# TMI CANopen Gebrauchsanleitung
# TMI CANopen Instructions for Use

novotechnik
Siedle Gruppe

## 1 Allgemeine Beschreibung

Magnetostriktive Wegaufnehmer für direkte, genaue und absolute Messung von Wegen bzw. Längen in der Steuerungs-, Regelungs- und Messtechnik.

## 2 Sicherheitshinweise

### 2.1 Bestimmungsgemäße Verwendung

Der Wegaufnehmer TMI wird zu seiner Verwendung in eine Maschine oder Anlage eingebaut. Er bildet zusammen mit einer Steuerung ein Wegmesssystem und darf auch nur für diese Aufgabe eingesetzt werden.
Bei unbefugten Eingriffen, unzulässiger Anwendung oder Nichtbeachtung der Montagehinweise kommt es zum Verlust von Garantie- und Haftungsansprüchen.

### 2.2 Installation und Inbetriebnahme

Der Wegaufnehmer ist nur von Fachpersonal und unter Berücksichtigung aller geltenden Sicherheitsbestimmungen in Betrieb zu nehmen.
Alle Maßnahmen zum Schutz von Personen bei einem Defekt des Wegaufnehmers müssen vor der Inbetriebnahme getroffen werden.

**Starke magnetische oder elektromagnetische Felder in unmittelbarer Nähe zum Wegaufnehmer können zu fehlerhaften Signalen führen !**

### 2.3 Anschlüsse prüfen

Falsche Verbindungen und Überspannung können zur Beschädigung des Wegaufnehmers führen.
Prüfen Sie deshalb vor dem Einschalten die Anschlüsse immer sorgfältig.

**Achtung:** Potentialdifferenzen zwischen Versorgung GND und Signal GND sind zu vermeiden.
Durch Potentialdifferenzen zwischen Versorgung GND und Signal GND kann der Wegaufnehmer zerstört werden!

### 2.4 Einschalten des Systems

Bitte beachten Sie, dass das System beim Einschalten unkontrollierte Bewegungen ausführen kann, vor allem wenn die Wegmesseinrichtung Teil eines Regelsystems ist, dessen Parameter noch nicht eingestellt sind. Stellen Sie daher sicher, dass hiervon keine Gefahren ausgehen können.

### 2.5 Messwerte prüfen

Nach dem Austausch eines Wegaufnehmers wird empfohlen, die Ausgangswerte in der Anfangs- und Endstellung des Positionsgebers im Handbetrieb zu überprüfen. ( Änderungen oder fertigungsbedingte Streuungen vorbehalten)

### 2.6 Funktionsfähigkeit prüfen

Die Funktionsfähigkeit des Wegmesssystems und aller damit verbundenen Komponenten ist regelmäßig zu überprüfen und zu protokollieren.

### 2.7 Funktionsstörung

Wenn das Wegmesssystem nicht ordnungsgemäß arbeitet, ist es außer Betrieb zu nehmen und gegen unbefugte Benutzung zu sichern.

## 1 General description

This device is a magnetostricitve transducer for direct, precise and absolute measurement of displacements or lengths in control, regulation and measuring applications.

## 2 Safety instructions

### 2.1 Conventional application

The TMI transducer is intended to be installed in a machine or system. Together with a controller it comprises a position measuring system and may only be used for this purpose.
In case of unauthorized modifications, non-permitted usage or non-observance of installation instructions, the warranty and liability claims will be lost.

### 2.2 Installation and startup

The transducer must be installed by qualified personnel in consideration of all relevant safety regulations.
Non-observance of the installation instructions will void any warranty or liability claims.
All personal protection measures in case of a transducer defect or failure must be taken before startup.

**Strong magnetic or electromagnetic fields in close vicinity to the linear transducer may lead to faulty readings !**

### 2.3 Check connections

Improper connections and overvoltage can damage the transducer.
Please always check the connections carefully before turning on the system.

**Caution:** Potential differences between supply voltage GND and signal GND must be avoided.
With different potentials between supply voltage GND and signal GND the transducer can be destroyed!

### 2.4 Turning on the system

Please note that the system may execute uncontrolled movements when first turned on or when the transducer is part of a closed-loop system whose parameters have not yet been set. Therefore make sure that no hazards can result from these situations.

### 2.5 Check output values

After replacing or repairing a transducer, it is advisable to verify the output values for the start and end position of the position marker in manual mode. (Transducers are subject to modification or manufacturing tolerances)

### 2.6 Check functionality

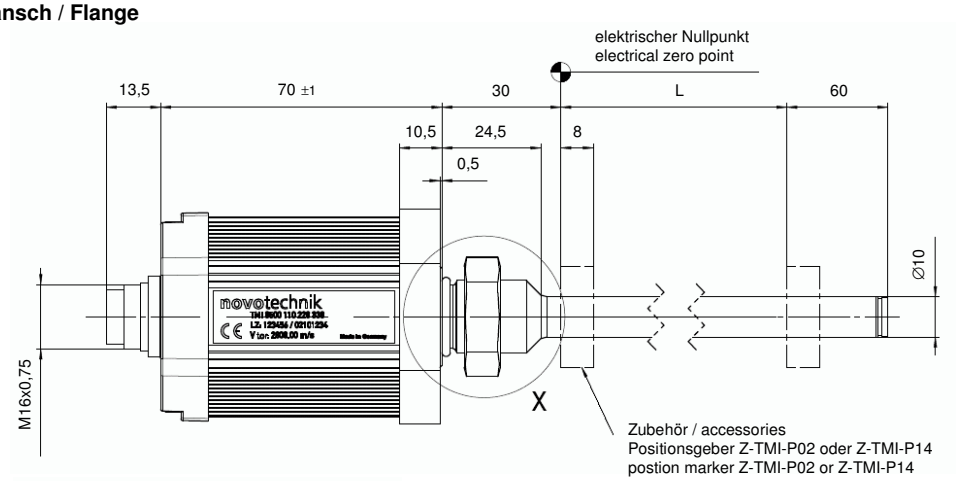
The functionality of the transducer system and all its associated components should be regularly checked and recorded.

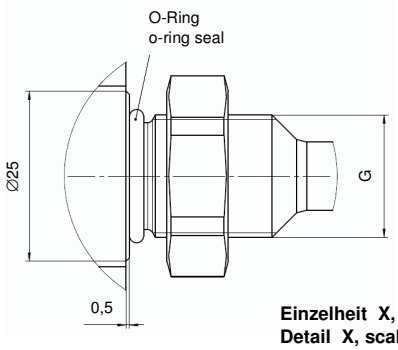
### 2.7 Fault conditions

If the transducer system doesn‘t operate properly, it should be taken out of service and protected against unauthorized use.

