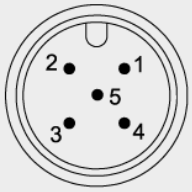
posihall®
Magnetic Multiturn Encoders

Output specification CANopen

MCANOP, CANOPR CANopen	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	1 kHz (asynchronous)
	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

Signal wiring
Connector M12, 5 pin



View to the sensor connector

Output signals	Connector pin no.	Cable color
Shield	1	brown
Excitation +	2	white
GND	3	blue
CAN-H	4	black
CAN-L	5	grey

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.

⚠ 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).

Process Data Message (TPDO)

Process data messages are broadcast messages. The structure of the 8 Byte data frame is product specific.

11-Bit CAN-Id	8 Byte data frame
PDO COB-Id	**Process Data**

← Sensor to Control Unit

180h + Node-Id	LSB	…					..	MSB

Format of Process Data Field

B0	B1	B2	B3	B4	B5	B6	B7
Position value							**Error Register**
LSB	...	...	MSB	reserved	reserved	reserved	Byte

TPDO 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).

Bit structure of object 1001, Error Register

b7	b6	b5	b4	b3	b2	b1	b0
							Generic

b0 Generic Error
0: No Error
1: Internal Error or Communication Error

Communication Profile CiA 301

Object	Index [hex]	Sub-index	Access	Type	Default	Value Range / Note
Device type	1000	0	ro	U32	80196h	encoder profile ‚406'
Error register	1001	0	ro	U8	0	
COB-ID-Sync	1005	0	rw	U32	80	
Manufacturer device name	1008	0	ro	String	-	
Manufacturer hardware version	1009	0	ro	String	-	
Manufacturer software version	100A	0	ro	String	-	
Guard time	100C	0	rw	U16	0	0 .. 7FFFh
Life time factor	100D	0	rw	U8	0	0 .. FFh
Save Settings	1010	1	w	U32	-	„save" (65766173h)[1]
Load Manufacturer Settings	1011	1	w	U32	-	„load" (64616F6Ch)[2]
COB-ID-EMCY	1014	0	ro	U32	FFh	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	-	
Identity Object Revision number		3	ro	U32	-	
Identity Object Serial number		4	ro	U32	-	
COB-ID Server->Client	1200	1	ro	U32	67Fh	SDO
COBID Client-> Sever	1200	2	ro	U32	5FFh	SDO
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
PDO2 COB-ID	1801	1	rw	U32	2FFh	281h .. 2FFh
PDO2 Transmission-Type		2	rw	U8	1	0 .. FFh
PDO2 Inhibit time		3	rw	U16	0	0 .. 7FFFh
PDO2 Event timer		5	rw	U16	0	0 .. 7FFFh
PDO4 COB-ID	1803	1	rw	U32	4FFh	381h .. 3FFh
PDO4 Transmission-Type		2	rw	U8	FEh	0 .. FFh
PDO4 Inhibit time		3	rw	U16	0	0 .. 7FFFh

PDO4 Event timer		5	rw	U16	0	0 .. 7FFFh
TPDO1-Mapped Object	1A00	1	ro	U32	60040020h	
TPDO2-Mapped Object	1A01	1	ro	U32	60040020h	
TPDO4-Mapped Object	1A03	1	ro	U32	63000108h	
NMT-Startup	1F80	0	rw	U32	0	0: OFF, 8: ON

1) “save”: LSB...MSB: 73h 61h 76h 65h

2) “load”: LSB...MSB: 6Ch 6Fh 61h 64h
Reload factory defaults does not affect Node-Id and Bit Rate

Device profile CiA 406

Parameter	Index [hex]	SubIndex [hex]	Read / Write	Type	Default	Range / Selection [Unit]
Control						
Node Address 1)	2000	0	rw	U8	7Fh	.. 7Fh
Bit Rate 1)	2010	0	rw	U8	4	125 … 1000 kBit/s 5 ... 0
Termination Resistor	2050	0	rw	U8	0	0=OFF, 1=ON
Filter Time Constant $T_{90\%}$ 4)	2102	0	rw	U16	0	0 .. 2^{16}-1 ms
Measurement						
Operating Parameters 3)	6000	0	rw	U16	0	
Total measuring range in measuring steps 2), 5)	6002	0	ro / rw	U32	10^5	10^3 ... 10^6
Preset value	6003	0	ro / rw	U32	0	0
Position value	6004	0	ro	S32	-	
Event Timer	6200	0	rw	U16	100	0..2^{16}-1 ms

1) Effective after "store parameters" and next power-up
2) Write access to Objects 6002 only when scaling function enabled (Object 6000, bit 2)
3) If Operating Parameters will be changed, Objects 6002, 6003 will reset to default values
4) Filter time constant T90% defined as 90% step response settling time
5) Setting resolution by object 6002 - example:
Desired resolution: 1°: Set object 6002 to 360° * 31 turns = **11160**
Desired resolution: 0.1°: Set object 6002 to 360° * 31 turns * 10 = **111600**

Operating Parameters (Object 6000)

