Temposonics
AN AMPHENOL COMPANY

Protocol Manual

MH-Series CANopen

Magnetostrictive Linear Position Sensors

Document Part No.
901493 Revision 0.4

1. History

Rev.	By	Date	Changes	Areas Affected	Comments
0.1	PL	April 13th 2010	First released		
0.2	PL	February 11th 2011	Manufacturer Area deleted		
0.3	PL	March 18th 2011	Deleted PDO message format now only standard	Formally 12 11.1.4	
0.4	PL	Jan 28th 2013	Object table overworked	10.3	

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5 Abbreviations

Tx	-	MH CANopen sensor is the producer of the CAN data frame
Rx	-	MH CANopen sensor is the consumer of the CAN data frame
SDO	-	Service Data Object
PDO	-	Process Data Object
SRDO	-	Safety Relevant Data Object
CiA	-	CAN in Automation e.V.
ro	-	read only
rw	-	read/write
wo	-	write only

6 Abbreviations

This document reflects the MTS Position Sensor protocol implementation of the standard CANopen protocol.
The Sensor supports the CANopen Communication profile DS301 V4.02, the Encoder profile DS406 V3.2 and the LSS Services DS305 V2.1.1

7 Network Management

The MH CANopen sensor is used in a CANopen network with a slave functionality,
So, normally a CANopen master has the control over the MH CANopen sensor in a CANopen network.

The following description is part of the CANopen communication profile DS301.

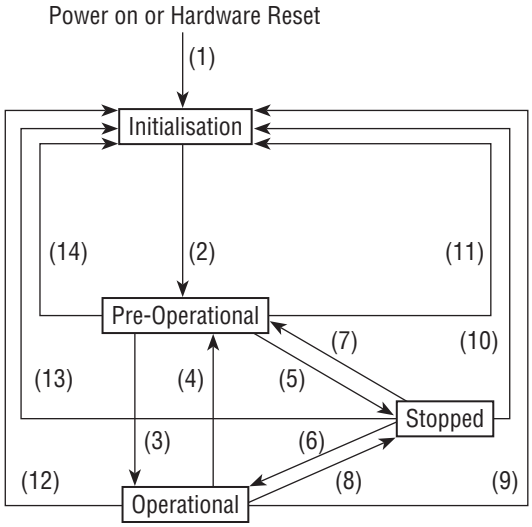

Figure 1 MNT State machine

(1)	At Power on the initialisation state is entered autonomously
(2)	Initialisation finished - enter PRE-OPERATIONAL automatically
(3),(6)	Start_Remote_Node indication
(4),(7)	Enter_PRE-OPERATIONAL_STATE
(5),(8)	Stop_Remote_Node indication
(9),(10),(11)	Reset_Node indication
(12),(13),(14)	Reset Communication indication

Table 1 Trigger for State Transition

7.1 Module Control Protocol

The following messages are not confirmed by the MH CANopen sensor.

7.1.1 Start_Remote_Node indication (3),(6)

Through this service the NMT Master sets the state of the selected NMT slaves to OPERATIONAL.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x000	Rx	2	0x01	PAR	-	-	-	-	-	-

Figure 2 Start Node message

PAR - 0 All devices
PAR - Node ID This device

7.1.2 Enter_PRE-OPERATIONAL_STATE indication (4),(7)

Through this service the NMT Master sets the state of the selected NMT slave(s) to „PREOPERATIONAL“.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x000	Rx	2	0x80	PAR	-	-	-	-	-	-

Figure 3 Enter Pre-Operational message

PAR - 0 All devices
PAR - Node ID This device

7.1.3 Stop_Remote indication (5),(8)

Through this service the NMT Master sets the state of the selected NMT slaves to STOPPED.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x000	Rx	2	0x02	PAR	-	-	-	-	-	-

Figure 4 Stop Node message

PAR - 0 All devices
PAR - Node ID This device

7.1.4 Reset_Node indication (9),(10),(11)

Through this service the NMT Master sets the state of the selected NMT Slave(s) from any state to the „reset application“ sub-state.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x000	Rx	2	0x81	PAR	-	-	-	-	-	-