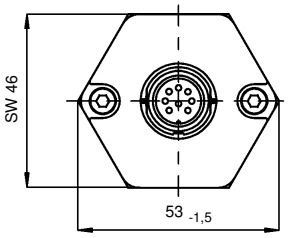
## 3 Einbau / Installation

### 3.1 Flansch / Flange

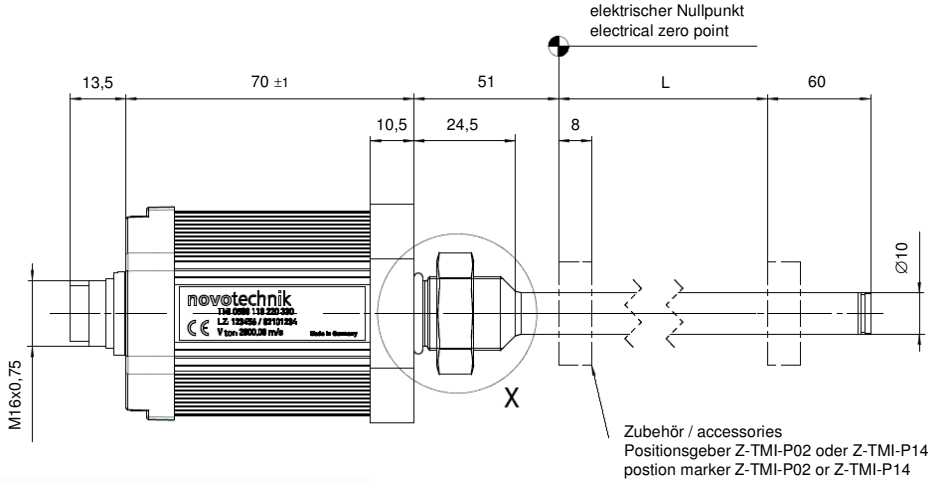


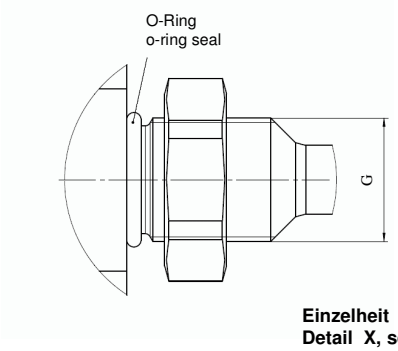




| | G |
|---|---|
| Code 002 | M18x1,5 |
| Code 003 | 3/4"-16UNF |

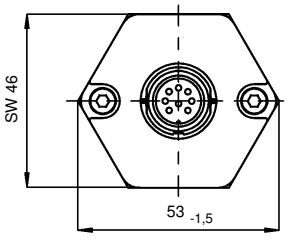



**Einzelheit X, Maßstab 2:1**
**Detail X, scale 2:1**



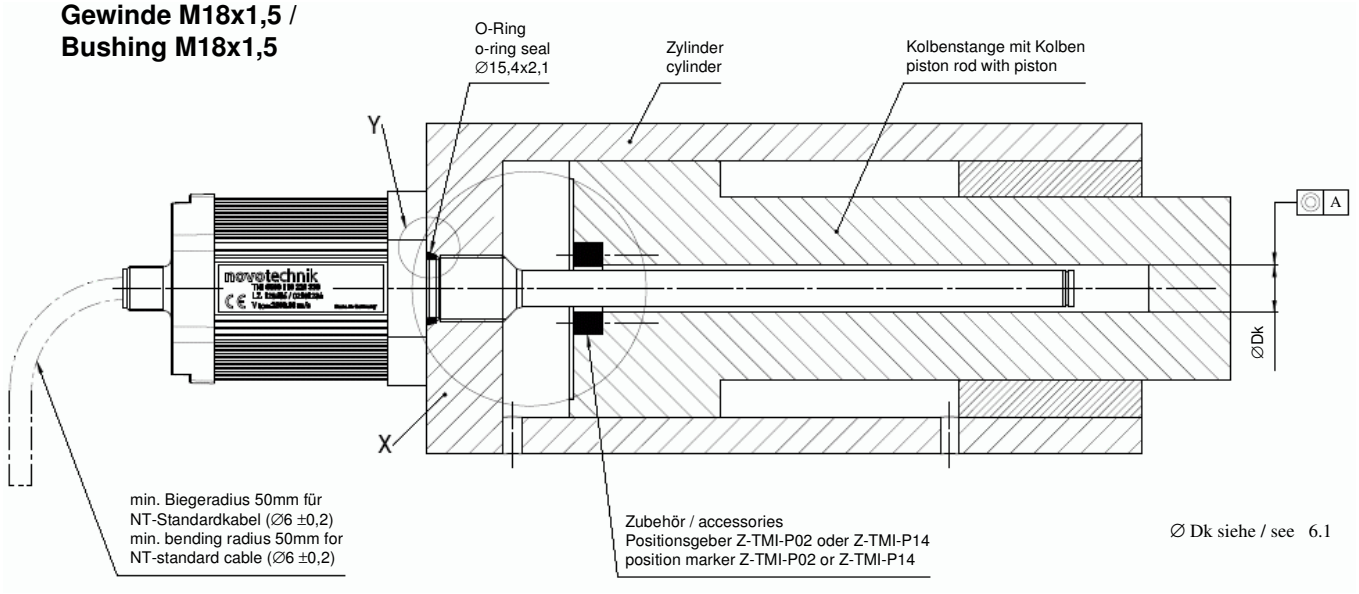




| | G |
|---|---|
| Code 004 | M18x1,5 |
| Code 005 | 3/4"-16UNF |

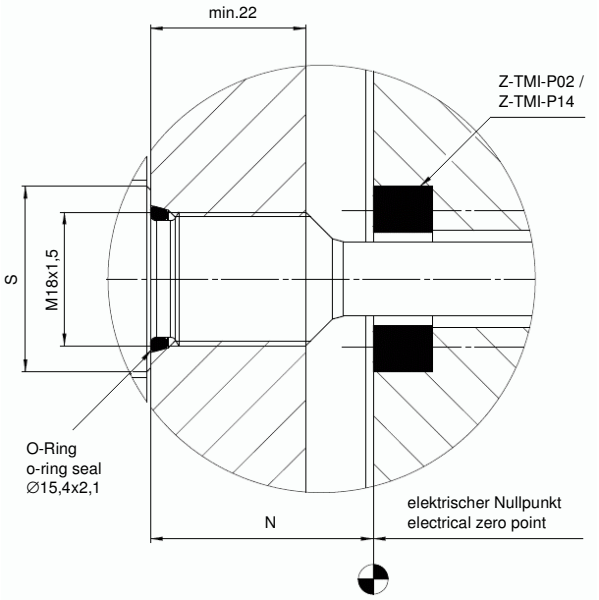



**Einzelheit X, Maßstab 2:1**
**Detail X, scale 2:1**

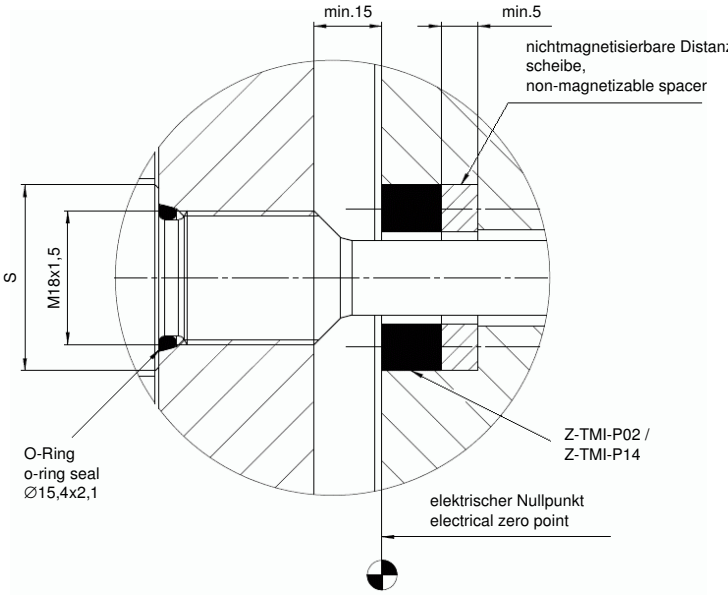
## Gewinde M18x1,5 / Bushing M18x1,5

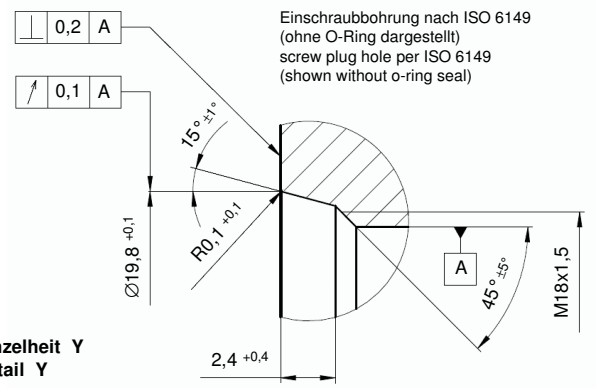



