonlinearity	0,1%FS
	acceleration effect	(0,1°/s)/g
Acceleration:	bandwidth 3dB	15Hz
	measurement range	±2g
	resolution	0,2mg
	accuracy offset	±15mg
	accuracy gain	0,5%FS
	nonlinearity	0,5%FS
Inclination:	bandwidth 3dB	15Hz
	measurement range	±180°
	resolution	0,01°
	accuracy	±1,5° (typ. 0,5°)

4.4 Environment

Operating temperature:	-40…+85°C
EMC:	EN ISO 14982
Temperature:	EN 60068-2-14
	EN 60068-2-2
Climatic:	EN 60068-2-30
Shock:	EN 60068-2-27
Vibration:	EN 60068-2-64
Chemical resistance:	Diesel fuel, Hydraulic fluid, Antifreeze fluid, NaCl
Protection class:	IP67 / IP69k

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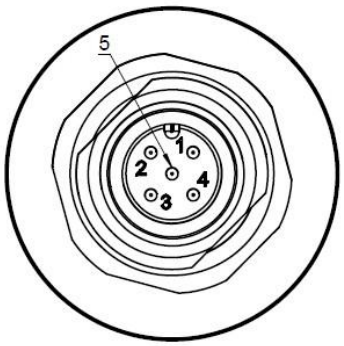
4.5 Connector Pin Assignment

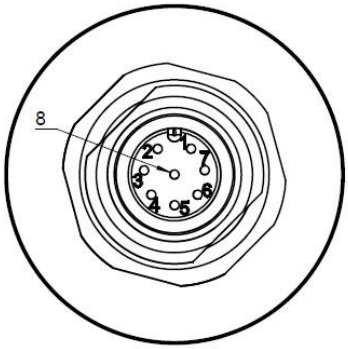
Pin connection (CiA DR303-1) for the 5 pole M12 connector (fig.: connector front view).

Signal	Pin
n.c.	1
CAN_V+, Supply	2
CAN_GND, Ground	3
CAN_H, CAN+	4
CAN_L, CAN-	5



Optional Pin connection for the 8 pole M12 connector (fig.: connector front view).

Signal	Pin
ANALOG_GND	6
V+, Supply	2
GND, Ground	8
CAN_H, CAN+	1
CAN_L, CAN-	7
ANALOG_OUT1	3
ANALOG_OUT2	4
ANALOG_OUT3	5



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5 CANopen communication

5.1 Summary of the CANopen functions

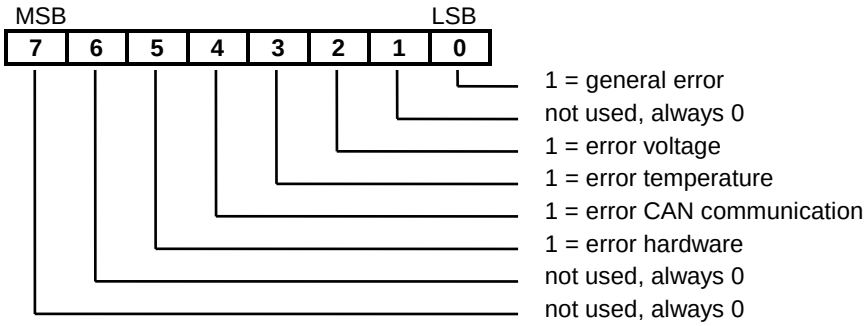
CANopen type:	NMT slave
Network bootup:	minimum bootup
COB Id placing:	pre-defined connection set, SDO
Node Id:	object (specific entry)
Bitrate:	object (specific entry)
Number of PDOs:	PDO1 synchronous, asynchronous PDO2 synchronous, asynchronous PDO3 synchronous, asynchronous PDO4 synchronous, asynchronous PDO-mapping configurable
Emergency message:	supported
Heartbeat:	supported
Device profile:	DS404

Default Settings: **Bitrate 250 kbit/s**
NodeID 1

5.2 Object Dictionary: Communication Profile

Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
1000	00	Device Type	Unsigned32	ro	0x00020194	DSP404 analog input block
1001	00	Error Register	Unsigned8	ro	0x00	

Error register (Index 1001H):



Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
1003		Pre-defined Error Field				
	00	Number of errors	Unsigned8	rw	0x04	Write 0: clear errors
	01	Standard Error Field	Unsigned32	ro		
	02	Standard Error Field	Unsigned32	ro		
	03	Standard Error Field	Unsigned32	ro		
	04	Standard Error Field	Unsigned32	ro		

Standard Error Field (Index 1003H, 01):

