posiwire® WST
positape® WBT
Combined displacement and inclination sensors

Output specification CANopen

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MCANOP, CANOPR 	CAN specification	ISO 11898, Basic and Full CAN 2.0 B
	Communication profile	CANopen CiA 301 V 4.02, Slave
	Encoder profile	Encoder CiA 406 V 3.2
	Error Control	Node Guarding, Heartbeat, Emergency Message
	Node ID	Adjustable via LSS or SDO, default: 127
	PDO	3 TxPDO, 0 RxPDO, no linking, static mapping
	PDO Modes	Event-/Time triggered, Remote-request, Sync cyclic/acyclic
	SDO	1 Server, 0 Client
	CAM	8 cams
	Certified	Yes
	Transmission rate	50 kBit bis 1 Mbit, adjustable via LSS or SDO, default: 125 kBit
	Bus connection	M12 conncector, 5 pin
	Integrated bus terminating resistor	120Ω adjustable by the customer
	Bus, galvanic isolated	no

Specifications	Excitation voltage	8 ... 36 V DC
	Excitation current	20 mA typical at 24 V DC 40 mA typical at 12 V DC 80 mA max.
	Measuring rate	0.5 kHz
	Stability (temperature)	±50 x 10^{-6}/°C f.s. (typical)
	Repeatability	1 LSB
	Operating temperature	See specification of the respective sensor
	Protection	Reverse polarity, short circuit
	Dielectric strength	1 kV (V AC, 50 Hz, 1 min.)
	EMC	EN 61326-1:2013

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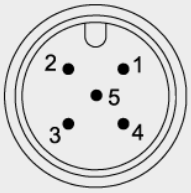
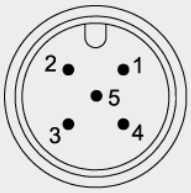
Signal wiring Connector M12, 5 pin	Output signals	Connector pin no.
 View to the sensor connector	Shield	1
	Excitation +	2
	GND	3
	CAN-H	4
	CAN-L	5

positape® WBT

Signal wiring Connector M12, 5 pin	Output signals	Connector pin no.
 View to the sensor connector	Shield	1
	Excitation +	2
	GND	3
	CAN-H	4
	CAN-L	5

Overview Setup, User Configuration

Setup

Before connecting the sensor to the CAN-Bus the devices have to be checked for correct bitrate and unique node-IDs. Both parameters are configurable by Layer-Setting-Service (LSS) or by Service Data Object (SDO).

After power-on the sensor will enter pre-operational state and send a boot-up message being ready for configuration by Service Data Objects. Parameters configured by the user can be stored nonvolatile by SAVE command. On receiving "NMT-Node-Start" the sensor transits to operational state and starts process data transmission. When "Auto-Start" is configured the sensor will automatically transit to operational after boot-up without a need for the Node-Start message.

Node monitoring is supported by Node Guarding and Heartbeat protocol. Node Guarding implements cyclic querying of the node status by the NMT-Master within the guard time window. The Heartbeat protocol provides automatic transmission of the node status (heartbeat message) by the slave within producer heartbeat time window.

By using the CAN example protocols included in this manual the sensor may be used without CANopen master device.

Dual Channel Configuration

Each of the two channels is a logically independent CAN device having a Node-ID on its own. Each channel has to be configured separately. Channel 1 which has the default Node-ID 07Fh accepts odd Node-ID values only while channel 2 which has the default Node-ID 07Eh accepts only even numbers.

⚠ WARNING

Risk of injury by unexpected machine movement!

- Changing parameters may cause unexpected machine movement.
- Changing parameters may influence dependent parameters e.g. changing the resolution may have influence on position of CAM switches.
- Precautions have to be taken to avoid damage to human and machine parts!
- Change parameters only when machine is in a safe condition!

Configuration Message

Service Data Object (SDO)

Configurable parameters of the sensor are accessible by peer to peer communication. The identifier (COB) of the SDO message is defined by the predefined connection set. Parameters to be uploaded or downloaded are addressed by Index and Subindex.