**Einzelheit X, nichtmagnetisierbarer Werkstoff**
**Detail X, non-magnetizable material**




**Einzelheit X, magnetisierbarer Werkstoff**
**Detail X, magnetizable material**

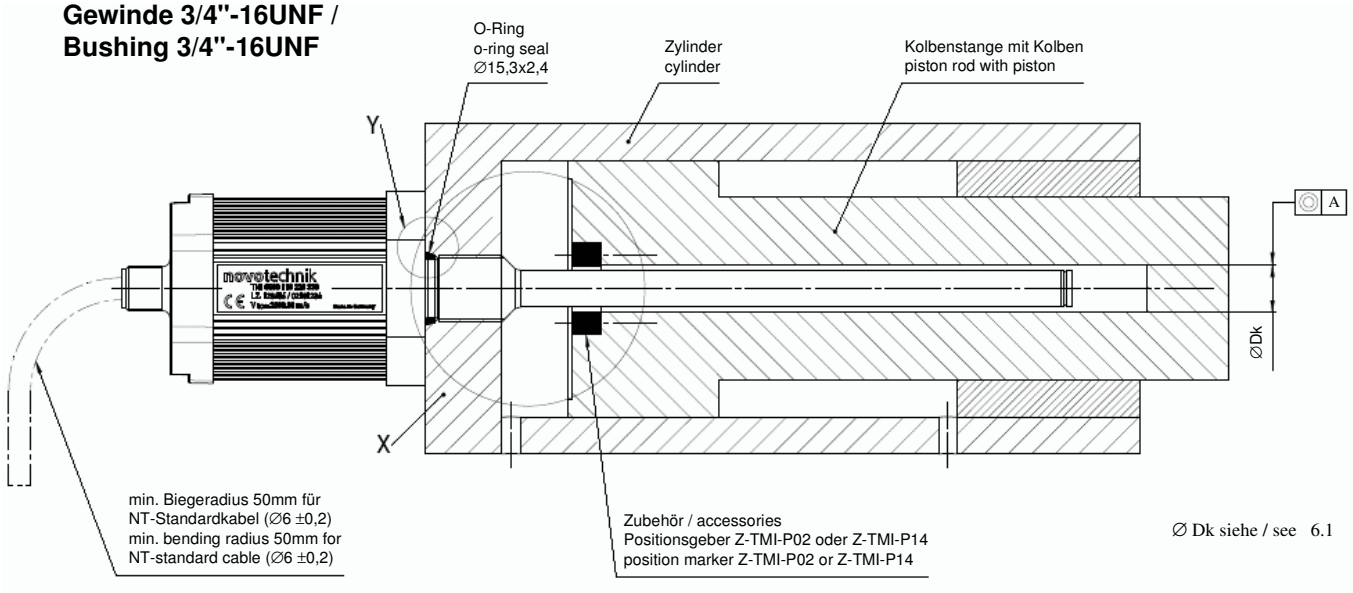


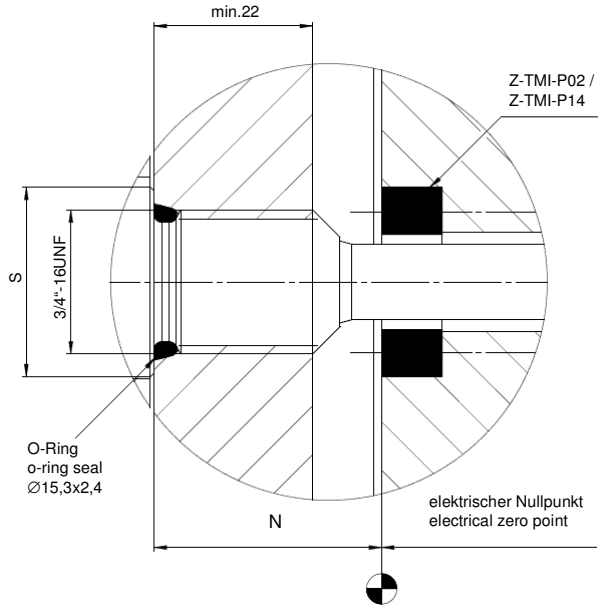

**Einzelheit Y**
**Detail Y**

| | N | S |
|---|---|---|
| Code 002 | 30 | ∅ 25 |
| Code 004 | 51 | - |

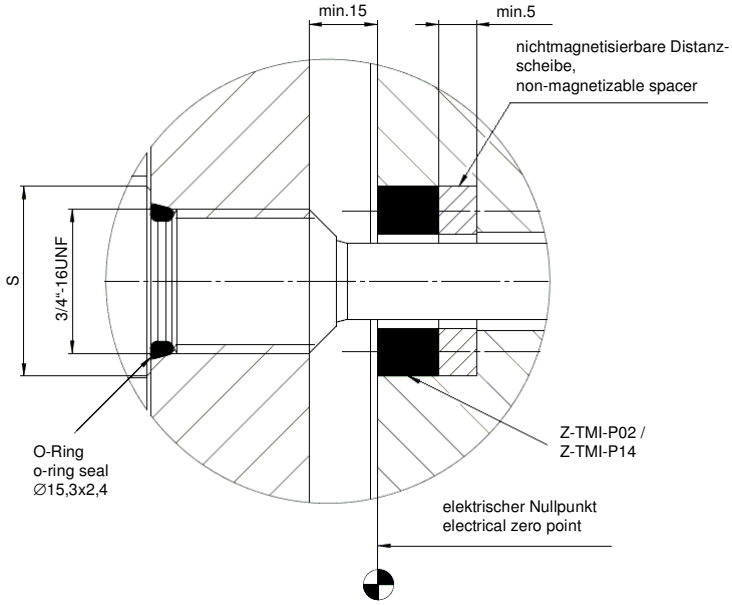
**Gewinde 3/4"-16UNF /**
**Bushing 3/4"-16UNF**

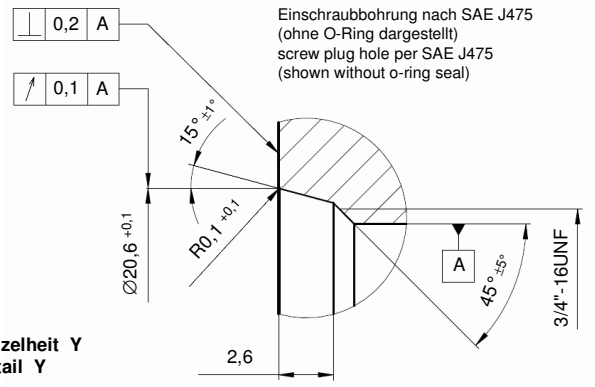



**Einzelheit X, nichtmagnetisierbarer Werkstoff**
**Detail X, non-magnetizable material**




**Einzelheit X, magnetisierbarer Werkstoff**
**Detail X, magnetizable material**



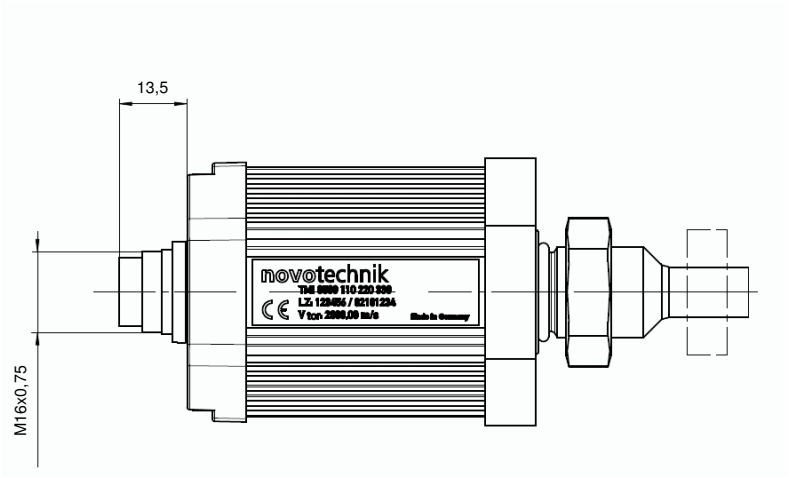




**Einzelheit Y**
**Detail Y**

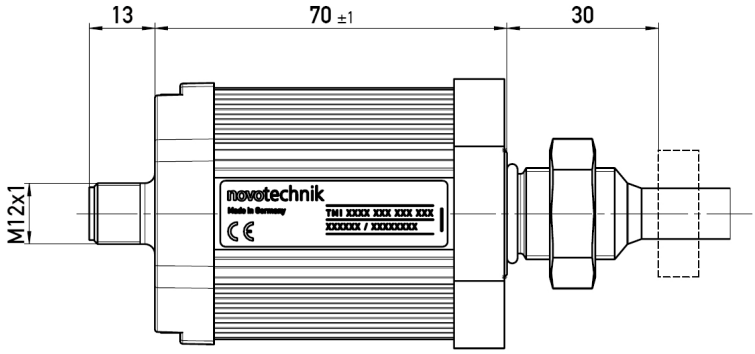
| | N | S |
|---|---|---|
| Code 003 | 30 | ∅ 25 |
| Code 005 | 51 | - |

