positilt®-PTDM
Inclination Sensors

Output specifications
CANopen and SAE J1939
posilit®-PTDM
Inclination Sensors
Output specification CANopen

<table>
<thead>
<tr>
<th>CANopen CANopen</th>
<th>Communication profile</th>
<th>CANopen CiA 301 V 4.02, Slave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encoder profile</td>
<td>CiA 410 V 1.2, Profile „Inclinometer“</td>
<td></td>
</tr>
<tr>
<td>Configuration services</td>
<td>LSS, CiA Draft Standard 305 (Transmission rate, node ID)</td>
<td></td>
</tr>
<tr>
<td>Error Control</td>
<td>Node guarding, Heartbeat, Emergency message</td>
<td></td>
</tr>
<tr>
<td>Node ID</td>
<td>Adjustable via LSS or SDO, default: 127</td>
<td></td>
</tr>
<tr>
<td>PDO</td>
<td>1 TxPDO, 0 RxPDO, no linking, static mapping</td>
<td></td>
</tr>
<tr>
<td>PDO Modes</td>
<td>Event-/Time triggered, Remote-request, Sync cyclic/acyclic</td>
<td></td>
</tr>
<tr>
<td>SDO</td>
<td>1 Server, 0 Client</td>
<td></td>
</tr>
<tr>
<td>Certified</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Transmission rate</td>
<td>50 kBit … 1 Mbit, adjustable via LSS or SDO, default: 125 kBit</td>
<td></td>
</tr>
<tr>
<td>Bus connection</td>
<td>M12 connector, 5 pin</td>
<td></td>
</tr>
<tr>
<td>Bus with integrated terminating resistance</td>
<td>optional</td>
<td></td>
</tr>
<tr>
<td>Bus, galvanic isolated</td>
<td>no</td>
<td></td>
</tr>
</tbody>
</table>

**Specifications**

| | Excitation voltage | 8 ... 36 V DC |
| | Excitation current | 15 mA typical at 24 V DC 30 mA typical at 12 V DC 100 mA max. |
| | Measuring rate | 1 kHz (standard) |
| | Stability (temperature) | ±100 x 10⁻⁶ / °C f.s. |
| | Repeatability | 1 LSB |
| | Operating temperature | -40 ... +85 °C |
| | Protection | Reverse polarity, short circuit |
| | EMC | DIN EN 61326-1:2013 |

**Signal wiring**

**Connector M12, 5 pin**

<table>
<thead>
<tr>
<th>Output signals</th>
<th>Connector pin no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shield</td>
<td>1</td>
</tr>
<tr>
<td>Excitation +</td>
<td>2</td>
</tr>
<tr>
<td>GND</td>
<td>3</td>
</tr>
<tr>
<td>CAN-H</td>
<td>4</td>
</tr>
<tr>
<td>CAN-L</td>
<td>5</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>11-Bit CAN-id</th>
<th>8 Byte data frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDO COB-id</td>
<td>CS</td>
</tr>
</tbody>
</table>

→ Request: Control Unit to Sensor

600h + Node-id

<table>
<thead>
<tr>
<th>580h + Node-id</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte</td>
</tr>
</tbody>
</table>

← Response: Sensor to Control Unit

<table>
<thead>
<tr>
<th>580h + Node-id</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte</td>
</tr>
</tbody>
</table>

**SDO - Download Protocol**

<table>
<thead>
<tr>
<th>8 Byte data frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
</tr>
</tbody>
</table>

→ Request: Control Unit to Sensor

ccs

<table>
<thead>
<tr>
<th>scs</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSB</td>
</tr>
</tbody>
</table>

← Response: Sensor to Control Unit

<table>
<thead>
<tr>
<th>sscs</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSB</td>
</tr>
</tbody>
</table>

**Bit structure of command specifier CS:**

<table>
<thead>
<tr>
<th>b7</th>
<th>b6</th>
<th>b5</th>
<th>b4</th>
<th>b3</th>
<th>b2</th>
<th>b1</th>
<th>b0</th>
</tr>
</thead>
</table>

→ Request: Control Unit to Sensor

ccs: X n e s

← Response: Sensor to Control Unit

sscs: X

ccs: control unit command specifier, ccs = 1 (⇒ CS₈ = 2Fh, CS₁₆ = 2Bh, CS₃₂ = 23h)

sscs: sensor command specifier, sscs = 3 (⇒ CS = 60h)