11-Bit CAN-Id	8 Byte data frame							
SDO COB-Id	**CS**	**Index**		**Sub-Index**	**Data**			
→ Request: Control Unit to Sensor								
600h + Node-Id	Byte	LSB	MSB	Byte	LSB	..	..	MSB
← Response: Sensor to Control Unit								
580h + Node-Id	Byte	LSB	MSB	Byte	LSB	..	..	MSB

SDO - Download Protocol

8 Byte data frame							
CS	**Index**		**Sub-Index**	**Data**			
→ Request: Control Unit to Sensor							
ccs	LSB	MSB	Byte	LSB	..	..	MSB
← Response: Sensor to Control Unit							
scs	LSB	MSB	Byte	Reserved			

Bit structure of command specifier CS:

b7	b6	b5	b4	b3	b2	b1	b0
→ Request: Control Unit to Sensor							
ccs			X	n		e	s
← Response: Sensor to Control Unit							
scs			X				

ccs: control unit command specifier, ccs = 1 (=> CS_8 = 2Fh, CS_{16} = 2Bh, CS_{32} = 23h)
scs: sensor command specifier, scs = 3 (=> CS = 60h)
X: reserved
e: expedited transfer e = 1
s: data set size = 1
n: number of bytes which do not contain data

SDO - Upload Protocol

8 Byte data frame			
CS	**Index**	**Sub-Index**	**Data**

→ Request: Control Unit to Sensor

scs	LSB	MSB	Byte	Reserved

← Response: Sensor to Control Unit

ccs	LSB	MSB	Byte	LSB	..	..	MSB

Bit structure of command specifier CS:

b7	**b6**	**b5**	**b4**	**b3**	**b2**	**b1**	**b0**

→ Request: Control Unit to Sensor

scs	X

← Response: Sensor to Control Unit

ccs	X	n	e	s

ccs: control unit command specifier, ccs = 2 (=> CS = 40h)
scs: sensor command specifier, scs = 2 (=> CS_8 = 4Fh, CS_{16} = 4Bh, CS_{32} = 43h)
X: reserved
e: expedited transfer e = 1
s: data set size = 1
n: number of bytes which do not contain data

SDO - Abort Peer-to-Peer-Protocol

8 Byte data frame			
CS	**Index**	**Sub-Index**	**Data**

→ **Response: Control Unit or Sensor**

cs	LSB	MSB	Byte	Abort Code

Bit structure of command specifier CS for Abort Protocol:

b7	**b6**	**b5**	**b4**	**b3**	**b2**	**b1**	**b0**

→ **Request: Control Unit to Sensor**

cs	X

cs: control unit / sensor command specifier, cs = 4, (=> CS = 8h)
X: reserved

SDO - Abort Code Description

Abort Code	**Description**
0601 0001h	Attempt to read a write only object.
0601 0002h	Attempt to write a read only object.
0602 0000h	Object does not exist in the object dictionary.
0604 0043h	General parameter incompatibility
0607 0012h	Data type does not match, length of service parameter too high
0607 0013h	Data type does not match, length of service parameter too low
0609 0030h	Value range of parameter exceeded (only for write access).

Transmit-PDO Transmission Type

Transmission type of TPDO-1, -2 is configurable by object PDO Communication Parameter 1800, 1801 sub-indices -1, -2, -3 and -5.

Transmission type example for TPDO-1	COB-Id 1800-1	Transmission Type 1800-2	Inhibit Time 1800-3	Event Timer [ms] 1800-5
Event Timer Driven	1FFh	FEh	0 ... FFFFh	0 ... FFFFh
Cyclic Synchronous	1FFh	N = 1 ... F0h		-
TPDO Disable	80 00 xx xx	-		-
TPDO Enable	00 00 xx xx	-		-

Transmission type "Event Timer Driven" triggers TPDO-transmission periodically with a time period defined by the event timer. In "Cyclic Synchronous" a TPDO is transmitted on reception of a number of one or multiple SYNC commands. Enable or disable a TPDO by setting Bit 31 of the COB-Id '0' resp. '1' (Default: "0" Enabled).