### 3.2 Elektrischer Anschluss / Electrical connection

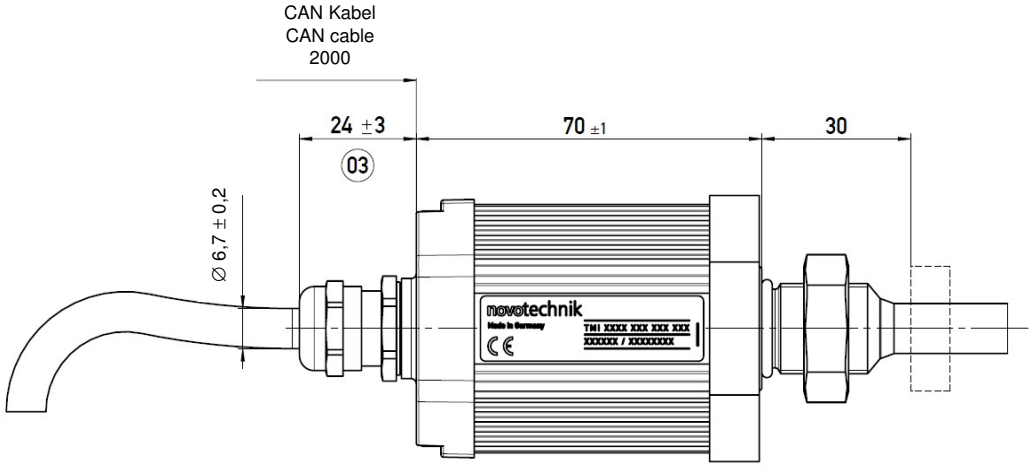
#### 3.2.1 Code 105




#### 3.2.2 Code 106

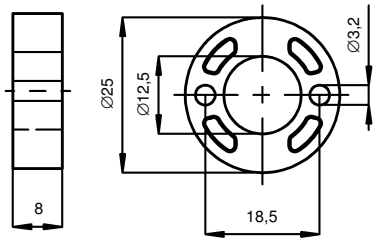



#### 3.2.3 Code 252

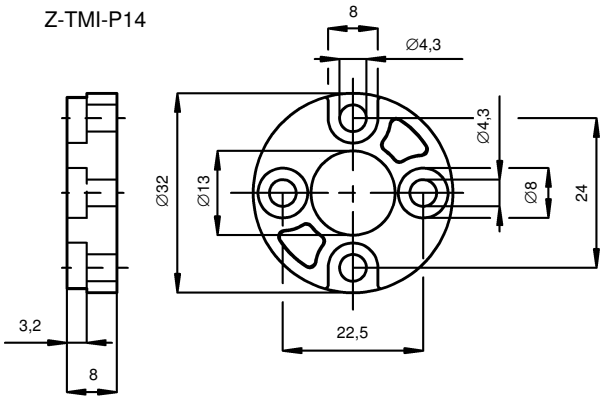


### 3.3 Positionsgeber / Position marker

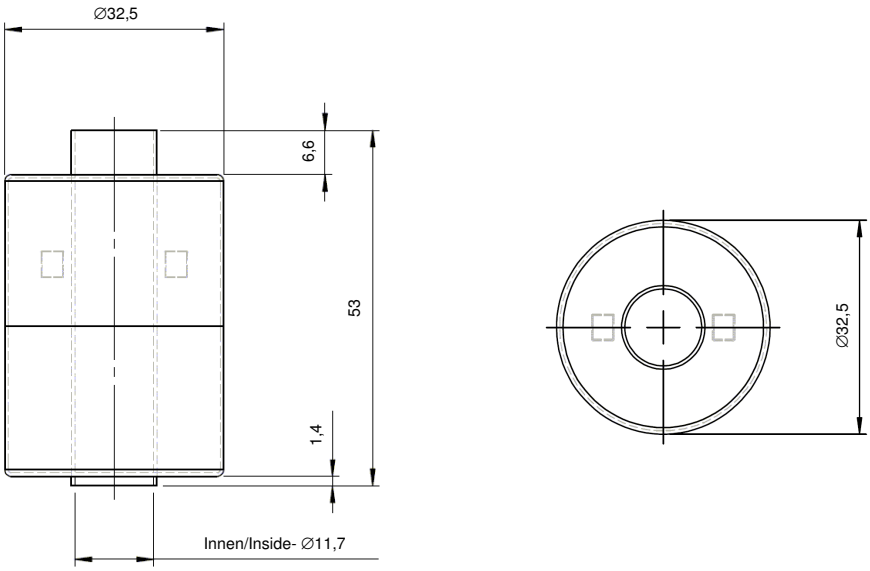
Z-TMI-P02



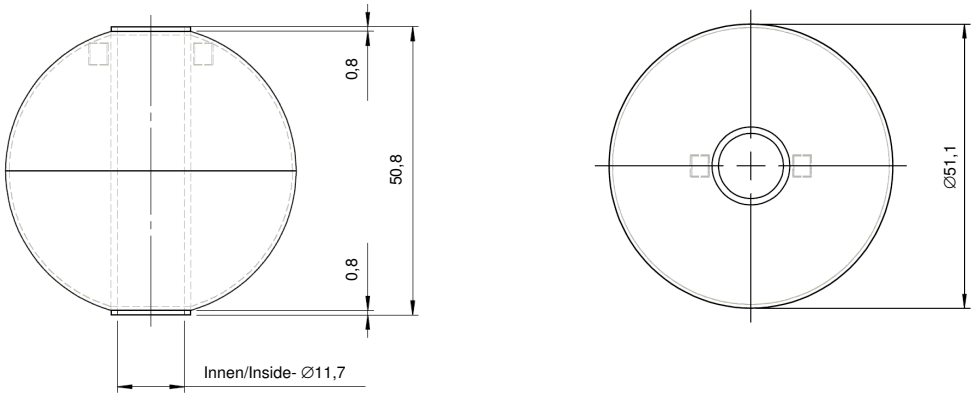

Z-TMI-P14



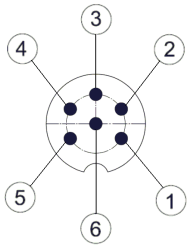

Z-TMI-P10 (Füllstandsmessung / level measuring)




Z-TMI-P11 (Füllstandsmessung / level measuring)



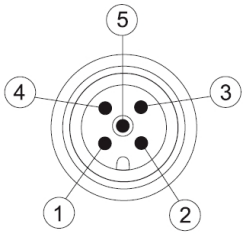
### 3.4 Steckerbelegung / Pin configuration
**( Sicht auf den Flanschstecker / front view to the flange connector )**




Flanschstecker 6-pol. / 6 pin flange connector
IEC130-9, DIN 45326

Beispiel Teileschlüssel / example ordering code: TLM xxxx xxx xxx **105**

Zubehör / accessories: Kupplungsdose / straight connector EEM 33-82; IP67; Art.-Nr. / P/N 005639
Winkeldose / angled connector EEM 33-94; IP67; Art.-Nr. / P/N 005648




Flanschstecker 5-pol. / 5 pin flange connector
M12x1, DIN EN 50044

Beispiel Teileschlüssel / example ordering code: TLM xxxx xxx xxx **106**

Zubehör / accessories: Kupplungsdose / straight connector EEM 33-73; IP67; Art.-Nr. / P/N 005645
Winkeldose / angled connector EEM 33-75; IP67; Art.-Nr. / P/N 005646

## 4 Montagehinweis

### 4.1 Positionsgeber
Für die direkte Hubmessung im Zylinder wird der Positionsgeber mit 2 Schrauben M3 oder M4 (je nach Positionsgeber ) direkt auf dem Kolbenboden montiert.
Alternativ kann der Positionsgeber auch durch einen Schraubring oder eine Einpressverbindung fixiert werden.
Für die Aufnahme des magnetischen Positionsgebers ist möglichst nichtmagnetisches Material zu verwenden.
Gegebenenfalls ist eine nichtmagnetische Distanzscheibe (min. 5 mm stark) zwischen Positionsgeber und Kolbenboden zu montieren.
Die Bohrung in der Kolbenstange ist abhängig vom Druck und der Verfahrgeschwindigkeit auszulegen. Der empfohlene Bohrungsdurchmesser beträgt Dk ≥ 12,7 mm.
Das Ende des TMI-Stabes ist vor Verschleiß zu schützen. Der Positionsgeber darf nicht auf dem Stab schleifen.

**<u>Achtung:</u> Wird der Schraubflansch in einen Zylinder aus magnetisierbarem Material eingebaut, dann ist unbedingt darauf zu achten, dass der Abstand zwischen Positionsgeber in der Nullpunktstellung und dem Zylinder min. 15 mm axial beträgt!**

### 4.2 M18 Schraubflansch
Der Sensor wird mit Hilfe des Sechskantflansches (SW46) eingeschraubt.
**Achtung: das Anschraubmoment darf 50 Nm nicht überschreiten!!**
Der mitgelieferte O-Ring dichtet den Druckbereich des Zylinders am Einschraubloch ab. Die Flanschauflagefläche muss vollständig an der entsprechenden Auflagefläche des Zylinders aufliegen.
Bei waagrechter Montage von Wegaufnehmern mit einem elektrisch definierten Bereich über 1000 mm empfiehlt es sich, den TMI-Stab am Ende abzustützen.

**Der Bereich für den Kabelabgang muss ausreichend dimensioniert werden, der Mindestbiegeradius ist einzuhalten und scharfe Kanten sind zu vermeiden!**

## 4 Installation instructions

### 4.1 Position marker
For direct stroke measuring in a cylinder the position marker has to be fixed with 2 screws M3 or M4 (depending on the position marker) directly on the cylinder‘s piston bottom.
Alternatively the position marker can also be fixed by a threaded ring or by an press-fit-connection. For the mounting of the position marker non-magnetizable material has to be used preferably.
You have to mount a non-magnetizable spacer of min. 5 mm thickness between position marker and cylinder‘s piston bottom if necessary.
The bore in the piston rod has to be laid out dependent on the pressure and the velocity of the movement. The recommended bore diameter amounts to Dk ≥ 12,7 mm.
The end of the TM -rod has to be protected against wear. The position marker may not drag on the rod.

**<u>Attention:</u> When the screw flange will be mounted in a cylinder of magnetizable material, it‘s important to have axially a electrical spacing of min. 15 mm between position marker in setting to zero point and cylinder!**

### 4.2 M18 Screw flange
The sensor has to be screwed in via the hexagon flange (SW46).
**Attention: maximum tightening torque must never exceed 50 Nm when fastening down the sensor head!!**
The provided O-ring seals the pressure area of the cylinder at the screw plug hole. The contact surface of the flange must rest completely against the mounting surface of the cylinder.

For horizontal mounting of transducer with a defined electrical range longer than 1000 mm the TMI rod should be supported or attached at ist end.

**For the area of the cable please take care that enough space is available, the minimum bending radius has been observed and sharp edges have be avoided.**

**4.3 Mehrere Positionsgeber**
Bei den Varianten mit mehreren Positionsgebern muss der Abstand zwischen den Positionsgebern jeweils min. 100 mm betragen!

**4.3 Several position markers**
For the versions with several position markers the distance between the position markers must be min. 100 mm !

**5 Anschlüsse**
**Beim elektrischen Anschluss unbedingt zu beachten:**
Anlage (Versorgung GND) und Schaltschrank (Signal GND) müssen auf gleichem Potential liegen. Um die elektromagnetische Verträglichkeit (EMV) zu gewährleisten, sind nachfolgende Hinweise unbedingt zu beachten:

- Wegaufnehmer und Steuerung müssen mit einem geschirmten Kabel verbunden werden.
- Schirmung: Geflecht aus Kupfer-Einzeldrähten, 85% Bedeckung.
- Auf der Seite der Steuerung muss der Kabelschirm geerdet, d.h. mit dem Schutzleiter verbunden werden.

**5 Wiring**
**Note the following when making electrical connections:**
System (supply voltage GND) and control cabinet (signal GND) must be at the same potential. To ensure the electromagnetic compatibility, the following instructions must be strictly followed:

- Transducer and controller must be connected using shielded cable.
- Shielding: Copper filament braided, 85% coverage.
- On the controller side the shield must be tied to the connector housing in the BKS connector.