MSB Bit31…24	Bit23…16	Bit15…0 LSB
not used, always 0	Error Register (Index 1001H)	Error Code: 0x8100 communication error 0x6161 internal software error 0x6363 PDO mapping error 0x6300 data error 0x5000 hardware 0x3000 powerfail 0x4000 temperature

Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
1005	00	COB-ID SYNC	Unsigned32	rw	0x80	
1008	00	Manufacturer Device Name	String	ro	„NGS-CANopen“	
1009	00	Manufacturer Hardware Version	String	ro	„x.xxrx“	
100A	00	Manufacturer Software Version	String	ro	„x.xxrx“	
1010		Store parameters				
	00	Number of entries	Unsigned8	ro	0x04	
	01	Save all parameters	Unsigned32	rw	0x1	Data will be saved with the command 0x65766173 (ASCII: „save“)
	02	Save communication related parameters	Unsigned32	ro	0x0	NOT SUPPORTED
	03	Save application related parameters	Unsigned32	ro	0x0	NOT SUPPORTED
	04	Save Autozero, Filter constant and Bitrate	Unsigned32	ro	0x2	This means that the parameters for Autozero, Filter and Bitrate are saved autonomously.
1011		Restore default parameters				
	00	Number of entries	Unsigned8	ro	0x4	
	01	Restore default parameters	Unsigned32	rw	0x1	Default values will be restored with the command 0x64616F6C (ASCII: „load“) Reset of device required
	02	Restore communication related parameters	Unsigned32	ro	0x0	NOT SUPPORTED
	03	Restore application related parameters	Unsigned32	ro	0x0	NOT SUPPORTED
	04	Restore Autozero, Filter constant and Bitrate	Unsigned32	rw	0x1	Default values for Autozero, Filter, and Bitrate will be restored with the command 0x64616F6C (ASCII: „load“) Reset of device required
1014	00	COB ID Emergency message	Unsigned32	ro	0x81	0x00000080 + Node-ID
1016		Consumer heartbeat time				
	00	Number of entries	Unsigned8	ro	0x1	
	01	Consumer heartbeat time	Unsigned32	rw	0	
1017	00	Producer heartbeat time	Unsigned16	rw	0	
1018		Identity object				
	00	Number of entries	Unsigned8	ro	0x4	
	01	Vendor Id	Unsigned32	ro	0x023D	STW-Vendor-Id

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Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
	02	Product Code	Unsigned32	ro		STW article number
	03	Revision number	Unsigned32	ro		
	04	Serial number	Unsigned32	ro		STW internal serial number

Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
1800 - 1803		Transmit PDO1-4 parameter				
	00	Number of entries	Unsigned8	ro	0x5	
	01	COB ID used by PDO	Unsigned32	rw	0x181 0x281 0x381 0x481	(0x00000X80 + Node-ID)
	02	Transmission type	Unsigned8	rw	0xFF	Only 0x01 (sync) or 0xFF (async) with delta, limit and/or event timer
	03	Inhibit Time	Unsigned16	rw	0	
	04	Reserved	Unsigned8	rw	0	
	05	Event Timer	Unsigned16	rw	0x3E8 0x3E8 0x3E8 0x0	
1A00 - 1A03		Transmit PDO1-4 mapping				
	00	Number of entries	Unsigned8	rw	0x4	
	01	PDO mapping for the 1. application object to be mapped	Unsigned32	rw		Gyro PV X as int16: 0x71300110 Gyro PV Y as int16: 0x71300210 Gyro PV Z as int16: 0x71300310 Accel PV X as int16: 0x71300410 Accel PV Y as int16: 0x71300510 Accel PV Z as int16: 0x71300610 Angle PV X as int16: 0x71300710 Angle PV Y as int16: 0x71300810 Angle PV Z as int16: 0x71300910 Temperature PV as int16: 0x71300A10 AI Field Values and AI Status can be mapped, too.
	02	PDO mapping for the 2. application object to be mapped	Unsigned32	rw		
	03	PDO mapping for the 3. application object to be mapped	Unsigned32	rw		
	04	PDO mapping for the 4. application object to be mapped	Unsigned32	rw		

Default Mappings:

PDO1: Gyro PV X as int16, Gyro PV Y as int16, Gyro PV Z as int16
PDO2: Accel PV X as int16, Accel PV Y as int16, Accel PV Z as int16
PDO3: Angle PV X as int16, Angle PV Y as int16, Angle PV Z as int16
PDO4: unused/disabled

Index	Sub	Name	Type	Acc	Default	Comment

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(HEX)	Index			ess		
1F80	00	NMT startup	Unsigned32	rw	8	0x00000004: The NMT master has to start the NMT slave. 0x00000008: NMT slave shall enter the NMT state *Operational* after the NMT state *Initialisation* autonomously (self starting).

