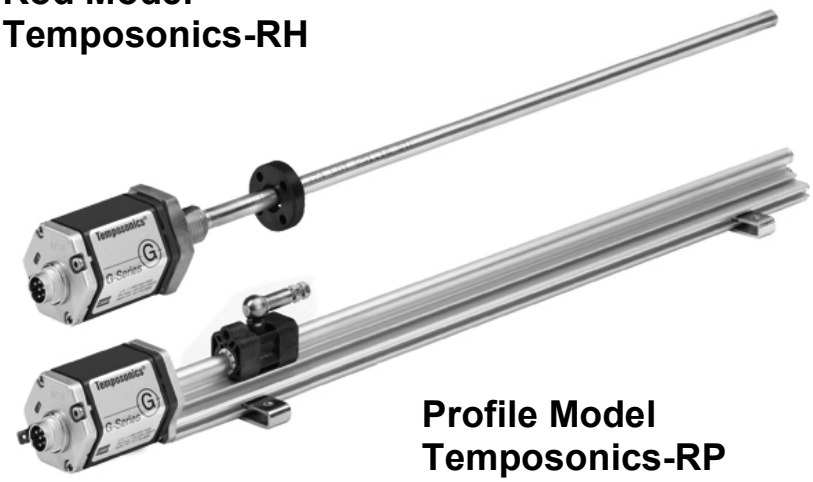
Temposonics®

The Magnetostrictive Position Sensors

MTS SENSORS

Temposonics R-Series

Rod Model
Temposonics-RH



Profile Model
Temposonics-RP

CAN Bus Interface

CANopen Data Protocol 304

Part 2 - Configuration and CAN-Bus Coupling

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1. CAN Bus Interface

CAN-Bus (Controller Area Network) is designed for high-speed data exchange at machine level. CAN is a vendor independent open fieldbus system, based on standard ISO 11898. CAN specifies the functional and technical parameters with which the intelligent digital automation devices can be networked via a master-slave serial link by using a communication profile. Protocol architecture (see below) of functional and applications data is oriented to the OSI reference model (ISO 7498). Bus technology is administrated and devoloped by the user organisation CiA (CAN in Automation).

SOF	Arbitration		Control	Data Field	CRC	ACK			EOF	Interframe Space
1	11	1	6	0..8 Bytes	15	1	1	1	7	≥ 3

Fig. CAN Bus data protocol

2. System Description

TEMPOSONICS sensors are suitable for all CAN Bus transmission protocols, for example the CANopen protocol which is described as follows. The CANopen protocol is suitable for use in all corresponding standard devices/units available on the market.

The sensor can be used as a CAN-Bus Slave in networks with the CANopen data protocol CiA Standard DS 301 V3.0 and the encoder profile DS 406 V3.1. It can be connected directly to the Bus and acts as a node in the Bus system.

The evaluation electronics which are integrated in the sensor convert the measurements into CAN-data which are then transmitted to the Bus, where there can be picked up by the control unit and processed. The CAN-Bus uses the following communication objects in order to transfer the data:

The following communication objects are used for data transmission on the CAN bus:

SDO (Service Data Object)
The SDO messages are used for read and write access to all entries of the object dictionary. The main usage of this facility is the device configuration.

PDO (Process Data Object)
The real-time data transfer of position, velocity and limit switch states is performed by PDO messages. Which kind of data are transmitted in the maximum 8 byte wide data blocks can be configured over SDO messages.

SYNC-Object
The SYNC object is broadcasted periodically by the synchronisation device to all application devices. Synchronous PDOs will be transmitted to the controller after receiving the SYNC message.

Emergency-Object
Emergency messages are triggered by the occurence of a device internal fatal error situation and are transmitted from the concerned application device to the other devices with highest priority. This makes them suitable for interrupt type error alerts.

Nodeguard-Object
The Nodeguard object is used to monitor the whole network state. The Nodeguard object is sent cyclic to detect the sensor that the controler works well. On a missing Nodeguard object (i. e. controller stopped) the sensor automaticly can stop PDO data transmission to reduce the busload.

Heartbeat-Funktion*)
Instead of the node-guarding the heartbeat-function can be used. The Producer-Heartbeat-Time defines the time frame in which a new heartbeat message is being sent.