**6 Elektrische Daten / Electrical data**

| | | |
|---|---|---|
| Versorgungsspannung / Supply voltage: | 24 VDC ± 20% | |
| Stromaufnahme / Current draw: | CANopen Schnittstelle / CANopen interface | ≤ 100 mA typisch / typical |

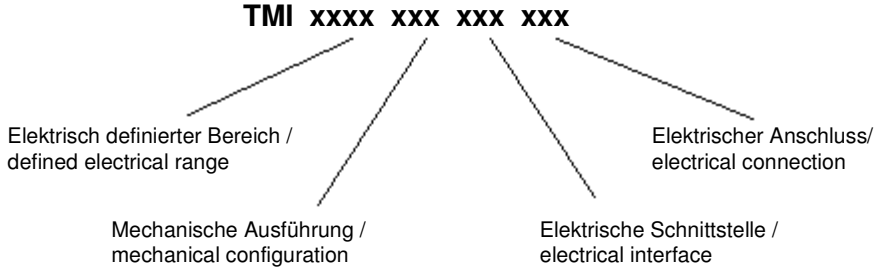
**7 Zubehör (separat zu bestellen)**

- Kupplungsdose 6-pol. IEC 130-9 (EEM 33-82 IP 67 ; Art.Nr. 005639)
- Winkeldose 6-pol. IEC 130-9 (EEM 33-94 IP 67; Art.Nr. 005648)
- Kupplungsdose 5-pol. M12x1 (EEM 33-73 IP 67 ; Art.Nr. 005645)
- Winkeldose 5-pol. M12x1 (EEM 33-75 IP 67; Art.Nr. 005646)
- Ring-Positionsgeber Z-TMI-P02 (Art.Nr. 005652)
- Ring-Positionsgeber Z-TMI-P14 (Art.Nr. 005657)
- Schwimmender Positionsgeber Z-TMI-P10 (Art.Nr. 005662)
- Schwimmender Positionsgeber Z-TMI-P11 (Art.Nr. 005663)

**7 Accessories (order separately)**

- Straight connector 6-pin IEC 130-9 (EEM 33-82 IP 67 ; P/N 005639)
- Angled connector 6-pin IEC 130-9 (EEM 33-94 IP 67; P/N 005648)
- Straight connector 5-pin M12x1 (EEM 33-73 IP 67 ; P/N 005645)
- Angled connector 5-pin M12x1 (EEM 33-75 IP 67; P/N 005646)
- Ring position marker Z-TMI-P02 (P/N 005652)
- Ring position marker Z-TMI-P14 (P/N 005657)
- Float position marker Z-TMI-P10 (P/N 005662)
- Float position marker Z-TMI-P11 (P/N 005663)

**8 Bestellcode / ordering code**



## 9 CANopen

**Contents**

# 1 CANopen

The basic knowledge of the CAN Bus is required for the good understanding of the present section.

## 1.1 EDS Files

For integration in a common CANopen projecting tool, electronic data sheet (eds) files are served. These files can be downloaded from the Novotechnik Web Site, see Downloads/Operating manuals where also this document can be found.

**Electric data sheet see file TMI_TLM_CANopen.eds.**

## 1.2 Features

### 1.2.1 Standards

Most of the definitions made are according to the following specifications. For making use of all the features that these specifications offer, a knowledge about them is absolutely necessary.

| | |
|---|---|
| CANopen communication<br>according to CiA Standard | DS-301, V4.02 |
| CANopen Encoder Profile<br>according to CiA Standard | DSP-406, V3.1 |
| CANopen Layer Setting Services<br>according to CiA Standard | DSP-305, V1.1.2 |

### 1.2.2 Basics based on DS-301, V4.02

| | |
|---|---|
| CAN Identifier | Standard 11 Bit<br>according Pre-Defined Connection Set |
| CAN bit rates | 10, 20, 50, 125, **250** (default), 500, 800, 1000 kBit/s, Auto-baud, setting per LSS or object 0x2001 |
| Node-ID | 1- **127** (default)<br>255 to be set per LSS or object 0x2000 |
| SYNC | Consumer |
| Time Stamp | no |
| Emergency Messages | Producer |
| Node Guarding<br>Heartbeat | no<br>Producer |
| Non-volatile storage | yes |
| Program Download | no |
| NMT Service | Slave |

#### 1.2.3 Basics based on DSP-406, V3.1

| | |
|---|---|
| Encoder class | ☒ C1 ☐ C2 |
| Encoder type | Absolute linear encoder |
| Max. bit bandwidth of position value | 24 bit |
| Encoder Cams<br>Channels to be detected<br>Cams per channel<br>Polarity<br>hysteresis | <br>Pos.ch1, Pos.ch2<br>4<br>adjustable<br>yes |
| Work Area Supervision<br>channels | <br>Pos.ch1, Pos.ch2 |

#### 1.2.4 SDO communication

| | |
|---|---|
| SDO communication<br>expedited transfer<br>segmented transfer | 1 Server<br>yes<br>no |
| Block transfer | No |

#### 1.2.5 PDO communication

| | | |
|---|---|---|
| PDO communication principle | Producer | |
| TPDO's | TPDO1:<br><br>TPDO2: | asynchronous with Event Timer, synchronous<br>synchronous; no RTR's |
| PDO Mapping | dynamic | |
| max. PDO Mapping logs per PDO | 5 | |
| mappable objects | pos. ch1/ch2:<br>velocity-value ch1/ch2:<br>cam state ch1/ch2 :<br>work area state ch1/ch2 : | 0x6020/1; 0x6020/2<br>0x6030/1; 0x6030/2<br>0x6300/1; 0x6300/2<br>0x6400/1; 0x6400/2 |

#### 1.2.6 LSS (Layer setting service)

| | |
|---|---|
| LSS Service | slave |

Necessary information for sensor configuration through LSS:
Vendor ID: 0x0182
SW version: Product code
rev.-No.: 0x020003
Serial No.: 8 dig. on sensor label (YYWWxxxx)
(Y: year; W: week; xxxx: sequential number)

### 1.3 Variation of Node-ID

Altering Node-ID can be done either by LSS (see chapter 14) or by writing object 0x2000.

Using writing to object 0x2000, non-volatile storage has to be done by writing the“save”- signature (0x65766173) on object 0x1010/1. These changes will become effective after a communication restart or a power up.

Changing the Node-ID will affect all COB-IDs according to the “predefined connection set”.

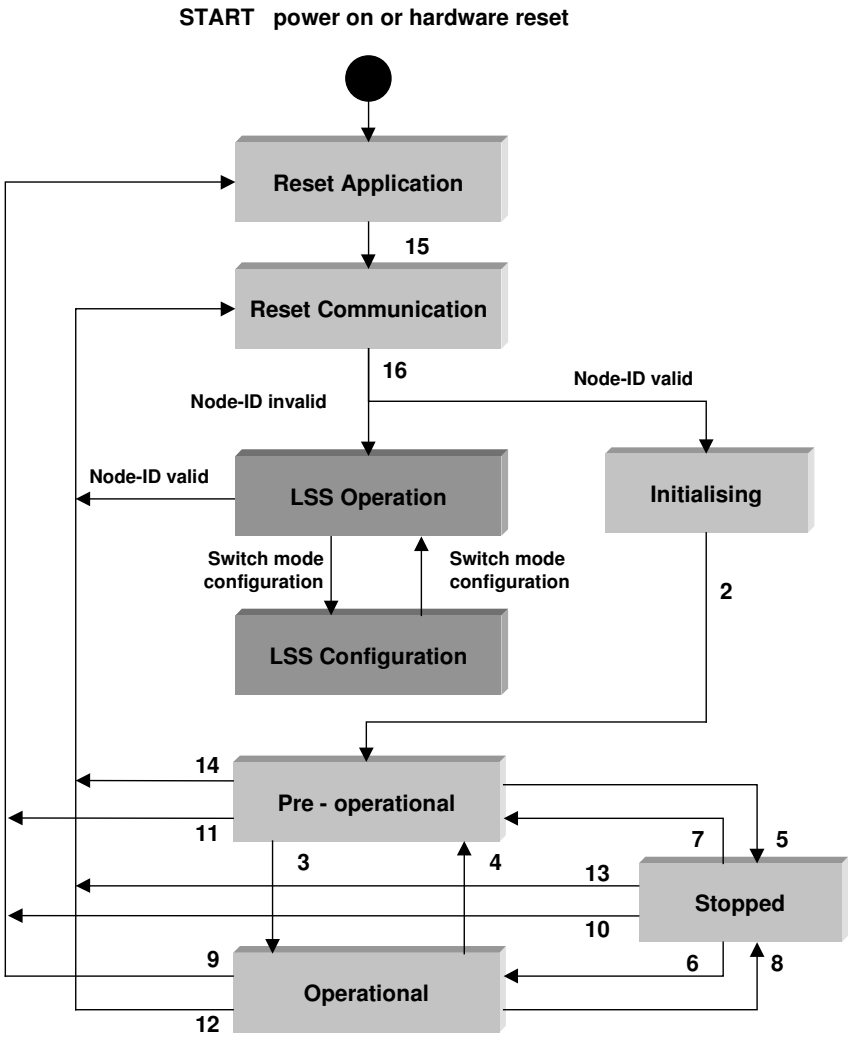
Example: COB-ID TPDO1 = 0x180 + (node-id).