5.3 Object Dictionary: Manufacturer Specific Profile

Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
4F00	00	Bitrate	Unsigned8	rw	250	Bitrate in kBit/s Supported Values: 20, 40, 50, 100, 125, 250, 500, 1000 This Value will be saved immediately in EEPROM. Changes take effect after reset or power on.
4F01	00	Node-Id	Unsigned8	rw	0x1	1…127; Changes take effect after reset or power on.

5.4 Object Dictionary: Device Profile

Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
6110		AI_Sensor_Type				
	00	Number of entries	Unsigned8	ro	0x0A	
	01	AI_Sensor_Type_1	Unsigned16	ro	10401	gyroscope
	02	AI_Sensor_Type_2	Unsigned16	ro	10401	gyroscope
	03	AI_Sensor_Type_3	Unsigned16	ro	10401	gyroscope
	04	AI_Sensor_Type_4	Unsigned16	ro	10501	acceleration
	05	AI_Sensor_Type_5	Unsigned16	ro	10501	acceleration
	06	AI_Sensor_Type_6	Unsigned16	ro	10501	acceleration
	07	AI_Sensor_Type_7	Unsigned16	ro	10601	angle
	08	AI_Sensor_Type_8	Unsigned16	ro	10601	angle
	09	AI_Sensor_Type_9	Unsigned16	ro	10601	angle
	10	AI_Sensor_Type_10	Unsigned16	ro	100	temperature sensor
6125		AI_Input_Autozero				
	00	Number of entries	Unsigned8	ro	0x6	
	01	AI_Input_Autozero_1	Unsigned32	wo		Autozero for gyro X, saved autonomously, 0x6F72657A “ZERO”
	02	AI_Input_Autozero_2	Unsigned32	wo		Autozero for gyro Y, saved autonomously, 0x6F72657A “ZERO”
	03	AI_Input_Autozero_3	Unsigned32	wo		Autozero for gyro Z, saved autonomously, 0x6F72657A “ZERO”
	04	AI_Input_Autozero_4	Unsigned32	wo		Autozero for accel X, saved autonomously, 0x6F72657A “ZERO”
	05	AI_Input_Autozero_5	Unsigned32	wo		Autozero for accel Y, saved autonomously, 0x6F72657A “ZERO”
	06	AI_Input_Autozero_6	Unsigned32	wo		Autozero for accel Z, saved autonomously,