X: reserved

e: expedited transfer e = 1

s: data set size = 1

n: number of bytes which do not contain data
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Output specification CANopen

SDO - Upload Protocol

<table>
<thead>
<tr>
<th></th>
<th>Index</th>
<th>Sub-Index</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

→ Request: Control Unit to Sensor

|     |       |          |      |
| scs | LSB   | MSB      | Byte |
|     |       |          |      |

← Response: Sensor to Control Unit

|     |       |          |      |
| ccs | LSB   | MSB      | Byte |
|     |       |          |      |

8 Byte data frame

Bit structure of command specifier CS:

<table>
<thead>
<tr>
<th>b7</th>
<th>b6</th>
<th>b5</th>
<th>b4</th>
<th>b3</th>
<th>b2</th>
<th>b1</th>
<th>b0</th>
</tr>
</thead>
</table>

→ Request: Control Unit to Sensor

|     |       |
| scs | X    |
|     |      |

← Response: Sensor to Control Unit

|     |       |          |      |
| ccs | X     | n        | e    |
|     |       |          |      |

ccs: control unit command specifier, ccs = 2 (=> CS = 40h)
scs: sensor command specifier, scs = 2 (=> CS8 = 4Fh, CS16 = 4Bh, CS32 = 43h)
X: reserved
e: expedited transfer e = 1
s: data set size = 1
n: number of bytes which do not contain data
SOO - Abort Peer-to-Peer-Protocol

<table>
<thead>
<tr>
<th>8 Byte data frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
</tr>
</tbody>
</table>

→ Response: Control Unit or Sensor

<table>
<thead>
<tr>
<th>cs</th>
<th>LSB</th>
<th>MSB</th>
<th>Byte</th>
<th>Abort Code</th>
</tr>
</thead>
</table>

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

<table>
<thead>
<tr>
<th>Abort Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0601 0001h</td>
<td>Attempt to read a write only object.</td>
</tr>
<tr>
<td>0601 0002h</td>
<td>Attempt to write a read only object.</td>
</tr>
<tr>
<td>0602 0000h</td>
<td>Object does not exist in the object dictionary.</td>
</tr>
<tr>
<td>0604 0043h</td>
<td>General parameter incompatibility</td>
</tr>
<tr>
<td>0607 0012h</td>
<td>Data type does not match, length of service parameter too high</td>
</tr>
<tr>
<td>0607 0013h</td>
<td>Data type does not match, length of service parameter too low</td>
</tr>
<tr>
<td>0609 0030h</td>
<td>Value range of parameter exceeded (only for write access).</td>
</tr>
</tbody>
</table>
Process Data Message (TPDO)
Process data messages are broadcast messages. The structure of the 8 Byte data frame is product specific.

<table>
<thead>
<tr>
<th>11-Bit CAN-id</th>
<th>8 Byte data frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDO COB-id</td>
<td>Process Data</td>
</tr>
</tbody>
</table>

← Sensor to Control Unit
180h + Node-id   LSB ... ... MSB

Format of Process Data Field

<table>
<thead>
<tr>
<th>B0</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>B5</th>
<th>B6</th>
<th>B7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSB</td>
<td>...</td>
<td>...</td>
<td>MSB</td>
<td>reserved</td>
<td>reserved</td>
<td>reserved</td>
<td>Byte</td>
</tr>
</tbody>
</table>

Bit structure of object 1001, Error Register

<table>
<thead>
<tr>
<th>b7</th>
<th>b6</th>
<th>b5</th>
<th>b4</th>
<th>b3</th>
<th>b2</th>
<th>b1</th>
<th>b0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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.

<table>
<thead>
<tr>
<th>Transmission type example for TPDO-1</th>
<th>COB-id 1800-1</th>
<th>Transmission Type 1800-2</th>
<th>Inhibit Time 1800-3</th>
<th>Event Timer [ms] 1800-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event Timer Driven</td>
<td>1FFh</td>
<td>FEh</td>
<td>0 ... FFFFh</td>
<td>0 ... FFFFh</td>
</tr>
<tr>
<td>Cyclic Synchronous</td>
<td>1FFh</td>
<td>N = 1 ... F0h</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TPDO Disable</td>
<td>80 00 xx xx</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TPDO Enable</td>
<td>00 00 xx xx</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