### 1.4 Altering Bit rate

Altering bit rate can be done either by LSS (see chapter 14) or by writing object 0x2001; in this case, non-volatile storage has to be done by writing the“save”- signature (0x65766173) on object 0x1010/1. These changes will become effective after a communication restart or a power up.

By setting the bit rate to 0xFFFF autobaud will be configured. To detect the bit rate correctly by autobaud, a continuous communication (4-5 messages) has to be provided on the bus.

### 1.5 Using Layer Setting service (LSS)




**Picture 1: Overview LSS event machine**

The communication-event machine and the LSS-event machine exist parallelly.

| Event transition | Action |
|---|---|
| 2 | End of initialisation, automatic event |
| 3 | Start Remote Node command |
| 4 | Enter Pre-Operational command |
| 5 | Stop Remote Node command |
| 6 | Start Remote Node command |
| 7 | Enter Pre-Operational command |
| 8 | Stop Remote Node command |
| 10,11,12 | Reset Node command<br>CAN application executes “reset” and sets back CAN Controller in Sensor |
| 9,13,14 | Reset Communication command |
| 15 | Reboot, automatic event |
| 16 | Automatic event after reset of objects (0x1000-0x1FFF) |

### 1.6 Sensor configuration

In accordance to the ordering code, the sensor can provide a 1-channel capability with position and velocity information or a 2-channel capability with position and velocity information for both channels.

As modular eds-files are not in accord with the some controller types a separate eds-file is provided for each configuration !

### 1.7 Sensor measuring step

In accordance to the ordering code, the sensor can provide 2 minimum position measuring step values of 1µm or 5 µm. The value is set in Object 6500/1 in [nm] and can be increasingly altered in steps by 1000nm to up to 100µm.
The velocity measuring step value in Object 6500/2 is set in [0.01mm/s] per default to 2.5mm/s (250) and can be altered to 0.1mm/s (10) or 0.5mm/s (50) or 1mm/s (100) .

### 1.8 Explanations to object library

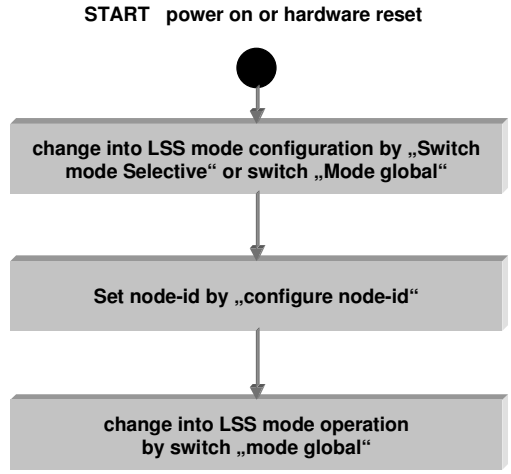
| Object | | Remarks |
|---|---|---|
| **Index** | **Name** | |
| 0x1018/2 | Product code | It contains the essential physical information of the sensor:<br>bit 31: 0 – pos_ch1/vel_ch1<br>1 – pos_ch1/vel_ch1 + pos_ch2/vel_ch2<br>bit 30: minimal position measuring step: 0 – various res.<br>1 – 5um<br>bit 29-17: reserved<br>bit 16-0: sensor length [mm] |

The value of above displayed parameters are dependent on the ordered type.

### 1.9 LSS / Layer Setting Service

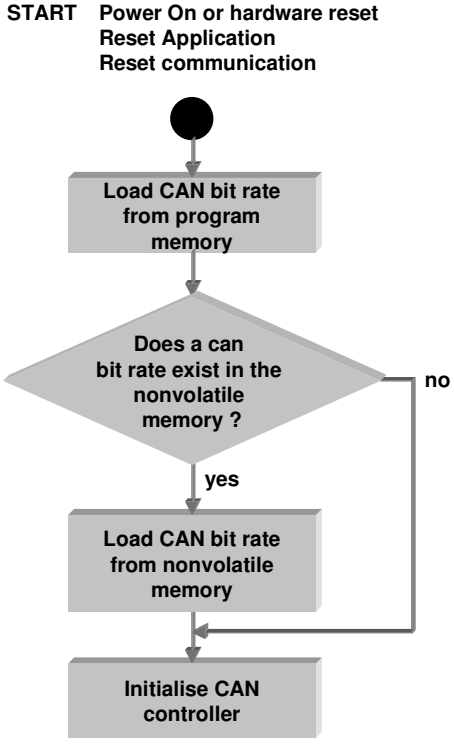
LSS configuration requires data content in the following objects:

Objects 1018/1: Vendor ID
1018/2: Product Code
1018/3: Rev. No.
1018/4: Serial No.

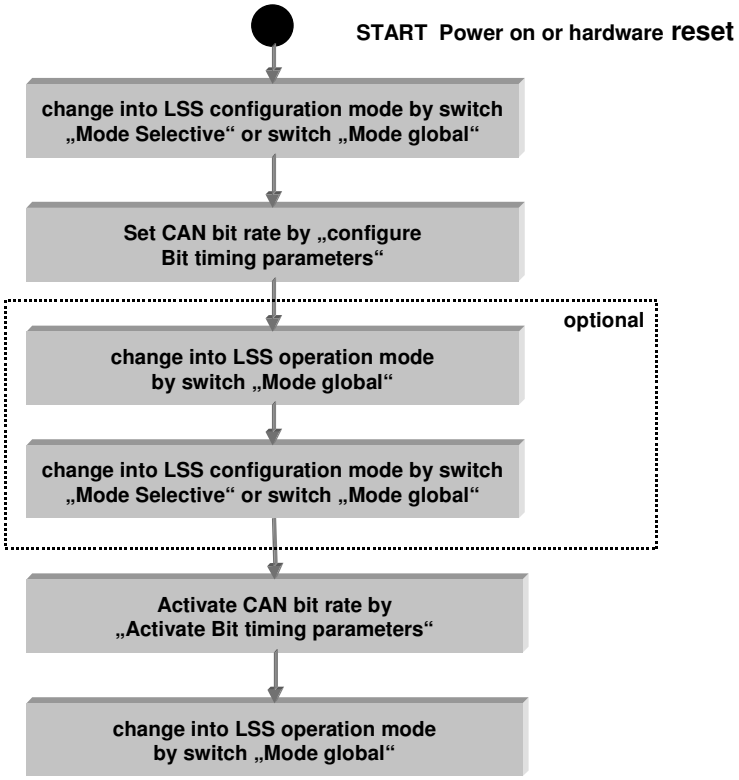



**Picture 2: Necessary Steps for configuration of Node-id via LSS**

Change of Node-ID will cause:
- Automatic alteration of COB-ID's for SDO1, EMCY and Heartbeat and TPDOs.
- Non-volatile Node-ID storage through „Store Configuration“ in the LSS mode configuration.




**Picture 3: CAN bit rate Initialization process**




**Picture 4: Setting CAN bit rate via LSS**

The CAN bit rate can be non-volatile stored by “Store Configuration” in LSS configuration mode.

### 1.10 Encoder Cams (6300h)

Encoder Cams are used to indicate if a position falls below or exceeds a defined value.

Each position channel is fixed to a Cam channel:

| **Position** | | **Encoder Cam** |
|---|---|---|
| Index | Subindex | Channel |
| 0x6020 | 1 | 1 |
| 0x6020 | 2 | 2 |

#### 1.10.1 Cam state registers

| **Cam enable 0x6301** | **Cam polarity 0x6302** | **Cam state 0x6300** | |
|---|---|---|---|
| 0 | 0 | 0 | cam inactive |
| | 1 | 1 | cam inactive |
| 1 | 0 | 0 | cam inactive |
| | | 1 | cam active |
| | 1 | 0 | cam active |
| | | 1 | cam inactive |

Cam active:
the current position value is between the upper and lower cam-limit.

Cam inactive:
the current position value is not between the upper and lower cam-limit.

The values for Low Limit (0x631x) and High Limit (0x632x) regard the values for preset (0x6010) and measuring steg settings (0x6005).

The value of hysteresis (0x633x) is added in direction of motion.
A change in cam state causes an EMCY message. The cam state objects (0x6300) are able to be mapped to the TPDOs.

### 1.11 Work Area (6400h)

It is possible for encoders to define a so-called user defined working area.

The main purpose for a work area is to get a high-priority information (via emcy message) when the transducer's position leaves its pre-defined working area.

The actual work area information with work area low limit and work area high limit may be stored in object 6401h. This way, the area state object (6400h) may also be used as software limit switches.

#### 1.11.1 Work Area Supervision

Each Work Area channel is fixedly linked to a position channel:

| **Position** | | **Work Area** |
|---|---|---|
| Index | Subindex | Channel |
| 0x6020 | 1 | 1 |
| 0x6020 | 2 | 2 |

#### 1.11.2 Work Area State

| **Condition** | **State register 0x6400** |
|---|---|
| Position < Work Area Low Limit<br>Position >= Work Area Low Limit | Bit 2 = 1<br>Bit 2 = 0 |
| Position > Work Area High Limit<br>Position <= Work Area High Limit | Bit 1 = 1<br>Bit 1 = 0 |
| Position <= Preset Value or<br>Position >= Sensor length<br>otherwise | Bit 0 = 1<br><br>Bit 0 = 0 |

The values for Low Limit (0x6401) and High Limit (0x6402) regard the values for preset (0x6010) and measuring step settings (0x6005).