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Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
						0x6F72657A “ZERO”
	07	AI_Input_Autozero_7	Unsigned32	wo		Autozero for angle X, saved autonomously, 0x6F72657A “ZERO”
	08	AI_Input_Autozero_8	Unsigned32	wo		Autozero for angle Y, saved autonomously, 0x6F72657A “ZERO”
	09	AI_Input_Autozero_9	Unsigned32	wo		Autozero for angle Z, saved autonomously, 0x6F72657A “ZERO”
6131		AI_Physical_Unit_PV				
	00	Number of entries	Unsigned8	ro	0xA	
	01	AI_Physical_Unit_PV_1	Unsigned32	ro	0xFE410300	°/s * 10^{-2}
	02	AI_Physical_Unit_PV_2	Unsigned32	ro	0xFE410300	°/s * 10^{-2}
	03	AI_Physical_Unit_PV_3	Unsigned32	ro	0xFE410300	°/s * 10^{-2}
	04	AI_Physical_Unit_PV_4	Unsigned32	ro	0xFDF10000	g * 10^{-3} (0xF1: g)
	05	AI_Physical_Unit_PV_5	Unsigned32	ro	0xFDF10000	g * 10^{-3} (0xF1: g)
	06	AI_Physical_Unit_PV_6	Unsigned32	ro	0xFDF10000	g * 10^{-3} (0xF1: g)
	07	AI_Physical_Unit_PV_7	Unsigned32	ro	0xFE410000	° * 10^{-2}
	08	AI_Physical_Unit_PV_8	Unsigned32	ro	0xFE410000	° * 10^{-2}
	09	AI_Physical_Unit_PV_9	Unsigned32	ro	0xFE410000	° * 10^{-2}
	10	AI_Physical_Unit_PV_10	Unsigned32	ro	0xFF2D0000	° C * 10^{-1}
7133		Ai interrupt delta input PV				
	00	Number of entries	Unsigned8	ro	0xA	
	01	PV_1	Integer16	rw	0 (disabled)	Gyro X
	02	PV_2	Integer16	rw	0 (disabled)	Gyro Y
	03	PV_3	Integer16	rw	0 (disabled)	Gyro Z
	04	PV_4	Integer16	rw	0 (disabled)	Accel X
	05	PV_5	Integer16	rw	0 (disabled)	Accel Y
	06	PV_6	Integer16	rw	0 (disabled)	Accel Z
	07	PV_7	Integer16	rw	0 (disabled)	Angle X
	08	PV_8	Integer16	rw	0 (disabled)	Angle Y
	09	PV_9	Integer16	rw	0 (disabled)	Angle Z
	10	PV_10	Integer16	rw	0 (disabled)	Temperature
7134		Ai interrupt lower limit input PV				
	00	Number of entries	Unsigned8	ro	0xA	
	01	PV_1	Integer16	rw	-32768 (disabled)	Gyro X
	02	PV_2	Integer16	rw	-32768 (disabled)	Gyro Y
	03	PV_3	Integer16	rw	-32768 (disabled)	Gyro Z
	04	PV_4	Integer16	rw	-32768 (disabled)	Accel X
	05	PV_5	Integer16	rw	-32768 (disabled)	Accel Y
	06	PV_6	Integer16	rw	-32768 (disabled)	Accel Z
	07	PV_7	Integer16	rw	-32768 (disabled)	Angle X
	08	PV_8	Integer16	rw	-32768 (disabled)	Angle Y
	09	PV_9	Integer16	rw	-32768 (disabled)	Angle Z
	10	PV_10	Integer16	rw	-32768 (disabled)	Temperature
7135		Ai interrupt upper limit input PV				
	00	Number of entries	Unsigned8	ro	0xA	
	01	PV_1	Integer16	rw	32767 (disabled)	Gyro X
	02	PV_2	Integer16	rw	32767 (disabled)	Gyro Y
	03	PV_3	Integer16	rw	32767 (disabled)	Gyro Z
	04	PV_4	Integer16	rw	32767 (disabled)	Accel X
	05	PV_5	Integer16	rw	32767 (disabled)	Accel Y
	06	PV_6	Integer16	rw	32767 (disabled)	Accel Z
	07	PV_7	Integer16	rw	32767 (disabled)	Angle X
	08	PV_8	Integer16	rw	32767 (disabled)	Angle Y
	09	PV_9	Integer16	rw	32767 (disabled)	Angle Z
	10	PV_10	Integer16	rw	32767 (disabled)	Temperature

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Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
7148		AI_span_start				
	00	Number of entries	Unsigned8	ro	0xA	
	01	AI_span_start_1	Integer16	ro	-5000	Gyro X -50°/s
	02	AI_span_start_2	Integer16	ro	-5000	Gyro Y -50°/s
	03	AI_span_start_3	Integer16	ro	-5000	Gyro Z -50°/s
	04	AI_span_start_4	Integer16	ro	-6000	Accel X -6g
	05	AI_span_start_5	Integer16	ro	-6000	Accel Y -6g
	06	AI_span_start_6	Integer16	ro	-6000	Accel Z -6g
	07	AI_span_start_7	Integer16	ro	-9000	Angle X -90°
	08	AI_span_start_8	Integer16	ro	-9000	Angle Y -90°
	09	AI_span_start_9	Integer16	ro	-9000	Angle Z -90°
	10	AI_span_start_10	Integer16	ro	-400	Temperature -40 °C
7149		AI_span_end				
	00	Number of entries	Unsigned8	ro	0xA	
	01	AI_span_end_1	Integer16	ro	5000	Gyro X 50°/s
	02	AI_span_end_2	Integer16	ro	5000	Gyro Y 50°/s
	03	AI_span_end_3	Integer16	ro	5000	Gyro Z 50°/s
	04	AI_span_end_4	Integer16	ro	6000	Accel X 6g
	05	AI_span_end_5	Integer16	ro	6000	Accel Y 6g
	06	AI_span_end_6	Integer16	ro	6000	Accel Z 6g
	07	AI_span_end_7	Integer16	ro	9000	Angle X 90°
	08	AI_span_end_8	Integer16	ro	9000	Angle Y 90°
	09	AI_span_end_9	Integer16	ro	9000	Angle Z 90°
	10	AI_span_end_10	Integer16	ro	850	Temperature 85 °C
61A0		AI_filter_type				
	00	Number of entries	Unsigned8	ro	0x6	
	01	Gyro X filter type	Unsigned8	ro	1	moving average
	02	Gyro Y filter type	Unsigned8	ro	1	moving average
	03	Gyro Z filter type	Unsigned8	ro	1	moving average
	04	Accel X filter type	Unsigned8	ro	1	moving average
	05	Accel Y filter type	Unsigned8	ro	1	moving average
	06	Accel Z filter type	Unsigned8	ro	1	moving average
61A1		AI_filter_constant				
	00	Number of entries	Unsigned8	ro	0x6	
	01	Gyro X filter constant	Unsigned16	rw	8	These parameters are saved autonomously. Supported values: 0 (off), 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024
	02	Gyro Y filter constant	Unsigned16	ro		
	03	Gyro Z filter constant	Unsigned16	ro		
	04	Accel X filter constant	Unsigned16	rw	8	
	05	Accel Y filter constant	Unsigned16	ro		
	06	Accel Z filter constant	Unsigned16	ro		
7100		AI Field Value				
	00	Number of entries	Unsigned8	ro	0xA	
	01	AI_input_FV_1	Unsigned16	ro		act. ADC gyro value X
	02	AI_input_FV_2	Unsigned16	ro		act. ADC gyro value Y
	03	AI_input_FV_3	Unsigned16	ro		act. ADC gyro value Z
	04	AI_input_FV_4	Unsigned16	ro		act. ADC accel value X
	05	AI_input_FV_5	Unsigned16	ro		act. ADC accel value Y
	06	AI_input_FV_6	Unsigned16	ro		act. ADC accel value Z
	07	AI_input_FV_7	Unsigned16	ro	0	(n/a)
	08	AI_input_FV_8	Unsigned16	ro	0	(n/a)
	09	AI_input_FV_9	Unsigned16	ro	0	(n/a)
	10	AI_input_FV_10	Unsigned16	ro		act. ADC temperature value
7130		AI Process Value				
	00	Number of entries	Unsigned8	ro	0x2	
	01	AI_input_PV_1	Integer16	ro		Gyro X
	02	AI_input_PV_2	Integer16	ro		Gyro Y
	03	AI_input_PV_3	Integer16	ro		Gyro Z
	04	AI_input_PV_4	Integer16	ro		Accel X
	05	AI_input_PV_5	Integer16	ro		Accel Y