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 CiA 301

<table>
<thead>
<tr>
<th>Object</th>
<th>Index [hex]</th>
<th>Sub-index</th>
<th>Access</th>
<th>Type</th>
<th>Default</th>
<th>Value Range / Note [time spec in ms]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device type</td>
<td>1000</td>
<td>0</td>
<td>ro</td>
<td>U32</td>
<td>2019Ah</td>
<td>inclinometer profile, 410</td>
</tr>
<tr>
<td>Error register</td>
<td>1001</td>
<td>0</td>
<td>ro</td>
<td>U8</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>COB-ID-Sync</td>
<td>1005</td>
<td>0</td>
<td>rw</td>
<td>U32</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Manufacturer device name</td>
<td>1008</td>
<td>0</td>
<td>ro</td>
<td>String</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Manufacturer hardware version</td>
<td>1009</td>
<td>0</td>
<td>ro</td>
<td>String</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Manufacturer software version</td>
<td>100A</td>
<td>0</td>
<td>ro</td>
<td>String</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Guard time</td>
<td>100C</td>
<td>0</td>
<td>rw</td>
<td>U16</td>
<td>0</td>
<td>0 .. 7FFFh</td>
</tr>
<tr>
<td>Life time factor</td>
<td>100D</td>
<td>0</td>
<td>rw</td>
<td>U8</td>
<td>0</td>
<td>0 .. FFh</td>
</tr>
<tr>
<td>Save Settings</td>
<td>1010</td>
<td>1</td>
<td>w</td>
<td>U32</td>
<td>-</td>
<td>„save“ 65766173h</td>
</tr>
<tr>
<td>Load Manufacturer Settings</td>
<td>1011</td>
<td>1</td>
<td>w</td>
<td>U32</td>
<td>-</td>
<td>„load“ 64616F6Ch*)</td>
</tr>
<tr>
<td>COB-ID-EMCY</td>
<td>1014</td>
<td>0</td>
<td>ro</td>
<td>U32</td>
<td>FFh</td>
<td>NodeID+80h</td>
</tr>
<tr>
<td>Producer heartbeat time</td>
<td>1017</td>
<td>0</td>
<td>rw</td>
<td>U16</td>
<td>0</td>
<td>0 .. 7FFFh</td>
</tr>
<tr>
<td>Identity Object VendorID</td>
<td>1018</td>
<td>1</td>
<td>ro</td>
<td>U32</td>
<td>252h</td>
<td></td>
</tr>
<tr>
<td>Identity Object Product Code</td>
<td>2</td>
<td>ro</td>
<td>U32</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identity Object Revision number</td>
<td>3</td>
<td>ro</td>
<td>U32</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identity Object Serial number</td>
<td>4</td>
<td>ro</td>
<td>U32</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COB-ID Server-&gt;Client</td>
<td>1200</td>
<td>1</td>
<td>ro</td>
<td>U32</td>
<td>67Fh</td>
<td>SOD</td>
</tr>
<tr>
<td>COBID Client-&gt; Sever</td>
<td>1200</td>
<td>2</td>
<td>ro</td>
<td>U32</td>
<td>5FFh</td>
<td>SDO</td>
</tr>
<tr>
<td>PDO1 COB-ID</td>
<td>1800</td>
<td>1</td>
<td>rw</td>
<td>U32</td>
<td>1FFh</td>
<td>181h .. 1FFh</td>
</tr>
<tr>
<td>PDO1 Transmission-Type</td>
<td>2</td>
<td>rw</td>
<td>U8</td>
<td>FFeH</td>
<td>0 .. FFh</td>
<td></td>
</tr>
<tr>
<td>PDO1 Inhibit time</td>
<td>3</td>
<td>rw</td>
<td>U16</td>
<td>0</td>
<td>0 .. 7FFFh</td>
<td></td>
</tr>
<tr>
<td>PDO1 Event timer</td>
<td>5</td>
<td>rw</td>
<td>U16</td>
<td>0</td>
<td>0 .. 7FFFh</td>
<td></td>
</tr>
<tr>
<td>TPDO1-Mapped Object 1</td>
<td>1A00</td>
<td>1</td>
<td>ro</td>
<td>U32</td>
<td>60100010h</td>
<td></td>
</tr>
<tr>
<td>TPDO1-Mapped Object 2</td>
<td>2</td>
<td>ro</td>
<td>U32</td>
<td>60200010h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NMT-Startup</td>
<td>1F80</td>
<td>0</td>
<td>rw</td>
<td>U32</td>
<td>0</td>
<td>0,8</td>
</tr>
</tbody>
</table>