A change in Work Area state causes an EMCY message. The Work Area state objects (0x6400) are able to be mapped to the TPDOs.

### 1.12 TPDOs

2 TPDOs with each max. 8 mapped entries are provided:

| **Mappable objects** | **Number of bytes necessary per TPDO** | |
|---|---|---|
| Chosen Type | Pos_ch1<br>Vel_ch1 | Pos_ch1 / Vel_ch1<br>Pos_ch2 / Vel_ch2 |
| 0x6020/1 | 4 | 4 |
| 0x6020/2 | | 4 |
| 0x6030/1 | 2 | 2 |
| 0x6030/2 | | 2 |
| 0x6300/1 | 1 | 1 |
| 0x6300/2 | | 1 |
| 0x6400/1 | 1 | 1 |
| 0x6400/2 | | 1 |
| Total | 8 Byte | 16 Byte |
| Number of TPDOs necessary<br>(8 bytes/ TPDO) | 1 | 2 |

TPDO1 value for Event Timer must always be higher than the value for Inhibit Time (except for value 0).

Failed sending of TPDOs can occur if:
- more TPDOs shall be sent than the CANbus may accept due to insufficient CAN bit rate compared to TPDO/Event Timer;
- excessive bus load or unfavourable setting of COB-ID in the CANopen network prevents TPDO sending.
- Object 0x1800/5- event timer- is set to 0.

### 1.13 Error Handling

Depending on the type of error occured, the transducer will react accordingly. Refer to table below.

| **Error Class** | **Error** | **Error Message from Sensor** |
|---|---|---|
| Protocol error | SDO protocol error, corrupted data received via SDO | Abort SDO Transfer* |
| | PDO protocol error, corrupted data received via PDO | Not relevant, sensor does support TPDOs only |
| Communication error | CAN bus off<br>CAN error passive<br>CAN overrun<br>CAN buffer overflow | EMCY message** |
| Process error | Position or sensor error | EMCY message** |
| | Data error | Abort SDO Transfer* or EMCY message** |
| Change of state | According to Cams and Work Areas | EMCY Message** |

**table 1: error reaction behaviour of transducer**

*…according to DS-301

** Details see Emergency Messages, next section

### 1.14 Emergency Messages

(COB-ID stored in object 1014)

| Error Code (hex) Byte 1,2 | Additional (hex) Byte 3,4 | Byte 5,6 | Byte 7 | Description |
|---|---|---|---|---|
| 0000 | 0 | 0 | 0 | *Sensor Error resetted* |
| 5000 | 1 | 1 | 0 | *Sensor Error*<br>Cause: An Internal error bit is set. The current process values stay in the object directory; the cam and work area states stay unchanged. If the internal error bit is reset to 0, an EMCY with 0x0000 is sent. |
| 5000 | 1 | 2 | 0 | *Wrong Sensor Mapping*<br>Cause: sensor doesn´t detect ist configuration pos1/2 or pos1/vel1.<br>Reaction: sensor changes into PRE-OPERATIONAL mode. NMT Master cannot set the sensor into OPERATIONAL mode, until error has been eliminated and sensor has been reset through power off/on.<br>Attempted setting into OPERATIONAL will result in repeated EMCY message sending. |
| 5000 | 1 | 3 | <br><br><br><br><br><br>1<br>2 | *System Data Error*<br>Cause: sensor system data exceed allowed internal data range.<br>Reaction: sensor changes into PRE-OPERATIONAL mode. NMT Master cannot set the sensor into OPERATIONAL mode, until error has been eliminated and sensor has been reset through power off/on.<br>Attempted setting into OPERATIONAL will result in repeated EMCY message sending.<br>*Wrong Vendor ID*<br>*Wrong Scale* |
| 5000 | 1 | 4 | 0 | *Wrong Sensor Resolution*<br>Cause: sensor has been set to wrong resolution internally.<br>Reaction: sensor changes into PRE-OPERATIONAL mode. NMT Master cannot set the sensor into OPERATIONAL mode, until error has been eliminated and sensor has been reset through power off/on.<br>Attempted setting into OPERATIONAL will result in repeated EMCY message sending. |
| 5000 | 1 | 5 | 0 | *Unexpected System Data*<br>Cause: application received sensor-internal system data instead of process data during normal operation mode.<br>Reaction: sensor changes into PRE-OPERATIONAL mode. System data is being computed as if power-up had occurred (system data are being checked and and serial number and product code, if correct, is being stored in EEPROM). If system data are correct, normal operation can continue afterwards. |

**table 2: Emengency messages (1 of 2))**

| Error Code (hex) Byte 1,2 | Additional (hex) Byte 3,4 | Byte 5,6 | Byte 7 | Description |
|---|---|---|---|---|
| 5000 | 1 | 6 | 0 | *No System Data*<br>Cause: application has not received system data after power-up. Sensor configuration is not detected internally.<br>Reaction: sensor changes into PRE-OPERATIONAL mode. NMT Master cannot set the sensor into OPERATIONAL mode, until error has been eliminated and sensor has been reset through power off/on.<br>Attempted setting into OPERATIONAL will result in repeated EMCY message sending. |
| 5000 | 2 | 1 | 0 | *Invalid Serial Number in EEPROM*<br>Cause: the serial number and product code stored in the EEPROM is invalid.<br>Reaction: sensor changes into PRE-OPERATIONAL mode. NMT Master cannot set the sensor into OPERATIONAL mode, until error has been eliminated and sensor has been reset through power off/on.<br>Attempted setting into OPERATIONAL will result in repeated EMCY message sending. |
| 6000 | 1 | 0 | 0 | *Insufficient Event Timer Value*<br>Cause: CAN bit rate has been set to a low value and an insufficient Event Timer value has been set for TPDO1 accordingly.<br>Reaction: TPDO1 sending will occur partially. |
| 8110 | 1 | 0 | 0 | *CAN Controller Overflow*<br>Cause: data buffers of CAN controller are still holding data and cannot accept new entries. Data is being lost.<br>Reaction: none |
| 8110 | 2 | 0 | 0 | *CAN Buffer Overflow*<br>Cause: data buffers of CANopen library are still holding data and cannot accept new entries. Data is being lost.<br>Reaction: none |
| 8120 | 0 | 0 | 0 | *CAN Error Passive*<br>Cause: CAN controller has detected communication errors and is reporting error passive.<br>Reaction: none |
| 8140 | 0 | 0 | 0 | *CAN Recovered From Bus-Off*<br>Cause: CAN controller registered too many sending errors. CAN communication could be restored afterwards.<br>Reaction: none |
| 9080 | Chan. | Cam | state | *Encoder CAM*<br>Cause: the state of cam / chan. has changed. State is coded according to 0x6300.<br>Reaction: none |
| 9090 | Chan. | 0 | State | *Work Areas*<br>Cause: the state of Work Area / chan. has changed. State is coded according to 0x6400.<br>Reaction: none |

**table 3: Emengency messages (2 of 2))**

### 1.15 Object 0x1002: Manufacturer-specific Status

This object shows the sensor status bit code and is used for internal process control purposes.

For servicing this information can be requested via SDO.

| Bit | Definition (bit value = 1) |
|---|---|
| 16 | TMI receiving process data |
| 15 | TPDO1 Event Timer Value insufficient for set CAN bit rate |
| 14 | EEPROM: CRC error, invalid data |
| 13 | Wrong Sensor Mapping |
| 12 | System Data Error: Wrong Vendor ID |
| 11 | System Data Error: Wrong Scale |
| 9 | Wrong Sensor Resolution |
| 8 | System Data received from sensor |
| 7 | No System Data received from sensor |
| 6 | CAN Controller Overflow |
| 5 | CAN Buffer Overflow |
| 4 | CAN Error Passive |
| 3 | CAN Bus-Off |
| 2 | CAN Bus-Off Timer started |
| 0-1 | NMT Condition of Sensor<br>%11 STOPPED<br>%10 OPERATIONAL<br>%01 PRE-OPERATIONAL<br>%00 INITIALISATION |

### 1.16 Non-Volatile Storage and Data Restoration

Default values for all data objects are stored in the program memory.