3. Configuration of Node Parameters

Each sensor (node) in the CAN network) is defined unique by the LMT/LSS address. This address consists of

LMT Adress:
Manufacturer: MTSGmbH
Product: T3_C304
Serial No.: 00000098440123 and

LSS Adress:
Vendor-ID: 0x40
Product Code: 0x43333034 (C304)
Revision No.: 0x00010001
Serial No.: 04301234

CAN bus specific parameters like baud rate and node address (Node ID) can be configured and recorded by LMT/LSS service routines.

Configure Baud rate
The maximum baud rate depends on cable length of the total CAN network. The sensor is shipped with a order dependent baud rate, printed on the sensor label. If necessary, the baud rate can be changed via LMT/LSS service.
Note:
The programming of baud rates is according to the LMT protocol. Please use the table given in DS205 of LMT protocol.

Cable length	Baud rate [kBit/s]
< 25 m	1.000
< 50 m	800
< 100 m	500
< 250 m	250
< 500 m	125
< 1000 m	50
< 2500 m	20

Fig. Baud rate according to cable length (see CiA DS 301)

Configure Node ID
Each node gets a node identifier (NodeID) for identitification in a CANopen network. Each NodeId can assigned only once in a CAN network. The NodeID can be in an area between 1 – 127. The default NodeId is set on **127** at factory.

Bus-Termination *)
The internal bus termination resistor (120 Ω) can be switched on by writing "1" to Object 2101 Subindex 0 and off by writing "0".

*) **for CAN update valid from Production # (FNr.) 0801 xxxx**

4. Configuration of Process Parameters

At boot up (power-on, reset) the sensor takes over the process parameters stored in the EEPROM. These parameters are on the first power up the default parameter or later the changed and stored data. The different identifier will be generated automatically if the NodeId will be changed. They can be changed later by using SDO services.

The encoder communication profile (Device Profile for Encoder – DS406 Vers. 3.1) is implemented in these sensors. The advantage of this profile is, that different devices from different manufacturers can be connected together or changed against other devices with this profile, because all devices with the same communication profile have nearly the same parameter.

How to program which kind of operating parameter is described in the following object dictionary.

PDO transmission type
The default value for the PDO transmission type is asynchronous. This means that the sensor transmits its process data cyclic with a programmed cycle time. It is possible to set the PDO transmission type synchronous after receiving a SYNC message.

Event timer/Cyclic timer

The cycle time defines the the transmission period for all asynchronous PDOs. A cyclic transmission of the position value is set, when the cyclic timer is programmed > 0. Values between 1 and 65535 ms can be selected. Changes in Object 6200 have only effects on PDO1 (see DS406 V3.0)

PDO Object mapping
The default values for the PDO mapping objects are set that PDO1 to PDO4 transmits the position, the velocity and the limit switch status of magnet 1 to magnet 4. It is possible to change these mapping parameter. The maximum data length for each PDO is 8 byte.

Measuring range
It is possible to program the transducer with a work area. If one or both of the magnets will leave these work area it is indicated by the sensor with an extra message. This prevents that no magnet can leave the work area without detection.

Limit values
It is possible to program the low limits and the polarity of CAMs. Therefore a fast comparison between set point and actual value is realized.

Male function
The sensor itself transmits automatically emergency objects, if an error occured. These errors can be sensor specific or communication specific.

5. Emergency-Object

After starting the system (power-on, reset) the sensor transmits an emergency object without any data (power-on message) to indicate the controler that he is present in the network. Later the transmission of emergency objects is triggered by a changement of the internal error status register (also if an occured error is removed). An emergency-objekt consists of 8 data byte and is build like shown.

Byte	0	1	2	3 ... 7
Content	Error code		Error register	Manufacturer specific

Fig. Emergency-Object

The following error messages can be set in the emergency object:

Error code	Function
00 00	No error
50 00	Device Hardware (i.e. no magnet)
81 00	Communications error
31 00	Main voltage error
81 30	Life guard error
63 00	Data set error
81 20	Node in CAN passive mode

6. Process-Data-Objects (PDO)

The sensor provides four process-data-objects (PDO). These PDOs can contain position data, velocity data or limit switch status data. Configuration of each PDO can be done by the user. By using the SDO services it is possible to give each PDO its own mapping.