*) Reload factory defaults does not affect Node-Id
# Device Profile

<table>
<thead>
<tr>
<th>Object</th>
<th>Index [hex]</th>
<th>Sub-index</th>
<th>Access</th>
<th>Type</th>
<th>Default</th>
<th>Value Range / Note</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturer specific</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Node-ID</td>
<td>2000</td>
<td></td>
<td>rw</td>
<td>127</td>
<td>1...127</td>
<td></td>
</tr>
<tr>
<td>Bitrate</td>
<td>2010</td>
<td></td>
<td>rw</td>
<td>4</td>
<td>0..4, 6</td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>2030</td>
<td></td>
<td>ro</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hysteresis</td>
<td>2040</td>
<td></td>
<td>rw</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus termination</td>
<td>2050</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td>0: OFF, 1: ON (PTDM27 only)</td>
</tr>
<tr>
<td>Filter (N_{Filter})</td>
<td></td>
<td>2102</td>
<td>rw</td>
<td>0*</td>
<td></td>
<td>0 ... 65535</td>
</tr>
<tr>
<td>Response Time (90%): T_{R} = N_{Filter} \times 5 ms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Inclinometer CiA410**       |             |           |        |      |         |                   |
| Resolution (in 0,001°)        | 6000        |           | rw     | 100  | 10 ... 10000 |                   |
| Slope long16 inclination angle round x axis | 6010 | | | | |
| Oper. parameters slope long16, 1 or 2 axes | 6011 | | 0 | | |
| Slope long16 preset value     | 6012        |           |       | 0    |         |                   |
| Slope lateral16 inclination angle round y axis | 6020 | | | | |
| Oper. parameters slope lateral16, 2nd axis | 6021 | | 0 | | |
| Slope lateral16 preset value  | 6022        |           |       | 0    |         |                   |

*) Preconfigured to 16

## Operating Parameters Bit Code

<table>
<thead>
<tr>
<th>7</th>
<th>...</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>m</td>
<td></td>
<td>s</td>
<td>cs</td>
<td></td>
</tr>
</tbody>
</table>

| m = 0/1 | operating mode: 1 axis x ±180°/2 axes x,y ±60° |
| s = 0/1 | Scaling function enabled/disabled |
| cs = 0/1| Code sequence CW/CCW |
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Output specification CANopen

Baud Rate (Object 2010)

<table>
<thead>
<tr>
<th>Baud Rate Index</th>
<th>Baud Rate [kbit/s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1000</td>
</tr>
<tr>
<td>1</td>
<td>800</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
</tr>
<tr>
<td>3</td>
<td>250</td>
</tr>
<tr>
<td>4</td>
<td>125</td>
</tr>
</tbody>
</table>

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

[CAN Monitor Screen Image]
Example: boot up and change parameter

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

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

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

```
<table>
<thead>
<tr>
<th>Time (ms)</th>
<th>Identifier</th>
<th>Format</th>
<th>Flags</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:50:43.447</td>
<td>77F Std</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>00:50:43.447</td>
<td>77E Std</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>00:51:54.461</td>
<td>67F Std</td>
<td></td>
<td>Self</td>
<td>23 00 18 01 00 00 00 80</td>
</tr>
<tr>
<td>00:51:54.463</td>
<td>5FF Std</td>
<td></td>
<td>Self</td>
<td>60 00 18 01 00 00 00 00</td>
</tr>
<tr>
<td>00:51:59.317</td>
<td>67F Std</td>
<td></td>
<td>Self</td>
<td>23 00 18 01 81 01 00 00</td>
</tr>
<tr>
<td>00:51:59.319</td>
<td>5FF Std</td>
<td></td>
<td>Self</td>
<td>60 00 18 01 00 00 00 00</td>
</tr>
</tbody>
</table>
```