For the following data objects an application-specific default value may be stored in the non-volatile memory, additionally:

| Object index (hex) | Store | | | | | | Load | | | | | | | Delete | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LSS | Object 1010/ | | | | Auto | Boot-Up | Reset Comm. | Object 1011/ | | | | Reset Appl. | Object 1010/ | | | |
| | | 1 | 2 | 3 | 4 | | | | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 1800/2 | - | x | x | - | - | - | x | x | * | * | - | - | x | x | x | - | - |
| 1800/3 | | | | | | | | | | | | | | | | | |
| 1800/5 | | | | | | | | | | | | | | | | | |
| 1A00/0 | | | | | | | | | | | | | | | | | |
| 1A00/1 | | | | | | | | | | | | | | | | | |
| 1A00/2 | | | | | | | | | | | | | | | | | |
| 1A00/3 | | | | | | | | | | | | | | | | | |
| 1A00/4 | | | | | | | | | | | | | | | | | |
| 1A00/5 | | | | | | | | | | | | | | | | | |
| 1801/2 | | | | | | | | | | | | | | | | | |
| 1801/3 | | | | | | | | | | | | | | | | | |
| 1A01/0 | | | | | | | | | | | | | | | | | |
| 1A01/1 | | | | | | | | | | | | | | | | | |
| 1A01/2 | | | | | | | | | | | | | | | | | |
| 1A01/3 | | | | | | | | | | | | | | | | | |
| 1A01/4 | | | | | | | | | | | | | | | | | |
| 1A01/5 | | | | | | | | | | | | | | | | | |
| 1017/0 | | | | | | | | | | | | | | | | | |
| 2000/0 | x | x | - | - | x | - | x | x | * | - | - | * | x | x | - | - | x |
| 2001/0 | | | | | | | | | | | | | | | | | |
| 6005/1 | - | x | - | x | - | - | x | - | * | - | * | - | x | x | - | x | - |
| 6005/2 | | | | | | | | | | | | | | | | | |
| 6010/1 | | | | | | | | | | | | | | | | | |
| 6010/2 | | | | | | | | | | | | | | | | | |
| 6302/1 | | | | | | | | | | | | | | | | | |
| 6302/2 | | | | | | | | | | | | | | | | | |
| 6310/1 | | | | | | | | | | | | | | | | | |
| 6310/2 | | | | | | | | | | | | | | | | | |
| 6311/1 | | | | | | | | | | | | | | | | | |
| 6311/2 | | | | | | | | | | | | | | | | | |
| 6312/1 | | | | | | | | | | | | | | | | | |
| 6312/2 | | | | | | | | | | | | | | | | | |
| 6313/1 | | | | | | | | | | | | | | | | | |

| Object index (hex) | Store | | | | | | Load | | | | | | | Delete | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LSS | Object 1010/ | | | | Auto | Boot-Up | Reset Comm. | Object 1011/ | | | | Reset Appl. | Object 1010/ | | | |
| | | 1 | 2 | 3 | 4 | | | | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 |
| 6313/2 | | | | | | | | | | | | | | | | | |
| 6320/1 | | | | | | | | | | | | | | | | | |
| 6320/2 | | | | | | | | | | | | | | | | | |
| 6321/1 | | | | | | | | | | | | | | | | | |
| 6321/2 | | | | | | | | | | | | | | | | | |
| 6322/1 | | | | | | | | | | | | | | | | | |
| 6322/2 | | | | | | | | | | | | | | | | | |
| 6323/1 | | | | | | | | | | | | | | | | | |
| 6323/2 | | | | | | | | | | | | | | | | | |
| 6330/1 | | | | | | | | | | | | | | | | | |
| 6330/2 | | | | | | | | | | | | | | | | | |
| 6331/1 | | | | | | | | | | | | | | | | | |
| 6331/2 | | | | | | | | | | | | | | | | | |
| 6332/1 | | | | | | | | | | | | | | | | | |
| 6332/2 | | | | | | | | | | | | | | | | | |
| 6333/1 | | | | | | | | | | | | | | | | | |
| 6333/2 | | | | | | | | | | | | | | | | | |
| 6401/1 | | | | | | | | | | | | | | | | | |
| 6401/2 | | | | | | | | | | | | | | | | | |
| 6402/1 | | | | | | | | | | | | | | | | | |
| 6402/2 | | | | | | | | | | | | | | | | | |
| 1800/1 | - | - | x | - | - | - | x | x | * | * | - | - | x | x | x | - | - |
| 1801/1 | | | | | | | | | | | | | | | | | |
| 1018/4 | - | - | - | - | - | x | - | x | - | - | - | - | x | - | - | - | - |
| 1018/2 | | | | | | | | | | | | | | | | | |

x ... non-volatile user stored parameters

* ... parameters from program memory

• **Storage via LSS:**
Data must be stored through the LSS Service Configuration/Store while in LSS Configuration Mode.

• **Object 0x1010:**
Data is stored in the non-volatile memory during encryption of object 0x1010 with „save“ signature (0x65766173).

• **Auto:**
Application will store data automatically in the non-volatile memory.

• **Load at Boot-up:**
CANopen Library will upload data from the non-volatile memory during the booting procedure.

• **Reset Communication:**
During Reset Communication data is being uploaded from the non-volatile memory.

• **Object 0x1011:**
Encryption of object 0x1011 with the signature „load“ (0x64616F6C) will upload data from the non-volatile memory. Default settings are being restored.

• **Reset Application:**
During Reset Applcation data is being uploaded from the non-volatile memory

• **Delete Via Object 0x1010:**
Additionally to the functionnality defined in CiA standard DS-301, CANopen Library offers the possibility to delete data in the non-volatile memory. Delete process is initiated by sending the signature “kill” (0x6B696C6C) to object 0x1010.

Data encryption to the non-volatile memory is only admitted in condition PRE_OPERATIONAL.

## 2 Physical Assignments

| Signal description | Notation |
|---|---|
| CAN_L bus line (dominant low) | CAN_L or $CAN_{low}$ or CAN- |
| CAN:H bus line (dominant high) | CAN_H or $CAN_{high}$ or CAN+ |
| CAN Ground | CAN_GND or $CAN_{GND}$ or Ground or GND |
| Optional CAN Shield | CAN_SHLD or $CAN_{SHIELD}$ or Shield or SHLD |
| Optional CAN external positive supply | CAN_V+ or $CAN_{V+}$ or V+ or UC or $U_{CAN}$ |
| Optional Ground | OPT_GND or $GND_{opt}$ or V- or 0V |

### 2.1 6-pin Flange Connector to IEC130-9, DIN 45326

The last 3 digits of ordering code are adressed.
Transducer P/N example: TLM xxxx xxx 6xx 105

Optional straight connector:
EEM 33-82; Protection Class IP67; Part No. 005639

Optional right angle connector:
EEM 33-94; Protection Class IP67; Part No. 005648

| Pin | Signal | Descrition |
|---|---|---|
| 1 | CAN_L | CAN_L bus line (dominant low) |
| 2 | CAN_H | CAN_H bus line (dominant high) |
| 3 | (CAN_SHLD) | Optional CAN Shield (internally connected to CAN_GND) |
| 4 | - | nc |
| 5 | (CAN_V+) | Optional CAN external positive supply (dedicated for supply of transceiver and optocouplers, if galvanic isolation of the bus node applies) |
| 6 | CAN_GND | Ground / 0V / V- (internally connected to CAN_SHLD) |

### 2.2 5-pin Flange Connector to M12x1, DIN EN 50044

The last 3 digits of ordering code are adressed.
Transducer P/N example: TLM xxxx xxx 6xx 106

Optional straight connector:
EEM 33-73; Protection Class IP67; Part No. 005645

Optional right angle connector:
EEM 33-75; Protection Class IP67; Part No. 005646

| Pin | Signal | Descrition |
|---|---|---|
| 1 | (CAN_SHLD) | Optional CAN Shield (internally connected to CAN_GND) |
| 2 | (CAN_V+) | Optional CAN external positive supply (dedicated for supply of transceiver and optocouplers, if galvanic isolation of the bus node applies) |
| 3 | CAN_GND | Ground / 0V / V- (internally connected to CAN_SHLD) |
| 4 | CAN_H | CAN_H bus line (dominant high) |
| 5 | CAN_L | CAN_L bus line (dominant low) |

### 2.3 4-wire Cable exit

The last 3 digits of ordering code are adressed.
Transducer P/N example: TMI xxxx xxx 6xx 252

| Cable | Signal | Description |
|---|---|---|
| Shield | (CAN_SHLD) | Optional CAN Shield (internally connected to CAN_GND) |
| RD rot/ red | (CAN_V+) | Optional CAN external positive supply (dedicated for supply of transceiver and optocouplers, if galvanic isolation of the bus node applies) |
| BK schwarz/ black | CAN_GND | Ground / 0V / V- (internally connected to CAN_SHLD) |
| WH weiss/ white | CAN_H | CAN_H bus line (dominant high) |
| BU blau/ blue | CAN_L | CAN_L bus line (dominant low) |

### 3 Scope of delivery

TLM: Z46 mounting clamps (quantity varies with transducer length).

### 4 Accessories (order separately)

- Necessary: Position marker (diverse types, see separate datasheet)
- M12x1 straight female connector with cable, 2m
  (EEM 33-86 IP 67 ; P/N 005629)
- M12x1 right-angle female connector with cable, 2m
  (EEM 33-87 IP 67; P/N 005630)
- Other cable lengthes available (see datasheet)

### 5 Document Changes

| ***Version*** | ***Änderung*** | ***Datum*** | ***Bearb*** |
|---|---|---|---|
| | • Vorabversion “Instructions of use TLM TMI CANopen english.pdf” | 09.05.06 | VM/ss |
| 1_00 | • Urzustand: Gebrauchsanleitung TLM TMI CAN englisch.doc. Mit EE/Schnell besprochen. | 01.08.06 | VM/ss |
| 1_01 | • Variante 2 Positionsgeber ergänzt | 19.09.06 | VM/ss |
| 1_02 | • Variante Pos1/Pos2 entfällt | 06.10.06 | VM/ss |
| 2_00 | • TMI und TLM Anleitung separat neu aufgebaut. Anleitung zu CANopen wird unverändert übernommen. | 05.03.08 | VL/gt |
| 02 | • Kabelbelegung aufgenommen | 24.02.09 | PL/ch |