Figure 5 Reset Node message

PAR - 0 All devices
PAR - Node ID This device

7.1.5 Reset_Communication indication (12),(13),(14)

Through this service the NMT Master sets the state of the selected NMT Slave(s) from any state to the „reset communication“ sub-state. After completion of the service, the state of the selected remote nodes will be RESET COMMUNICATION.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x000	Rx	2	0x82	PAR	-	-	-	-	-	-

Figure 6 Reset Communication message

PAR - 0 All devices
PAR - Node ID This device

7.2 Network initialisation

When powering the sensor or after a NMT Reset command (7.1.4 and 7.1.5) or after an internal Reset the sensor enters automatically the NMT Initialisation state. In this state the MH CANopen sensor loads all parameter from the non-volatile memory into the RAM of the internal microcontroller. Also the microcontroller performs several test function and configuration tasks. In this state is no communication with the MH CANopen sensor possible. After finishing the NMT Initialisation state the MH CANopen sensor enters automatically the NMT Pre-Operational state. During that state transition the MH CANopen sensor sends automatically its Boot-up protocol message.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x700 + Node-ID	Tx	2	0x00	-	-	-	-	-	-	-

Figure 7 Boot-up protocol message

Note:
The COB-ID of the Boot-up protocol is the same as for the heartbeat message.
This COB-ID can be individually programmed with Index 100E. (see 10.2)
So the COB-ID of the Boot-up message can be different.

7.3 Network Pre-Operational state

In the PRE-OPERATIONAL state, the communication via Service Data Objects (see 10.2 SDO Objects) with the MH CANopen Sensor is possible. Process Data Objects (see 11.1 PDOs) do not exist, so PDO communication is not allowed. Configuration of PDOs, and device parameters may be performed by a configuration application. Also the Emergency Objects and Error Control Service like the MH CANopen Sensors 'Heartbeat message' are allowed in this state. The node may be switched into the Operational state directly by sending a Start_Remote_Node (3) (7.1.1)

7.4 Network Operational State

In the OPERATIONAL state all communication objects are active. Transitioning to OPERATIONAL creates all PDOs and (see 11.1).
The constructor uses the parameters as described in the Object Dictionary. Object Dictionary Access via SDO is possible.

7.5 Network Stopped State

By switching a device into the Stopped state it is forced to stop the communication altogether (exceptnode guarding and heartbeat, if active). Furthermore, this state can be used to achieve certain application behaviour. The definition of this behaviour falls into the scope of device profiles.

8 Emergency Object / Mal function

Emergency objects are triggered by the occurrence of a MH CANopen Sensor internal error situation. An emergency object is transmitted only once per ‚error event'. If one or all errors are repaired, the device transmits an emergency object with the error code 'reset error / no error'. This message contains also Error register with the remaining Errors.

For the MH CANopen Sensor are two Error conditions defined. This is the 'Device Hardware Error' and the 'Data Set Error'.

The 'Data Set Error' is send by the MH CANopen Sensor when internal test function detects a mismatch between the new calculated and the stored checksum of the non-volatile memory of the sensor. The checksum is checked during the NMT Initialisation state. The checksum is also checked when the LSS Store Configuration Data command 10.1.4) or a valid SDO download to Object 1010h – Store parameters is received. This Error can only be cleared by a reset of the device and a successful checksum comparison in the new initialization state.

The 'Device Hardware Error' is send when the Microcontroller detects no Stop pulses during one measuring cycle and when the Error Counter runs out.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x80 + Node-ID	Tx	8	Emergency Error Code		Error Register Object 1001h	0x00	0x00	0x00	0x00	0x00

Figure 8 Emergency Object message

The possible Error Codes are:

Error Code (hex)	Meaning
0x0000	Error Reset or No Error
0x5000	Device Hardware
0x6300	Data Set

Table 2 Error Code

The Error Register can contain the following data:

Error Code (hex)	Meaning
0x00	No Error
0x01	Data Set Error
0x81	Device Hardware Error or Device Hardware Error and Data Set Error

Table 3 Error Register

Note:
The COB-ID of the Emergency Object message can be individually programmed with Index 1014. (see 10.2) So the COB-ID of the Emergency message can be different.