The example sequence shows boot up of node 7Fh in line 1. Write access is enabled by 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

```
<table>
<thead>
<tr>
<th>Time (ms)</th>
<th>Identifier</th>
<th>Format</th>
<th>Flags</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:03:41.266</td>
<td>77F Std</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>00:03:41.266</td>
<td>77E Std</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>00:03:47.981</td>
<td>67F Std</td>
<td></td>
<td>Self</td>
<td>23 00 18 01 00 00 00 80</td>
</tr>
<tr>
<td>00:03:47.983</td>
<td>5FF Std</td>
<td></td>
<td>Self</td>
<td>60 00 18 01 00 00 00 00</td>
</tr>
<tr>
<td>00:03:55.413</td>
<td>67F Std</td>
<td></td>
<td>Self</td>
<td>2F 00 18 02 01 00 00 00</td>
</tr>
<tr>
<td>00:03:55.414</td>
<td>5FF Std</td>
<td></td>
<td>Self</td>
<td>60 00 18 02 00 00 00 00</td>
</tr>
<tr>
<td>00:04:02.309</td>
<td>67F Std</td>
<td></td>
<td>Self</td>
<td>23 00 18 01 FF 01 00 00</td>
</tr>
<tr>
<td>00:04:02.311</td>
<td>5FF Std</td>
<td></td>
<td>Self</td>
<td>60 00 18 01 00 00 00 00</td>
</tr>
</tbody>
</table>
```

The example sequence shows boot up of node 7Fh in line 1. Write access is enabled by 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).
## positilt®-PTDM

**Inclination Sensors**

**Output specification SAE J1939**

<table>
<thead>
<tr>
<th>CANJ1939 SAE J1939</th>
<th>CAN specification</th>
<th>ISO 11898, Basic and Full CAN 2.0 B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transceiver</td>
<td>24V-compliant, not isolated</td>
</tr>
<tr>
<td></td>
<td>Communication profile</td>
<td>SAE J1939</td>
</tr>
<tr>
<td></td>
<td>Transmission rate</td>
<td>250 kbit/s</td>
</tr>
<tr>
<td></td>
<td>Address</td>
<td>Default 247d, configurable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NAME Fields</th>
<th>Arbitrary address capable</th>
<th>1</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry group</td>
<td>0</td>
<td>0</td>
<td>Global</td>
</tr>
<tr>
<td>Vehicle system</td>
<td>7Fh (127d)</td>
<td>0</td>
<td>Non specific</td>
</tr>
<tr>
<td>Vehicle system instance</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td>FFh (255d)</td>
<td>0</td>
<td>Non specific</td>
</tr>
<tr>
<td>Function instance</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECU instance</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturer</td>
<td>145h (325d)</td>
<td>0</td>
<td>Manufacturer ID</td>
</tr>
<tr>
<td>Identity number</td>
<td>0nnn</td>
<td></td>
<td>Serial number 21 bit</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter Group Numbers (PGN)</th>
<th>Configuration data</th>
<th>PGN EF00h</th>
<th>Proprietary-A (PDU1 peer-to-peer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process data</td>
<td>PGN FFnnh</td>
<td></td>
<td>Proprietary-B (PDU2 broadcast); nn Group Extension (PS) configurable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Excitation voltage</th>
<th>8 ... 36 V DC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Excitation current</td>
<td>15 mA typical at 24 V DC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 mA typical at 12 V DC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100 mA max.</td>
</tr>
<tr>
<td>Measuring rate</td>
<td>1 kHz (standard)</td>
<td></td>
</tr>
<tr>
<td>Stability (temperature)</td>
<td>±100 x 10⁻⁶ / °C f.s.</td>
<td></td>
</tr>
<tr>
<td>Repeatability</td>
<td>1 LSB</td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-40 … +85 °C</td>
<td></td>
</tr>
<tr>
<td>Protection</td>
<td>Reverse polarity, short circuit</td>
<td></td>
</tr>
<tr>
<td>EMV</td>
<td>DIN EN 61326-1:2013</td>
<td></td>
</tr>
</tbody>
</table>
### Output specification SAE J1939

**Signal wiring**

**Connector M12, 5 pin**

- View to the sensor connector

<table>
<thead>
<tr>
<th>Output signals</th>
<th>Connector pin no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shield</td>
<td>1</td>
</tr>
<tr>
<td>Excitation +</td>
<td>2</td>
</tr>
<tr>
<td>GND</td>
<td>3</td>
</tr>
<tr>
<td>CAN-H</td>
<td>4</td>
</tr>
<tr>
<td>CAN-L</td>
<td>5</td>
</tr>
</tbody>
</table>

**Diagram of Connector M12, 5 pin**

[Diagram of Connector M12, 5 pin]

www.asm-sensor.com
Overview Boot-Up, User Configuration, Process Data
Address Claiming (Single Address capable device)
On power up the sensor claims a Node Address by sending an Address Claimed message which contains
the NAME as a unique identifier. Should another device claim the same address the device having the
NAME with a lower priority will send Cannot Claim Address and stay passive.