Data formats
The resolution of the position data is according to the value in the ordering guide. According to the resolution of the position data is the resolution of the velocity.

The programmed values can be read at index 6005 of the object dictionary.

The position data output is a 32 bit integer value; the volocity data output is a 16 bit integer value. The limit switch status is a 8 bit value within bit 0 to 3 corresponds to the limit switch 0 to 3.

Byte	0	1	2	3	4	5	6	7
PDO 1	Position Magnet 1				Speed Magnet 1		Limit status Magnet 1	free
PDO 2	Position Magnet 2				Speed Magnet 2		Limit status Magnet 2	free
PDO 3	Position Magnet 3				Speed Magnet 3		Limit status Magnet 3	free
PDO 4	Position Magnet 4				Speed Magnet 4		Limit status Magnet 4	free

Fig. PDO Default Mapping

7. Object Dictionary

The following object dictionary of TEMPOSONIC sensors is devided into two parts. These parts are:
Communication Profile describes all parameter necessary for the communication like setting identifier or configuration of PDOs etc.

The Device Profile
describes all parameter necessary for the operation of the sensor like resolution of position data, resolution of velocity data or cycle time etc.

7.1 Communication Profile Area

Index	Sub-index	Name	Type	Attri-bute	Default value	Comment
1000	0	device type	Unsigned32	ro	x196 x0A	Device Profile 406 multi-sensor encoder interface
1001	0	error register	Unsigned8	ro	0	0x00: no error 0x11: communication error 0x05: poker supplì error 0x81: sensor error 0x85: sensor, voltage error 0x15: communication, power supply error 0x91: communication, sensor error 0x95: communication, sensor, power supply error
1004	0 1 2	number of PDOs supported	Unsigned32 Unsigned32 Unsigned32	ro ro ro	4 4 4	number of PDOs supported number of synchronous PDOs number of asynchronous PDOs
1005	0	COB-ID SYNC-message	Unsigned32	rw	80h	COB-ID SYNC-message
1008	0	manufacturer device name	Visible String	const	C304	device name
1009	0	manufacturer hardware version	Visible String	const	1.00	hardware version release
100A	0	manufacturer software version	Visible String	const	1.00	software version release
100B	0	Node-ID	Unsigned32	ro	127	Node-ID can be changed via LMT or LSS protocol (maximum 127)
100C	0	guard time	Unsigned16	rw	0	guard time in ms multiplied by the life time factor
100D	0	life time factor	Unsigned8	rw	0	life time set-up for the Node Guarding Protocol
100E	0	COB-ID guarding protocol	Unsigned32	rw	700h+ Node-ID	node guarding identifier (should not be changed)
100F	0	number of SDO supported	Unsigned32	ro	1	number of SDO supported
1010	0 1	store parameters	Unsigned8 Unsigned32	ro rw	1 1	number of largest sub-index writing signature ‘save‘ will store all parameters into EEPROM (73, 61, 76, 65)
1011	0 1	restore default parameters	Unsigned8 Unsigned32	ro rw	1 1	number of largest sub-index writing signature ‘load‘ will load all parameters with default values (6C, 6F, 61, 64)
1014	0	COB-ID Emergency	Unsigned32	rw	80h+ Node-ID	COB-ID emergency message
1017 [a)]		Producer heartbeat time	Unsigned16		0	Producer Heartbeat time in multiples of 1 ms
1018	0 1 2 3 4	Identity Object	Unsigned8 Unsigned32 Unsigned32 Unsigned32 Unsigned32	ro ro ro ro ro	4 0x40 0x43333034 xxxx xxxx	Number of Entries Vendor-ID Product Code (ASCII C304) Revision number Serial number
1200	0 1 2	1st Server SDO parameter	Unsigned8 Unsigned32 Unsigned32	ro ro ro	2 600h+ Node-ID 580h+ Node-ID	Number of largest sub-index COB-ID Client -> Server (rx) COB-ID Server -> Client (tx)