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Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
	06	AI_input_PV_6	Integer16	ro		Accel Z
	07	AI_input_PV_7	Integer16	ro		Angle X
	08	AI_input_PV_8	Integer16	ro		Angle Y
	09	AI_input_PV_9	Integer16	ro		Angle Z
	10	AI_input_PV_10	Integer16	ro		Temperature
6150		AI Status				
	00	Number of entries	Unsigned8	ro	0x6	
	01	Gyro X Status	Unsigned8	ro		bit0: NotValid (LSB) bit1: PositiveOverload bit2: NegativeOverload bit3…7: reserved
	02	Gyro Y Status	Unsigned8	ro		
	03	Gyro Z Status	Unsigned8	ro		
	04	Accel X Status	Unsigned8	ro		
	05	Accel Y Status	Unsigned8	ro		
	06	Accel Z Status	Unsigned8	ro		

5.5 Emergency Message

Emergency messages show an internal device error. If the error situation for the device is changed it will send an emergency message with the actual error code.

An error code 0x0000 shows that all errors are removed.

The actual error situation could be read out with the object profile entry “Pre-defined Error Filed” index 0x1003, subindex 1.

Construction of the emergency message:

Data			
Byte 0			Byte 7
Error Code LSB	Error Code MSB	Error Register (Index 0x1001)	not used

Error Codes

Error Code	Bedeutung
0x8100	CAN-communication error
0x6161	internal software error
0x6363	PDO-mapping error
0x6300	data error
0x5000	hardware error
0x4000	temperature error
0x3000	supply error (power fail)

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CAN Communication without CANopen Functionality

5.6 Basic Configuration

The “NGS2” can be used without any problems in CAN networks without CANopen functionality. Before using the following basic configurations should be set:

1. Bitrate, default is 250 kbit/s, object 0x4F00
2. Node Id, default is 1, object 0x4F01.
   The CAN identifier will be created from the node Id (see table 5.10). All CAN identifiers are 11 bit identifiers (default setting).
3. Additional settings (Filter, mapping of CAN-Msgs etc.) can be found in the object dictionary (*5.4 Object Dictionary Device Profile*) and in *5.9 Change Node Configuration Manually*.
4. The new settings are saved with object 0x1010/01. The 0x65766173 (ASCII: „save“) must be entered here. The settings will be saved to non-volatile memory.

5.7 Network Operation without CANopen Master

After connecting the transmitter to the excitation voltage, the transmitter will send a bootup message with the CAN identifier 0x700 + Node Id (default 0x701) with one data byte (content = 0) if no error is detected.