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

md = 0/1 Measuring direction in / out
sfc = 0/1 Scaling function disabled/enabled

Process Data Object (TPDO) Mapping

TPDO	COB-Id	DLC	Data Frame Byte0 ... Byte7							
TPDO-01	180h +Node-Id	4	4 Byte Position Data							
			(LSB)	...	...	(MSB)				
TPDO-02	280h +Node-Id	4	4 Byte Position Data							
			(LSB)	...	...	(MSB)				
TPDO-04	480h +Node-Id	1	CAM State							

CAM State Data Format

8 Bit CAM State Register							
b7	b6	b5	b4	b3	b2	b1	b0
CAM 8	CAM 7	CAM 6	CAM 5	CAM 4	CAM 3	CAM 2	CAM 1

TPDO Default Settings

TPDO	Default COB-Id	Default Transmission Type
TPDO-01: Position Data, 4 Byte	1FFh	Event Timer 100ms (FE, T!=0)
TPDO-02: Position Data, 4 Byte	2FFh	Sync Mode
TPDO-04: CAM Status, 1 Byte	4FFh	Change of State Mode

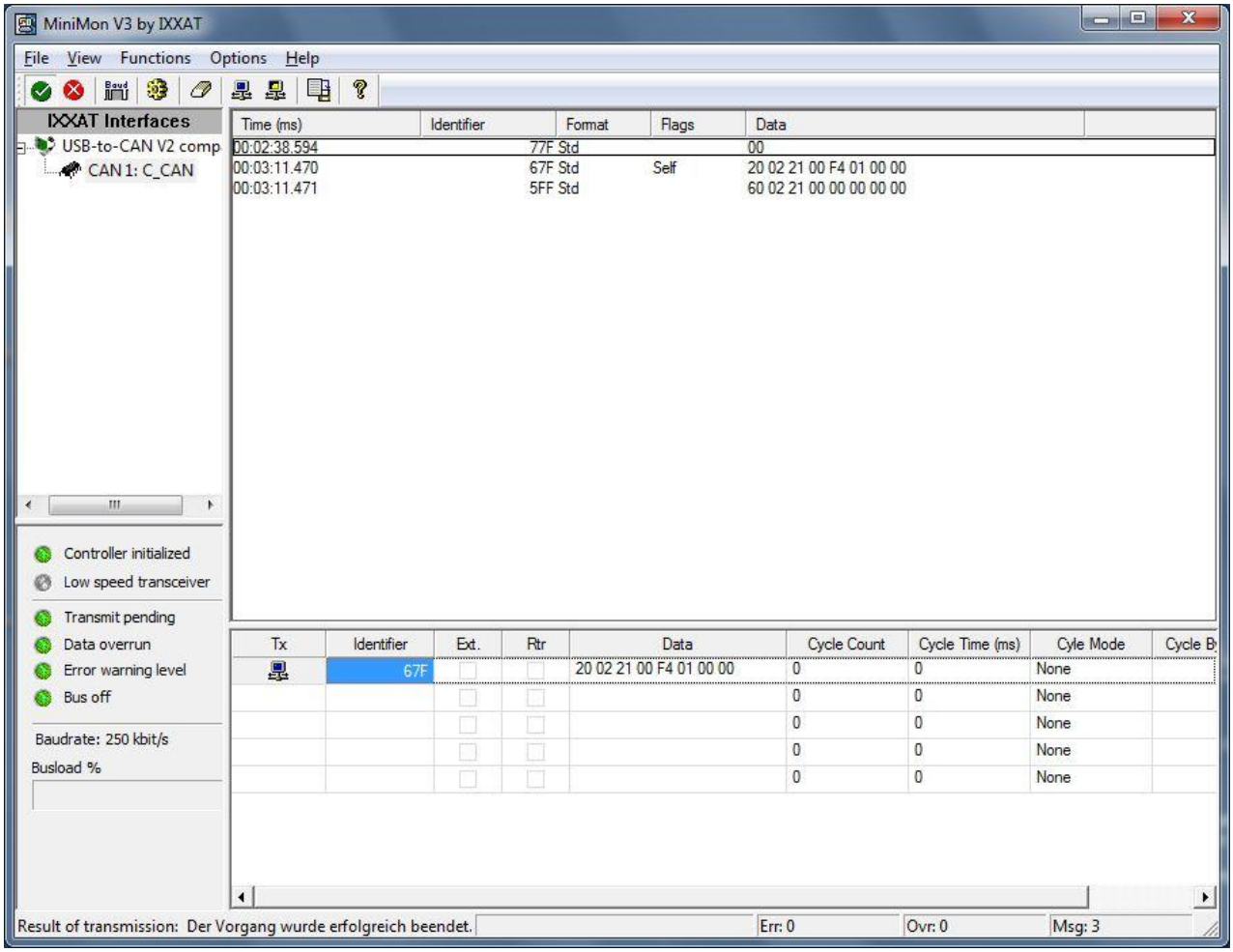
Baud Rate (Object 2010)

Baud Rate Index	Baud Rate [kbit/s]
0	1000
1	800
2	500
3	250
4	125
6	50

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).