[*)] **for CAN update valid from Production # (FNr.) 0801 xxxx**

7.1 Communication Profile Area (continuation)

Index	Sub-index	Name	Type	Attri-bute	Default value	Comment
1800	0	1st transmit PDO	Unsigned8	ro	5	number of largest sub-index
	1	parameter	Unsigned32	rw	180h+ Node-ID	COB-ID used by PDO1
	2		Unsigned8	rw	254	transmission type of PDO1 0: transmission on SYNC message 254: transmission runs asynchronous
	5		Unsigned16	rw	1	event timer
1801	0	2nd transmit PDO	Unsigned8	ro	5	number of largest sub-index
	1	parameter	Unsigned32	rw	80000280h+ Node-ID	COB-ID used by PDO2
	2		Unsigned8	rw	254	transmission type of PDO2 0: transmission on SYNC message 254: transmission runs asynchronous
	5		Unsigned16	rw	0	event timer
1802	0	3rd transmit PDO	Unsigned8	ro	5	number of largest sub-index
	1	parameter	Unsigned32	rw	80000380h+ Node-ID	COB-ID used by PDO3
	2		Unsigned8	rw	254	transmission type of PDO3 0: transmission on SYNC message 254: transmission runs asynchronous
	5		Unsigned16	rw	0	event timer
1803	0	4th transmit PDO	Unsigned8	ro	5	number of largest sub-index
	1	parameter	Unsigned32	rw	80000480h+ Node-ID	COB-ID used by PDO4
	2		Unsigned8	rw	254	transmission type of PDO4 0: transmission on SYNC message 254: transmission runs asynchronous
	5		Unsigned16	rw	0	event timer
1A00	0	1st transmit PDO	Unsigned8	rw	3	number of largest sub-index
	1	mapping	Unsigned32	rw	60200120	1st mapping parameter
	2		Unsigned32	rw	60300110	2nd mapping parameter
	3		Unsigned32	rw	63000108	3rd mapping parameter
	4		Unsigned32	rw	0	4th mapping parameter
1A01	0	2nd transmit PDO	Unsigned8	rw	3	number of largest sub-index
	1	mapping	Unsigned32	rw	60200220	1st mapping parameter
	2		Unsigned32	rw	60300210	2nd mapping parameter
	3		Unsigned32	rw	63000208	3rd mapping parameter
	4		Unsigned32	rw	0	4th mapping parameter
1A02	0	3rd transmit PDO	Unsigned8	rw	3	number of largest sub-index
	1	mapping	Unsigned32	rw	60200320	1st mapping parameter
	2		Unsigned32	rw	60300310	2nd mapping parameter
	3		Unsigned32	rw	63000308	3rd mapping parameter
	4		Unsigned32	rw	0	4th mapping parameter
1A03	0	4th transmit PDO	Unsigned8	rw	3	number of largest sub-index
	1	mapping	Unsigned32	rw	60200420	1st mapping parameter
	2		Unsigned32	rw	60300410	2nd mapping parameter
	3		Unsigned32	rw	63000408	3rd mapping parameter
	4		Unsigned32	rw	0	4th mapping parameter