9 Error Control Service

Through Error control services the NMT detects failures in a CAN-based Network. When the Error Control service is enabled the MH CANopen Sensor transmits a Heartbeat message cyclically. One or more Heartbeat Consumer receives the indication. The relationship between producer and consumer is configurable via the object dictionary by SDO. By default the Heartbeat is disabled. The first byte of the Heartbeat message contains the actual Network Management State of the MH CANopen Sensor.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x700 + Node-ID	Tx	1	STATE	-	-	-	-	-	-	-

Figure 9 Heartbeat Protocol message

STATE	Meaning
0x00	Bootup
0x04	Stopped
0x05	Operational
0x7F	Pre-Operational

Table 4 Heartbeat Protocol Data

Note:
This COB-ID can be individually programmed with Index 100E. (see 10.2)
So the COB-ID of the Heartbeat Protocol message can be different.

10 Configuration

The complete configuration of the MH CANopen Sensor is done through the CAN Bus interface.

10.1 LSS Protocol for CANopen

Every CANopen Device must have a unique Node-Identifier in the actual CANopen network. The Node Id and the Baud rate can be programmed by using the LSS Protocol DS305 published by the CiA.
To program the Node ID and/or the Baud rate the MH CANopen Sensor has change to the LSS Configuration State. There are two ways to switch the MH CANopen Sensor to the LSS Configuration State.

- **LSS Switch Mode Selective**
  In this case only the addressed device is switched to the LSS Configuration State.
  The configuration tool uses the unique LSS Address.
  The MH CANopen LSS Address has the following structure:

LSS Address	Meaning
Vendor-ID	0x40
Product Code	0x43787800
Revision Number	0x312E3031
Serial Number	Actual MH CANopen Sensors Serial Number

Table 5 LSS Address

With the following sequence you can switch the MH CANopen sensor to the LSS Configuration State

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x7E5	Rx	8	0x40	0x40	0x00	0x00	0x00	0x00	0x00	0x00
0x7E5	Rx	8	0x41	0x00	0x78	0x78	0x43	0x00	0x00	0x00
0x7E5	Rx	8	0x42	0x31	0x30	0x2E	0x31	0x00	0x00	0x00
0x7E5	Rx	8	0x43	0x34	0x12	0x50	0x09	0x00	0x00	0x00
0x7E5	Tx	8	0x44	0x00	0x00	0x00	0x00	0x00	0x00	0x00

Figure 10 LSS Switch Mode Selective sequence

- Serial Number in this example: 0x09501234

- **LSS Switch Mode Global**
  In this case all CANopen devices supporting the LSS Service are switched to the LSS Configuration State.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x7E5	Rx	8	0x04	0x01	0x00	0x00	0x00	0x00	-	-

Figure 11 LSS Switch Mode Global

When the CANopen devices are in Configuration State the Node ID and/or the Baud rate can be changed.

10.1.1 Node ID

With the following command the Node ID can be programmed.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x7E5	Rx	8	0x11	N ID	0x00	0x00	0x00	0x00	0x00	0x00
0x7E4	Tx	8	0x11	Err Code	0x00	0x00	0x00	0x00	0x00	0x00

Figure 12 Configure Node ID protocol

N ID The new Node ID in the range of 1 to 127
Err Code 0 - protocol successfully completed
1 - Node ID out of range

Note:
The new Node ID gets immediately active after a successful Response message of the MH CANopen sensor.
The following COB-IDs are automatically updated according to the Pre-defined Connection Set of the #2 DS301.
SDO(Tx); SDO(Rx); Emergency; Error control; PDO1(Tx)

10.1.2 Baud rate

With the following command the Baud rate can be programmed.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x7E5	Rx	8	0x13	0x00	Table Index	0x00	0x00	0x00	0x00	0x00
0x7E4	Tx	8	0x13	Err Code	0x00	0x00	0x00	0x00	0x00	0x00

Figure 13 Configure Bit-timing parameters protocol

Table index	Bit rate
0	1000 kbit/s
1	800 kbits
2	500 kbit/s
3	250 kbit/s
4	125 kbit/s
5	Reserved
6	50 kbit/s
7	20 kbit/s
8	10 kbit/s

Table 6 Baud rate indices

Err Code: 0 - protocol successfully completed
1 - Bit timing not supported

Note:
The Baud rate gets active after receiving the ‘Activate Bit timing parameters‘ command or after the ‘Store Configuration Data‘ command with the next Power on Reset.