Communication Profile CiA301

Object	Index [hex]	Subindex	Access	Type	Default	Value Range / Note
Communication Profile CiA301						
Device type	1000	0	ro	U32	FFFF0196h	Multisensor device: Encoder and Inclinometer
Error register	1001	0	ro	U8	0	Error status
Pre-defined Error Field, N	1003	0	rw	U8	0	Number of Errors
Pre-defined Error Field, Error List	1003	1 ..	ro	U32	0	Emergency Error Code
COB-ID-SYNC	1005	0	rw	U32	080h	1 .. 7FFh
Guard time	100C	0	rw	U16	0	0 .. 7FFFh
Life time factor	100D	0	rw	U8	0	0 .. FFh
Store Parameters	1010	1	w	U32	-	„save“ 65766173h
Restore Default Parameters	1011	1	w	U32	-	„load“ 64616F6Ch
COB-ID-EMCY	1014	0	ro	U32	0FFh	NodeID+80h
Producer heartbeat time	1017	0	rw	U16	0	0 .. 7FFFh
Identity Object VendorID	1018	1	ro	U32	252h	
Identity Object Product Code		2	ro	U32	57425400h	"WBT"
Identity Object Revision number		3	ro	U32	0001xxxxh	x: Software Revision
Identity Object Serial number		4	ro	U32	nnnnnnnnh	
COB-ID SDO tx	1200	1	ro	U32	67Fh	Node-Id + 600
COB-ID SDO rx	1200	2	ro	U32	5FFh	Node-Id + 580
PDO1 COB-ID	1800	1	rw	U32	1FFh	181h .. 1FFh
PDO1 Transmission-Type		2	rw	U8	FEh	0 .. FFh
PDO1 Inhibit time		3	rw	U16	0	0 .. 7FFFh
PDO1 Event timer		5	rw	U16	64h	0 .. 7FFFh
TPDO1-Mapped Object	1A00	1	ro	U32	60040010h	Position
TPDO1-Mapped Object		2	ro	U32	68100010h	Inclination axis 1
TPDO1-Mapped Object		3	ro	U32	68200010h	Inclination axis 2
TPDO1-Mapped Object		4	ro	U32	00050008h	reserved
TPDO1-Mapped Object		5	ro	U32	10010008h	reserved
NMT-Startup	1F80	0	rw	U32	0h	0: Self Starting OFF 8: Self Starting ON

Device Profile 'Linear Encoder' CiA406, 'Tilt Sensor' CiA410

Object	Index [hex]	Subindex	Access	Type	Default Ch1 | Ch2	Value Range, Measuring Unit, Note
Manufacturer						
NodeID	2000	0	rw	U8	Ch1: 7Fh Ch2: 7Eh	Ch1: 1, 3 .. 7Fh Ch2: 2, 4 .. 7Eh
Bit rate	2010	0	rw	U8	4	4, 3, 2, 1, 0
Termination Resistor, Ch1 only	2050	0	rw	U8	0	0 OFF, 1 ON
Mounting option	2070	2	rw	U8	2	1, 2, 3 Figure mounting options
Linear Position Filter	2102	0	rw	U16	0	0, 1 .. 65535ms Step Response Time (90%)
Inclination Filter	2103	0	rw	U16	100	0, 1 .. 65535ms Step Response Time (90%)
Linear Encoder						
Operating Parameters	6000	0	rw	U16	0 | 8h	ascending | descending
Total Measuring Range in Measuring Steps	6002	0	rw	U32	-	
Preset Value	6003	0	rw	U32	0	0 .. measuring range
Position Value	6004	0	ro	U32	0	0 .. measuring range
Linear encoder measuring step	6005	1	rw	U32	1000000	[nm] 10^6 .. 10^9
Cyclic Timer	6200	0	rw	U16	100	[ms] event timer of TPDO1 0-FFFFh
Inclinometer						
Device Type	67FF	0	ro	U32	2019Ah	Inclinometer 2 axes
Resolution	6800	0	rw	U16	10	10, 100, 1000 • 0.001°
Inclination around axis 1	6810	0	ro	I16		
Operating parameters axis 1	6811	0	rw	U8	0 | 3h	ascending | descending
Inclination around axis 1 Preset	6812	0	rw	I16	0	0 .. ±180°
Inclination around axis 1 Offset	6813	0	rw	I16	0	0 .. ±180°

- Changing Node ID, Bit Rate or Termination Resistor will be effective on next power up
- For 2-Channel redundant devices Ch1 / Ch2 accept odd / even numbers only
- Disable PDOs before changing PDO communication parameters (1800-1: Bit31=1)
- Objects 6002h and 6005h depend on each other: 6002h * 6005h = Measuring range [nm]
- Restoring to Default Parameters does not affect Bitrate, Node ID and Termination Resistor settings.

Operating Parameters for Linear Position (Object 6000)

15	..	..	..	4	3	2	1	0
msb								lsb
-	-	-	-	-	md	sfc	-	-

Definition

Field	Value	Definition
md	0	Measuring direction ascending
	1	Measuring direction descending
sfc	0	Scaling function disabled
	1	Scaling function enabled

Operating Parameters for Inclination (Object 6811, 6821)

7	6	5	4	3	2	1	0
msb							lsb
-	-	-	-	-	-	s	i

Definition

Field	Value	Definition
i	0	Inversion disabled
	1	Inversion enabled
s	0	Offset and Preset disabled
	1	Offset and Preset enabled

Baud Rate (Object 2010)

Baud Rate Index	Baud Rate [kbit/s]
0	1000
1	800
2	500
3	250
4	125

Process Data Object TPDO Mapping

The real time data transfer is provided by process data objects (PDO). The PDO mapping is fixed. The PDO-COB-Ids have a default value which can be changed by accessing object 1800 Sub-Index-1. DLC defines the length of the data field.