Access attributes: ro = read only
rw = read/write

7.2 Device Profile Area – DS406

Index	Sub-index	Name	Type	Attri-bute	Default value	Comment
6000	0	operating parameter	Unsigned16	rw	4h	operating parameters
6002	0	Total measuring range	Unsigned32	rw	xxxx	measuring range in measuring increments
6005	0	linear encoder	Unsigned8	ro	2	number of objects
	1	measuring step	Unsigned32	ro	5000	position measuring step in 0.001µm
	2	settings	Unsigned32	ro	50	speed measuring step in 0.01 mm/s
6010	0	preset value	Unsigned8	ro	4	number of available channels
	1		Integer32	rw	0	preset value channel 1
	2		Integer32	rw	0	preset value channel 2
	3		Integer32	rw	0	preset value channel 3
	4		Integer32	rw	0	preset value channel 4
6020*	0	position value	Unsigned8	ro	4	number of available channels
	1*		Integer32	ro	no	position value channel 1
	2*		Integer32	ro	no	position value channel 2
	3*		Integer32	ro	no	position value channel 3
	4*		Integer32	ro	no	position value channel 4
6030*	0	speed value	Unsigned8	ro	4	number of available channels
	1*		Integer16	ro	no	speed value channel 1
	2*		Integer16	ro	no	speed value channel 2
	3*		Integer16	ro	no	speed value channel 3
	4*		Integer16	ro	no	speed value channel 4
6200	0	cyclic timer	Unsigned16	rw	1	cyclic timer value in ms if value > 0
6300*	0	CAM state register	Unsigned8	ro	4	number of available channels
	1*		Unsigned8	ro	no	CAM state channel 1
	2*		Unsigned8	ro	no	CAM state channel 2
	3*		Unsigned8	ro	no	CAM state channel 3
	4*		Unsigned8	ro	no	CAM state channel 4
6301	0	CAM enable register	Unsigned8	ro	4	number of available channels
	1		Unsigned8	rw	0	CAM enable channel 1
	2		Unsigned8	rw	0	CAM enable channel 2
	3		Unsigned8	rw	0	CAM enable channel 3
	4		Unsigned8	rw	0	CAM enable channel 4
6302	0	CAM polarity register	Unsigned8	ro	4	number of available channels
	1		Unsigned8	rw	0	CAM polarity channel 1
	2		Unsigned8	rw	0	CAM polarity channel 2
	3		Unsigned8	rw	0	CAM polarity channel 3
	4		Unsigned8	rw	0	CAM polarity channel 4
6310	0	CAM 1 low limit	Unsigned8	ro	4	number of available channels
	1		Integer32	rw	0	CAM 1 low limit channel 1
	2		Integer32	rw	0	CAM 1 low limit channel 2
	3		Integer32	rw	0	CAM 1 low limit channel 3
	4		Integer32	rw	0	CAM 1 low limit channel 4
6311	0	CAM 2 low limit	Unsigned8	ro	4	number of available channels
	1		Integer32	rw	0	CAM 2 low limit channel 1
	2		Integer32	rw	0	CAM 2 low limit channel 2
	3		Integer32	rw	0	CAM 2 low limit channel 3
	4		Integer32	rw	0	CAM 2 low limit channel 4
6312	0	CAM 3 low limit	Unsigned8	ro	4	number of available channels
	1		Integer32	rw	0	CAM 3 low limit channel 1
	2		Integer32	rw	0	CAM 3 low limit channel 2
	3		Integer32	rw	0	CAM 3 low limit channel 3
	4		Integer32	rw	0	CAM 3 low limit channel 4
6313	0	CAM 4 low limit	Unsigned8	ro	4	number of available channels
	1		Integer32	rw	0	CAM 4 low limit channel 1
	2		Integer32	rw	0	CAM 4 low limit channel 2
	3		Integer32	rw	0	CAM 4 low limit channel 3
	4		Integer32	rw	0	CAM 4 low limit channel 4

7.2 Device Profile Area – DS406 (continuation)

Index	Sub-index	Name	Type	Attri-bute	Default value	Comment
6400*	0	area state register	Unsigned8	ro	4	number of available channels
	1*		Unsigned8	ro	no	work area state channel 1
	2*		Unsigned8	ro	no	work area state channel 2
	3*		Unsigned8	ro	no	work area state channel 3
	4*		Unsigned8	ro	no	work area state channel 4
6401	0	work area low limit	Unsigned8	ro	4	number of available channels
	1		Integer32	rw	min	work area low limit channel 1
	2		Integer32	rw	min	work area low limit channel 2
	3		Integer32	rw	min	work area low limit channel 3
	4		Integer32	rw	min	work area low limit channel 4
6402	0	work area high limit	Unsigned8	ro	4	number of available channels
	1		Integer32	rw	max	work area high limit channel 1
	2		Integer32	rw	max	work area high limit channel 2
	3		Integer32	rw	max	work area high limit channel 3
	4		Integer32	rw	max	work area high limit channel 4