If an error is detected the error code (see*0emergency message*) will be sent together with the CAN identifier.

By default the sensor starts directly after bootup into the Operational_State. You can configure this behaviour by writing a 0x8 (for autostart) or a 0x4 (for no autostart) into the Object Dictionary at 0x1F80.

If no autostart is configurated the sensor is in the “Pre_Operational_State” after bootup. With the CANopen command “Start_Remote_Node” the sensor will be activated:

„Start_Remote_Node“

	ID	DLC	Data							
			Byte 0							Byte 7
Command „Start_ Remote_ Node“	0x000	2	0x01	Node-ID or 0x00 (all CAN-open members)						

The “Start_Remote_Node” will be answered with a data message (PDO) with the CAN identifier 0x180 + Node Id (default 0x181). Now the CAN transmitter sends cyclically (default setting) PDOs with the angular velocity values, the inclination values and the acceleration values of all 3 axes. These PDOs are defined (default) as follows:

Construction of the message angular velocity measurement (PDO1):

	ID	DLC	Data Byte 0							Byte 7
PDO message	0x180 + Node-ID	6	Gyro value X Integer16 LSB	Gyro value X Integer16 MSB	Gyro value Y Integer16 LSB	Gyro value Y Integer16 MSB	Gyro value Z Integer16 LSB	Gyro value Z Integer16 MSB		

Construction of the message for acceleration measurement (PDO2):

	ID	DLC	Data Byte 0							Byte 7
PDO message	0x280 + Node-ID	6	Acceleration value X Integer16 LSB	Acceleration value X Integer16 MSB	Acceleration value Y Integer16 LSB	Acceleration value Y Integer16 MSB	Acceleration value Z Integer16 LSB	Acceleration value Z Integer16 MSB		

Construction of the message for inclination measurement (PDO3):

	ID	DLC	Data Byte 0							Byte 7
PDO message	0x380 + Node-ID	6	Angle value X Integer16 LSB	Angle value X Integer16 MSB	Angle value Y Integer16 LSB	Angle value Y Integer16 MSB	Angle value Z Integer16 LSB	Angle value Z Integer16 MSB		

PDO4: This PDO can be assigned as you like. By default this PDO is not used!

	ID	DLC	Data Byte 0							Byte 7
PDO message	0x480 + Node-ID	0	no default mapping	no default mapping	no default mapping	no default mapping	no default mapping	no default mapping	no default mapping	no default mapping

The mapping of all PDOs can be changed as described in *5.2 Object Dictionary Communication Profile*.

The values of all input values can be also read from the object dictionary (SDO access) as 16 bit integer. This access is independent of the current operational state of the inclinometer/gyroscope sensor.

Angular velocity measurement

Request value of angular velocity measurement (integer16, SDO access):

	ID	DLC	Data Byte 0							Byte 7
Command	0x600 + Node-ID	8	SDO-Request 0x40	Index LSB 0x30	Index MSB 0x71	Sub Index 0x01 (X) 0x02 (Y) 0x03 (Z)	not used			
Answer	0x580 + Node-ID	8	SDO Ack. 0x4B	Index LSB 0x30	Index MSB 0x71	Sub Index 0x01 (X) 0x02 (Y) 0x03 (Z)	Data LSB	Data MSB	not used	not used

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Acceleration measurement

Request value of acceleration measurement (integer16, SDO access):

	ID	DLC	Data Byte 0							Byte 7
Command	0x600 + Node-ID	8	SDO-Request 0x40	Index LSB 0x30	Index MSB 0x71	Sub Index 0x04 (X) 0x05 (Y) 0x06 (Z)	not used			
Answer	0x580 + Node-ID	8	SDO Ack. 0x4B	Index LSB 0x30	Index MSB 0x71	Sub Index 0x04 (X) 0x05 (Y) 0x06 (Z)	Data LSB	Data MSB	not used	not used

Inclination measurement

Request value inclination measurement (integer16, SDO access):

	ID	DLC	Data Byte 0							Byte 7
Command	0x600 + Node-ID	8	SDO-Request 0x40	Index LSB 0x30	Index MSB 0x71	Sub Index 0x07 (X) 0x08 (Y) 0x09 (Z)	not used			
Answer	0x580 + Node-ID	8	SDO Ack. 0x4B	Index LSB 0x30	Index MSB 0x71	Sub Index 0x07 (X) 0x08 (Y) 0x09 (Z)	Data LSB	Data MSB	not used	not used

5.7.1 SDO abort codes

If the SDO access fails, the NGS will answer with a SDO abort code.