TPDO	COB-Id	DLC	Byte0		Data Frame					Byte7
TPDO-1	180h +Node-Id (1FFh, 1FEh)	8	**Position**		**Inclination axis 1**		**Inclination axis 2**		**reserved**	**reserved**
			LSB	MSB	LSB	MSB	LSB	MSB	Byte	Byte

Definition

Field	mapped Object	Definition
Position	6004	unsigned integer16, position value
Inclination axis 1	6810	signed integer16, Inclination around axis 1
Inclination axis 2	6820	signed integer16, Inclination around axis 2

TPDO Default Settings

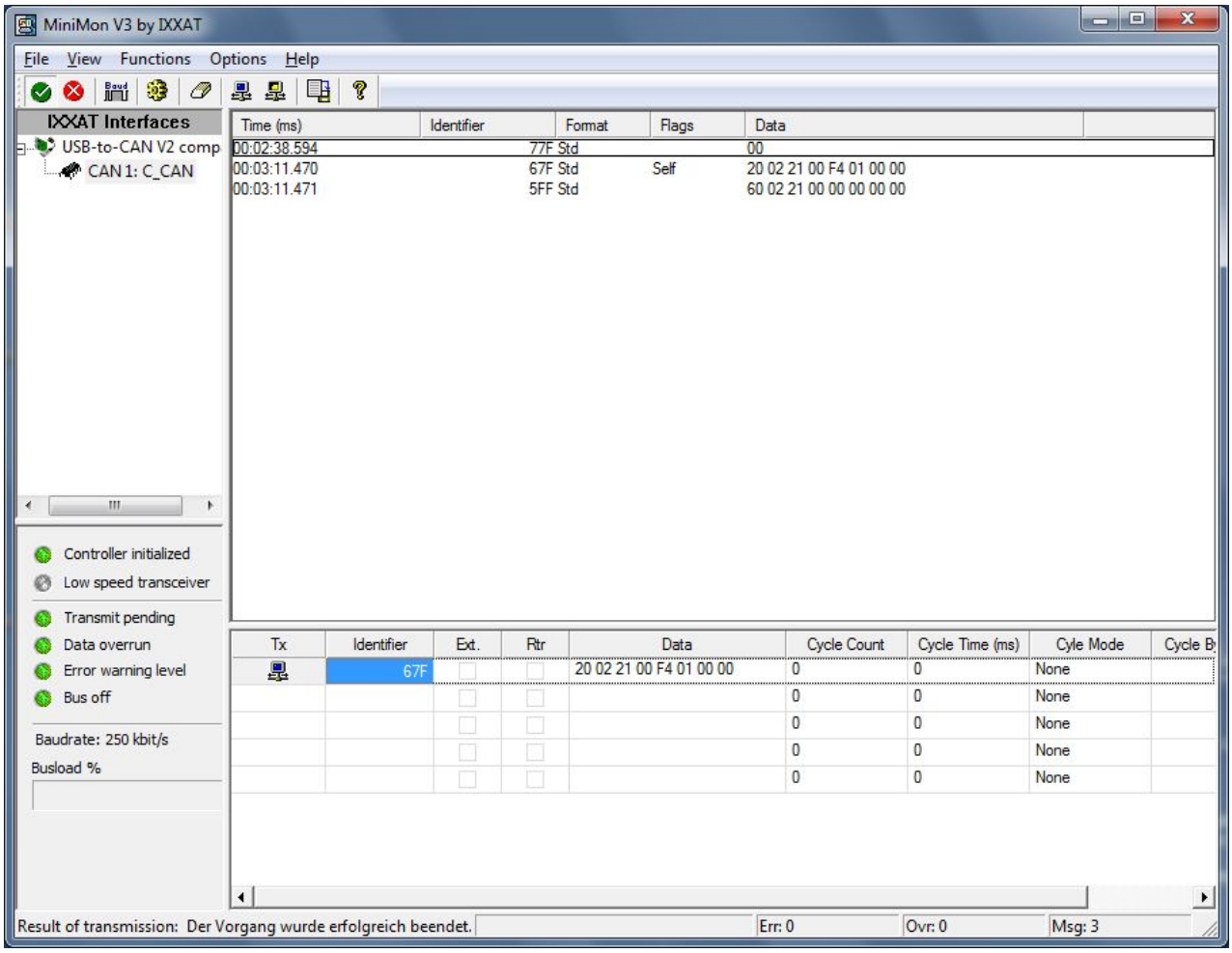
The default transmission type of the TPDOs provides ease of putting into operation without configuration work.