*** index can be set into PDO mapping parameters**

Index	Sub-index	Name	Typ	Attri-bute	Default value	Comment
6500	0	operating status	Unsigned16	ro	no	operating status
6501	0	measuring step	Unsigned32	ro	xxxx	position measuring step in 0.001µm
6503	0	alarms	Unsigned16	ro	no	alarms for emergency message
6504	0	supported alarms	Unsigned16	ro	1	supported alarms bit 0: position error
6505	0	warnings	Unsigned16	ro	no	warnings
6506	0	supported warnings	Unsigned16	ro	4	CPU watchdog status
6507	0	profile and software version	Unsigned32	ro	3.1 4.01	device profile version manufacturer specific version
650A	0	module identification	Unsigned8	ro	3	number of entries
	1		Integer32	ro	0	manufacturer offset value
	2		Integer32	ro	min	manufacturer minimum position value
	3		Integer32	ro	max	manufacturer maximum position value
650B	0	serial number	Unsigned32	ro	xxxx	serial number of device
650C	0	Offset value for multi	Unsigned8	ro	4	number of availlable channels
	1	Sensor device	Integer32	ro	0	offset value channel 1
	2		Integer32	ro	0	offset value channel 2
	3		Integer32	ro	0	offset value channel 3
	4		Integer32	ro	0	offset value channel 4

7.3 Manufacturer Specific Profile Area

Index	Sub-index	Name	Typ	Attri-bute	Default value	Comment
2101**	0	enable bus termination	BOOLEAN	rw	false	enable CAN bus termination (120 Ohm)
2901**	0	temperature	Unsigned8	ro	5	number of objects
	1		Integer8	ro	x	actual temperature
	2		Integer8	ro	x	max. temperature since startup
	3		Integer8	ro	x	min. temperature since startup
	4		Integer8	ro	x	max. temperature over operational life
	5		Integer8	ro	x	min. temperature over operational life

Access attributes: ro = read only
rw = read/write

** **for CAN update valid from Production # (FNr.) 0801 xxxx**

8. Getting Started

After power on or reset all hardware components of the TEMPOSONICS sensors are initialized. Therefore the sensor is at a defined output state. Following the sensor reads all device and communication specific parameters off the EEPROM and takes these to configure its objects. If the initialization is finished the sensor automatically switches into the pre-operational status. At this state it is possible to configure parameters over the Service Data Objects. The SDO-identifier will be set automatically by using the NodeId according the CANopen specification. Therefore the communication via SDOs is a peer-to-peer-connection. The identifier for the other objects are set also automatically according the CANopen standard. A changement of these is possible in a CANopen network by using a DBT-Master. Changed parameter can be stored in an EEPROM and are loaded automatically after the next power on or reset.

The sensor can be switched from the pre-operational into the operational status by using the Start_Remote_Node service. In the operational status the sensor can transmit process data (via PDO). The transmission of PDOs can be done in two different modes. It is possible that the sensor transmits its data cyclic or the transmission is started by receiving a SYNC-message.

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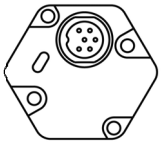
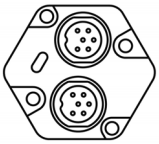
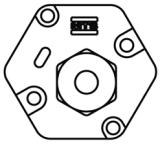
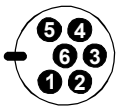
9. Connection Diagrams

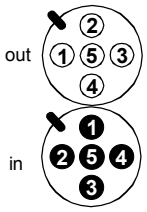
View: front of sensor connector resp. back of mating connector

6 pin M16 connector **6 pin M16 connector (2x)** **Cable outlet**

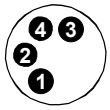
Pin	Cable	Signal
1	gray	CAN (-)
2	pink	CAN (+)
3	---	---
4	---	---
5	brown	+ 24 VDC (-15/+20%)
6	white	DC Ground

5 pin M12 connector (2x) + 4 pin M8 connector

5 pin M12 connector (Bus)

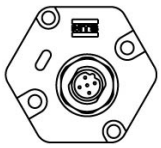
Pin	Signal
1	Screen
2	---
3	---
4	CAN (+)
5	CAN (-)



4 pin M8 Stecker (Power supply)

Pin	Cable	Signal
1	brown	+ 24 VDC (-15/+20%)
2	white	---
3	blue	DC Ground
4	black	---

5 pin M12 connector




5 pin M12 connector

Pin	Signal
1	Screen
2	+ 24 VDC (-15/+20%)
3	DC Ground
4	CAN (+)
5	CAN (-)

10. Status Leds

Green	Red	Description
ON	OFF	Normal operation (Operation mode)
ON	ON	Position magnet not detected or missing
OFF	ON	Sensor start-up failure
Flashing	Flashing	Power supply out of specified limits

Document Part Number: 140108 (EN)

MTS SENSORS

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