SDO abort code	Meaning
0x06010001	Attempt to read a write only object.
0x06010002	Attempt to write a read only object.
0x06020000	Object does not exist in the object dictionary.
0x06040041	Object cannot be mapped to the PDO.
0x06040042	The number and length of the objects to be mapped would exceed PDO length.
0x06040043	General parameter incompatibility reason.
0x06060000	Access failed due to an hardware error.
0x06070012	Data type does not match, length of service parameter too high
0x06070013	Data type does not match, length of service parameter too low
0x06090011	Sub-index does not exist.
0x06090030	Value range of parameter exceeded (only for write access).
0x06090031	Value of parameter written too high.
0x06090032	Value of parameter written too low.

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5.8 Cyclically Sending

The sensor is able to send the values of measurements (PDO) cyclic with a programmable time interval.

The event timer is activated by writing 0xFF to the object 0x1800 subindex 2 (transmission type).

The timer interval is written to the object 0x1800 subindex 5 (event timer). The value (unsigned16) is set in units of 1 ms. The value range is from 0 ms to 65535 ms. 0 stops the event timer.

Default settings:

- Transmission type: 0xFF (event timer active)
- Event timer: 100 ms

Activate Event Timer (SDO Access):

	ID	DLC	Data Byte 0					Byte 7
Command	0x600 + Node-ID	8	SDO-Write 0x2F	Index LSB 0x00 (PDO 1) 0x01 (PDO 2) 0x02 (PDO 3) 0x03 (PDO 4)	Index MSB 0x18	Sub Index 0x02	Trans-mission Type 0xFF	not used
Answer	0x580 + Node-ID	8	SDO Ack. 0x60	Index LSB 0x00 (PDO 1) 0x01 (PDO 2) 0x02 (PDO 3) 0x03 (PDO 4)	Index MSB 0x18	Sub Index 0x02	not used	

Set Event Timer (SDO Access):

	ID	DLC	Data Byte 0						Byte 7
Command	0x600 + Node-ID	8	SDO-Write 0x2B	Index LSB 0x00 (PDO 1) 0x01 (PDO 2) 0x02 (PDO 3) 0x03 (PDO 4)	Index MSB 0x18	Sub Index 0x05	Timer LSB	Timer MSB	not used
Answer	0x580 + Node-ID	8	SDO Ack. 0x60	Index LSB 0x00 (PDO 1) 0x01	Index MSB 0x18	Sub Index 0x05	not used		

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				(PDO 2) 0x02 (PDO 3) 0x03 (PDO 4)					

Get Event Timer (SDO Access):

	ID	DLC	Data Byte 0						Byte 7
Command	0x600 + Node-ID	8	SDO-Requ-est 0x40	Index LSB 0x00 (PDO 1) 0x01 (PDO 2) 0x02 (PDO 3) 0x03 (PDO 4)	Index MSB 0x18	Sub Index 0x05	not used		
Answer	0x580 + Node-ID	8	SDO Ack. 0x4B	Index LSB 0x00 (PDO 1) 0x01 (PDO 2) 0x02 (PDO 3) 0x03 (PDO 4)	Index MSB 0x18	Sub Index 0x05	Timer LSB	Timer MSB	not used

Note:

If the device is not configured as self starting device the message “start_remote_node” must be sent each time after reset or power up.

5.9 Change Node Configuration Manually

The basic configuration of the inclinometer/gyroscope sensor can be manually set through the object dictionary with the addresses 0x4F01 (node Id) and 0x4F00 (CAN bitrate). The new settings are active after a reset.

Node Id:

Set Node Id

	ID	DLC	Data Byte 0					Byte 7
Command	0x600 + Node-ID	8	SDO-Write 0x2F	Index LSB 0x01	Index MSB 0x4F	Sub Index 0x00	Node-ID Byte	not used
Answer	0x580 + Node-ID	8	SDO Ack. 0x60	Index LSB 0x01	Index MSB 0x4F	Sub Index 0x00	not used	

Get Node Id

	ID	DLC	Data Byte 0	Byte 7

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Command	0x600 + Node-ID	8	SDO-Requ-est 0x40	Index LSB 0x01	Index MSB 0x4F	Sub Index 0x00	not used	
Answer	0x580 + Node-ID	8	SDO Ack. 0x4F	Index LSB 0x01	Index MSB 0x4F	Sub Index 0x00	Node-ID Byte	not used

CAN-Bitrate:

Set CAN Bitrate

	ID	DLC	Data Byte 0						Byte 7
Command	0x600 + Node-ID	8	SDO-Write 0x2B	Index LSB 0x00	Index MSB 0x4F	Sub Index 0x00	Bitrate LSB	Bitrate MSB	not used
Answer	0x580 + Node-ID	8	SDO Ack. 0x60	Index LSB 0x00	Index MSB 0x4F	Sub Index 0x00	not used		