User configuration
User accessible parameters are configurable by peer-to-peer proprietary-A message (PGN EF00h). The
configuration parameters are accessed by a standard message format. The Node Address is configurable
either by Commanded Address or by peer-to-peer proprietary-A message. A new address set by peer-to-
peer proprietary-A message will be effective not before next power up. A new address set by Commanded
Address will be effective immediately and an Address Claimed message will be sent. On execution of Store
Parameters, the configuration is saved nonvolatile.

Process Data
Process Data are transmitted cyclic by Broadcast PGN FFnh on power up after successful address
claiming. The cycle time and the Group Extension Byte nn (PS) are user configurable.

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!

Peer-to-peer message (PGN 0x00EF00), send/receive format

<table>
<thead>
<tr>
<th>PGN</th>
<th>8 Byte data frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGNHIGH</td>
<td>PGNLOW (Node-ID)</td>
</tr>
</tbody>
</table>

Request: Control Unit → Sensor
→ 0EFh dd i 0/1 0 0 LSB .. .. MSB

Response: Control Unit ← Sensor
← 0EFh cc i 0/1 0 a LSB .. .. MSB

a: Acknowledge codes:
0: Acknowledge, 81: Read only parameter, 82: Range overflow,
83: Range underflow, 84: Parameter does not exist

dd: Sensor Node-ID (Default 0F7h, 247d)
cc: Control-Unit Node-ID

www.asm-sensor.com
Configuration examples

Example: Set Transmit Cycle to 10ms, Index 31, Node-ID 247d (F7h)

<table>
<thead>
<tr>
<th>PGN&lt;sub&gt;HIGH&lt;/sub&gt;</th>
<th>PGN&lt;sub&gt;LOW&lt;/sub&gt;</th>
<th>8 Byte data frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>0EFh</td>
<td>F7h</td>
<td>1Fh 01h 00 00 0Ah 00 00 00</td>
</tr>
<tr>
<td>0EFh</td>
<td>cc</td>
<td>1Fh 01h 00 00 0Ah 00 00 00</td>
</tr>
</tbody>
</table>

Example: Read Transmit Cycle value, Index 31

<table>
<thead>
<tr>
<th>PGN&lt;sub&gt;HIGH&lt;/sub&gt;</th>
<th>PGN&lt;sub&gt;LOW&lt;/sub&gt;</th>
<th>8 Byte data frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>0EFh</td>
<td>F7h</td>
<td>1Fh 00 00 00 00 00 00 00 00</td>
</tr>
<tr>
<td>0EFh</td>
<td>cc</td>
<td>1Fh 00 00 00 00 0Ah 00 00 00</td>
</tr>
</tbody>
</table>

Example: Store Parameters permanently, Index 28

<table>
<thead>
<tr>
<th>PGN&lt;sub&gt;HIGH&lt;/sub&gt;</th>
<th>PGN&lt;sub&gt;LOW&lt;/sub&gt;</th>
<th>8 Byte data frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>0EFh</td>
<td>F7h</td>
<td>1Ch 01h 00 00 65h 76h 61h 73h</td>
</tr>
<tr>
<td>0EFh</td>
<td>cc</td>
<td>1Ch 01h 00 00 65h 76h 61h 73h</td>
</tr>
</tbody>
</table>

Reload factory defaults, Index 29

<table>
<thead>
<tr>
<th>PGN&lt;sub&gt;HIGH&lt;/sub&gt;</th>
<th>PGN&lt;sub&gt;LOW&lt;/sub&gt;</th>
<th>8 Byte data frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>0EFh</td>
<td>F7h</td>
<td>1Dh 01h 00 00 64h 61h 6Fh 6Ch</td>
</tr>
<tr>
<td>0EFh</td>
<td>cc</td>
<td>1Dh 01h 00 00 64h 61h 6Fh 6Ch</td>
</tr>
</tbody>
</table>

Example: Broadcast (PGN<sub>Low</sub> = 0FFh - Reload factory defaults of all sensors, Index 29