TPDO	Default COB-Id	Default Transmission Type
TPDO-1	Ch1 1FFh, Ch2 1FEh	Event Timer 100ms

CANopen example protocols

The example protocols are prepared using the USB-to-CAN Interface with CAN-Monitor „IXXAT“ (HMS Industrial Networks AB). The examples enable the user to configure and run the CANopen sensor from a host PC without using a CANopen master ECU.

CAN Monitor Screen



Example: boot up and change parameter

Time (ms)	Identifier	Format	Flags	Data
00:02:38.594	77F	Std		00
00:03:11.470	67F	Std	Self	20 02 21 00 F4 01 00 00
00:03:11.471	5FF	Std		60 02 21 00 00 00 00 00

After boot up (line 1) the filter (Object 2102-00) will be changed to 1F4h by an SDO message (line 2). The sensor sends a response message (line 3).

Example: change Node-ID

Time (ms)	Identifier	Format	Flags	Data
00:14:34.540	77F	Std		00
00:14:36.969	67F	Std	Self	2F 00 20 00 7E 00 00 00
00:14:36.970	5FF	Std		60 00 20 00 00 00 00 00
00:14:38.633	67F	Std	Self	23 10 10 01 73 61 76 65
00:14:38.637	5FF	Std		60 10 10 01 00 00 00 00
00:14:41.486	77E	Std		00

After boot up (line 1) the node-ID (2000h) will be changed from 7F to 7Eh by SDO (line 2, 3). The changed setting is stored nonvolatile by SDO "SAVE" (line 4). The sensor node-ID stays unchanged (Line5, 6) and will become valid on next power down - boot up cycle (line 6). Note: While the configurable parameters will become valid immediately node-ID and baud rate stay unchanged until the next power cycle.

Example: switch to operational

Time (ms)	Identifier	Format	Flags	Data
00:00:41.658	77F	Std		00
00:00:46.441	0	Std	Self	01 00
00:00:46.441	1FF	Std		2F 1A 00 00
00:00:46.542	1FF	Std		2F 1A 00 00
00:00:46.643	1FF	Std		2F 1A 00 00
00:00:46.743	1FF	Std		2F 1A 00 00
00:00:46.843	1FF	Std		2F 1A 00 00

After boot up (line 1) a "Start all Nodes" NMT message (line 2) will switch the sensor from pre-operational to operational starting transmission of the process data objects (lines 3...).

Example: change COB-ID of a TPDO

Time (ms)	Identi...	Format	Flags	Data
00:50:43.447	77F	Std		00
00:50:43.447	77E	Std		00
00:51:54.461	67F	Std	Self	23 00 18 01 00 00 00 80
00:51:54.463	5FF	Std		60 00 18 01 00 00 00 00
00:51:59.317	67F	Std	Self	23 00 18 01 81 01 00 00
00:51:59.319	5FF	Std		60 00 18 01 00 00 00 00

The example sequence shows boot up of node 7Fh in line 1. Write access is enabled be writing 80000000h to COB-ID object, Index 1800-1 (lines 3, 4). Next frame writes a new COB-ID 181h to Index 1800-1 (lines 5, 6).

Example: change transmission type of a TPDO

Time (ms)	Identi...	Format	Flags	Data
00:03:41.266	77F	Std		00
00:03:41.266	77E	Std		00
00:03:47.981	67F	Std	Self	23 00 18 01 00 00 00 80
00:03:47.983	5FF	Std		60 00 18 01 00 00 00 00
00:03:55.413	67F	Std	Self	2F 00 18 02 01 00 00 00
00:03:55.414	5FF	Std		60 00 18 02 00 00 00 00
00:04:02.309	67F	Std	Self	23 00 18 01 FF 01 00 00
00:04:02.311	5FF	Std		60 00 18 01 00 00 00 00

The example sequence shows boot up of node 7Fh in line 1. Write access is enabled be writing 80000000h to COB-ID object, Index 1800-1 (lines 3, 4). Next two frames write a new Transmission Type 1h to Index 1800-2 (lines 5, 6) and restore the COB-ID object, Index 1800-1 to its original value 1FFh (lines 7, 8).