Get CAN Bitrate

	ID	DLC	Data Byte 0						Byte 7
Command	0x600 + Node-ID	8	SDO-Requ-est 0x40	Index LSB 0x00	Index MSB 0x4F	Sub Index 0x00	not used		
Answer	0x580 + Node-ID	8	SDO Ack. 0x4B	Index LSB 0x00	Index MSB 0x4F	Sub Index 0x00	Bitrate LSB	Bitrate MSB	not used

NMT startup:

Activate automatic transition to the „Operational_State“

	ID	DLC	Data Byte 0							Byte 7
Command	0x600 + Node-ID	8	SDO-Write 0x23	Index LSB 0x80	Index MSB 0x1F	Sub Index 0x00	Data LSB 0x08	Data 0x00	Data 0x00	Data MSB 0x00
Answer	0x580 + Node-ID	8	SDO Ack. 0x60	Index LSB 0x80	Index MSB 0x1F	Sub Index 0x00	not used			

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Deactivate automatic transition to the „Operational_State“

	ID	DLC	Data Byte 0							Byte 7
Command	0x600 + Node-ID	8	SDO-Write 0x23	Index LSB 0x80	Index MSB 0x1F	Sub Index 0x00	Data LSB 0x04	Data 0x00	Data 0x00	Data MSB 0x00
Answer	0x580 + Node-ID	8	SDO Ack. 0x60	Index LSB 0x80	Index MSB 0x1F	Sub Index 0x00	not used			

„save“-command to store all parameters to non-volatile memory

	ID	DLC	Data Byte 0							Byte 7
Command	0x600 + Node-ID	8	SDO-Requ-est 0x23	Index Lo 0x10	Index Hi 0x10	Sub Index 0x01	ASCII ‚s’ 0x73	ASCII ‚a’ 0x61	ASCII ‚v’ 0x76	ASCII ‚e’ 0x65
Answer	0x580 + Node-ID	8	SDO Ack. 0x60	Index Lo 0x10	Index Hi 0x10	Sub Index 0x01	not used			

„load“-command to restore all default-parameters

	ID	DLC	Data Byte 0							Byte 7
Command	0x600 + Node-ID	8	SDO-Requ-est 0x23	Index Lo 0x11	Index Hi 0x10	Sub Index 0x01	ASCII ‚l’ 0x6C	ASCII ‚o’ 0x6F	ASCII ‚a’ 0x61	ASCII ‚d’ 0x64
Answer	0x580 + Node-ID	8	SDO Ack. 0x60	Index Lo 0x11	Index Hi 0x10	Sub Index 0x01	not used			

5.10 Reserved CAN Identifiers

The following CAN identifiers are reserved by the CAN protocol:

CAN-Identifier (11Bit), Hex	**Description**
0x000	NMT, network management
0x080	SYNC, synchronisation message, not used in asynchronous mode (see 5.2)
0x080 + Node Id max. range 0x081…0x0FF	Emergency message
0x180 + Node Id max. range 0x181…0x1FF	PDO1 TX, message with the value of angular velocity measurement
0x280 + Node Id max. range 0x281…0x2FF	PDO2 TX, message with the value of acceleration measurement
0x380 + Node Id max. range 0x381…0x3FF	PDO3 TX, message with the value of inclination measurement
0x480 + Node Id max. range 0x481…0x4FF	PDO4 TX, message with no default mapping (only if PDO4 is used, by default: not used)
0x580 + Node Id max. range 0x581…0x5FF	SDO TX, CANopen configuration message

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0x600 + Node Id max. range 0x601…0x67F	SDO RX, CANopen configuration message
0x700 + Node Id max. range 0x701…0x77F	CANopen node guarding

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6 Extensions

- Device profile DS404
- Heartbeat function
- Programmable monitoring of the measurement range
- Autozero function

7 Appendix

7.1 CoEdit

The CoEdit is a program for reading and writing the objects of the “NGS2”. The objects are defined in the EDS file for the gyroscope/inclinometer sensor.

7.2 References

DS301	Application Layer and Communication Profile
DS302-2	Additional Application Layer Functions Part 2: Network Management
DR303-1	Cabling and Connector Pin Assignment
DS404	Device Profile Measuring Devices and Closed-Loop Controllers

7.3 Definitions

COB	Communication Object Data must be sent inside a COB across a CAN network. There exist 2048 different COBs in a CAN network. A COB contains maximal 8 data bytes.
PDO	Process Data Object
SDO	Service Data Object

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