<table>
<thead>
<tr>
<th>PGN&lt;sub&gt;HIGH&lt;/sub&gt;</th>
<th>PGN&lt;sub&gt;LOW&lt;/sub&gt;</th>
<th>8 Byte data frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>0EFh</td>
<td>0FFh</td>
<td>1Dh 01h 00 00 64h 61h 6Fh 6Ch</td>
</tr>
<tr>
<td>0EFh</td>
<td>cc</td>
<td>1Dh 01h 00 00 64h 61h 6Fh 6Ch</td>
</tr>
</tbody>
</table>
### Configurable parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Index [hex]</th>
<th>Sub-Index [hex]</th>
<th>Read / Write</th>
<th>Type</th>
<th>Default</th>
<th>Range / Selection [Unit]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store parameters</td>
<td>1010</td>
<td>1</td>
<td>wo 2)</td>
<td>U32</td>
<td>-</td>
<td>“save”</td>
</tr>
<tr>
<td>Reload factory defaults</td>
<td>1011</td>
<td>1</td>
<td>wo 2)</td>
<td>U32</td>
<td>-</td>
<td>“load”</td>
</tr>
<tr>
<td>Node Address</td>
<td>2000</td>
<td>0</td>
<td>rw 1)</td>
<td>U8</td>
<td>F7h</td>
<td>80h..F7h</td>
</tr>
<tr>
<td>PGN Group Extension (PS)</td>
<td>2001</td>
<td>0</td>
<td>rw</td>
<td>U8</td>
<td>0</td>
<td>0..255</td>
</tr>
<tr>
<td>Bit Rate</td>
<td>2010</td>
<td>0</td>
<td>ro</td>
<td>U8</td>
<td>3</td>
<td>250 kBit/s</td>
</tr>
<tr>
<td>Termination Resistor</td>
<td>2050</td>
<td>0</td>
<td>rw</td>
<td>U8</td>
<td>0</td>
<td>0=OFF, 1=ON</td>
</tr>
<tr>
<td>Mounting Option 5)</td>
<td>2110</td>
<td>0</td>
<td>rw</td>
<td>U8</td>
<td>1</td>
<td>1=2A, 2=2B, 3=2C</td>
</tr>
<tr>
<td>Low Pass Output Filter</td>
<td>2103</td>
<td>0</td>
<td>rw</td>
<td>U16</td>
<td>0</td>
<td>0 ... 65535</td>
</tr>
<tr>
<td><strong>Measurement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resolution (in steps of 0.001°)</td>
<td>6000</td>
<td>0</td>
<td>rw</td>
<td>U16</td>
<td>10</td>
<td>10, 100, 1000</td>
</tr>
<tr>
<td>Slope long16 inclination angle round x axis</td>
<td>6010</td>
<td>0</td>
<td>ro</td>
<td>I16</td>
<td>no</td>
<td>-180 ... +180 [°]</td>
</tr>
<tr>
<td>Operating parameters 1)</td>
<td>6011</td>
<td>0</td>
<td>ro / rw 3)</td>
<td>U8</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Slope long16 preset value</td>
<td>6012</td>
<td>0</td>
<td>rw</td>
<td>I16</td>
<td>0</td>
<td>-180 ... +180 [°]</td>
</tr>
<tr>
<td>Slope lat16 inclination angle round y axis</td>
<td>6020</td>
<td>0</td>
<td>ro</td>
<td>I16</td>
<td>no</td>
<td>-180 ... +180 [°]</td>
</tr>
<tr>
<td>Operating parameters 1)</td>
<td>6021</td>
<td>0</td>
<td>ro / rw 3)</td>
<td>U8</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Slope lat16 preset value</td>
<td>6022</td>
<td>0</td>
<td>rw</td>
<td>I16</td>
<td>0</td>
<td>-180 ... +180 [°]</td>
</tr>
<tr>
<td>Cyclic timer</td>
<td>6200</td>
<td>0</td>
<td>rw</td>
<td>U16</td>
<td>100</td>
<td>0..2^{16}-1 ms</td>
</tr>
<tr>
<td><strong>Identification</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SW Version</td>
<td>2F05</td>
<td>0</td>
<td>ro</td>
<td>U32</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Serial number</td>
<td>2F00, 2F01</td>
<td>0</td>
<td>ro</td>
<td>U32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identity Number</td>
<td>2002</td>
<td>0</td>
<td>ro</td>
<td>U32</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

1) Effective after "store parameters" and next power-up
2) "save": LSB...MSB: 73h 61h 76h 65h
   "load": LSB...MSB: 6Ch 6Fh 61h 64h
3) Reload factory defaults does not affect Node-Id and Bit Rate
4) Write access to objects 6012, 6022 only when scaling function enabled (Object 6011, 6021)
5) See Table below
6) Set preset to 0 for both axes while the sensor is in the new zero-position
Inclination Sensors
Output specification SAE J1939

Bit structure of object 6011, 6021, operating parameters:

<table>
<thead>
<tr>
<th>Bit7</th>
<th>Bit6</th>
<th>Bit5</th>
<th>Bit5</th>
<th>Bit4</th>
<th>Bit3</th>
<th>Bit2</th>
<th>Bit1</th>
</tr>
</thead>
<tbody>
<tr>
<td>ms</td>
<td>r</td>
<td>s</td>
<td>i</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

i  Slope Inversion
0: slope inversion disabled
1: slope inversion enabled

s  Scaling Enable
0: scaling disabled
1: scaling enabled

r  reserved

ms  Manufacturer specific
SAE J1939 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: Address-Claiming and Change Parameter

<table>
<thead>
<tr>
<th>Time (ms)</th>
<th>Identifier</th>
<th>Format</th>
<th>Flags</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:30:12.461</td>
<td>18EFFFF6 Ext</td>
<td>00 00 B2 28 00 FF FE 00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00:30:13.815</td>
<td>1CEFF600 Ext</td>
<td>Self</td>
<td>2B 02 21 00 F4 01 00 00</td>
<td></td>
</tr>
<tr>
<td>00:30:13.821</td>
<td>1CEFF00F6 Ext</td>
<td>60 02 21 00 00 00 00 00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After boot up the sensor claims address F6h by "Address Claim" message (line 1). The filter (Object 2102-00) will be changed to 1F4h by a configuration message (line 2) and the sensors sends a response message (line 3).

Example: Change Node-ID

<table>
<thead>
<tr>
<th>Time (ms)</th>
<th>Identifier</th>
<th>Format</th>
<th>Flags</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:33:31.336</td>
<td>18EFFFF6 Ext</td>
<td>00 00 B2 28 00 FF FE 00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00:33:32.195</td>
<td>1CEFF600 Ext</td>
<td>Self</td>
<td>2F 00 20 00 F4 00 00 00</td>
<td></td>
</tr>
<tr>
<td>00:33:32.196</td>
<td>1CEFF600 Ext</td>
<td>60 00 20 00 00 00 00 00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00:33:33.459</td>
<td>1CEFF600 Ext</td>
<td>Self</td>
<td>23 10 10 01 73 61 76 65</td>
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</tr>
<tr>
<td>00:33:33.475</td>
<td>1CEFF600 Ext</td>
<td>60 10 10 01 00 00 00 00</td>
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<td></td>
</tr>
<tr>
<td>00:33:34.670</td>
<td>18EFFFF4 Ext</td>
<td>00 00 B2 28 00 FF FE 00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After boot up and address claim (line 1) the node-ID (2000h) will be changed from F6h to F4h (line 2, 3). The changed setting is stored nonvolatile by "SAVE" (line 4, 5). The sensor node-ID stays unchanged (Line 5, 6) and will become valid on next power 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: Autostart

<table>
<thead>
<tr>
<th>Time (ms)</th>
<th>Identifier</th>
<th>Format</th>
<th>Flags</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:21:20.412</td>
<td>18EFFFF6 Ext</td>
<td>00 00 B2 28 00 FF FE 00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00:21:20.605</td>
<td>18FF00F6 Ext</td>
<td>59 00 00 00 00 00 00 80</td>
<td></td>
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</tr>
<tr>
<td>00:21:20.805</td>
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<td>ED 3F 00 00 00 00 00 80</td>
<td></td>
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<tr>
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<td>18FF00F6 Ext</td>
<td>0C 00 00 00 00 00 00 80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00:21:21.205</td>
<td>18FF00F6 Ext</td>
<td>F0 3E 00 00 00 00 00 80</td>
<td></td>
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<td>0B 00 00 00 00 00 00 80</td>
<td></td>
<td></td>
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<tr>
<td>00:21:21.605</td>
<td>18FF00F6 Ext</td>
<td>84 00 00 00 00 00 00 80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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