10.1.3 Activate Bit timing parameter

With the following command the LSS master shall activate the bit timing defined by the configure bit timing parameters service.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x7E5	Rx	8	0x15	Switch delay		0x00	0x00	0x00	0x00	0x00

Figure 14 Activate Bit timing protocol

Switch delay: Time in ms internal multiplied by 2 when the new Bit timing parameters become active.

Note:
No communication should be performed until the (2*Switch delay) time runs out.

10.1.4 Store Configuration Data

With the following command the LSS Configuration Data (Node ID and Baud rate) is stored to the nonvolatile memory of the MH CANopen sensor.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x7E5	Rx	8	0x17	0x00	0x00	0x00	0x00	0x00	0x00	0x00
0x7E4	Tx	8	0x17	Err Code	0x00	0x00	0x00	0x00	0x00	0x00

Figure 15 Store LSS Configuration protocol

Err Code: 0 - Protocol successfully completed
2 - Storage media access error

10.1.5 Inquiry and identification services

The MH CANopen sensor supports also the inquiry and identification services described in the LSS protocol. (See #1 DS 305 for details).

10.2 SDO Services

With Service Data Objects (SDO) the access to entries of a device Object Dictionary is provided.

10.2.1 SDO Download

The SDO Download service is used to configure the communication, device and manufacturer specific parameters of the MH CANopen sensor.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x600 + Node ID	Rx	8	0x2x	Index		Subindex	Data LSB	Data	Data	Data MSB
0x580 + Node ID	Tx	8	0x60	Index		Subindex	0x00	0x00	0x00	0x00

Figure 16 SDO Download protocol

D0 0x2x: x depends upon the data size of the transferred data (see #2 DS301)
Index: Object dictionary parameter index
Subindex: Object dictionary parameter subindex

10.2.2 SDO Upload

The SDO Upload service is used to read the communication, device and manufacturer specific parameters of the MH CANopen sensor.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x600 + Node ID	Rx	8	0x40	Index		Subindex	0x00	0x00	0x00	0x00
0x580 + Node ID	Tx	8	0x42	Index		Subindex	Data LSB	Data	Data	Data MSB

Figure 17 SDO Upload protocol

Index: Object dictionary parameter index
Subindex: Object dictionary parameter subindex

10.2.3 SDO Abort

If the SDO Download or SDO Upload service fails for any reason the MH CANopen sensor responds not with the corresponding SDO message. The MH CANopen sensor responds with a SDO Abort protocol.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x580 + Node ID	Tx	8	0x80	Index		Subindex	Abort code			

Figure 18 SDO Abort protocol

Abort Code	Meaning
0x06090011	Subindex does not exist
0x06090030	Value exceeded
0x06020000	Object does not exist
0x06010001	Object is write only
0x06010002	Object is read only
0x08000020	Data transport error
0x08000000	General error
0x08000022	Wrong state

Table 7 SDO abort codes

10.3 Object dictionary

The following table shows all parameters implemented in the MH CANopen sensor.

Communication Profile Area

Index	Subindex	Name	Typ	Attribute	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 0x81: transducer error
1002	0	manufacturer status register	unsigned8	ro	1	Additional status register
1005	0	COB-ID SYNC-message	unsigned32	rw	80h	COB-ID SYNC-message
1008	0	manufacturer device name	visible string	const	C01	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 LSS protocol
100E	0	COB-ID Error Control	unsigned32	rw	700h + Node ID	error control identifier (should not be changed)
1010	0 1	store parameters	unsigned8 unsigned32	ro rw	1 1	number of largest sub-index writing the 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 the 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	0	producer heartbeat time	unsigned16	rw	0	time period in ms
1018	0 1 2 3 4	identity object	unsigned8 unsigned32 unsigned32 unsigned32 unsigned32	ro ro ro ro ro	4 0x40 0x43787800 xxxx xxxx	number of entries Vendor-ID product code (ASCII C01) 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)

Index	Subindex	Name	Typ	Attribute	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
						transmission type of PDO1
	2		unsigned8	rw	254	0–240 : transmission on SYNC message
	5		unsigned16	rw	1	254: transmission runs asynchronous event timer
1A00	0	1st trasmit PDO	unsigned32	const	2	number of largest sub-index
	1	mapping	unsigned32	const	60200120	1st mapping parameter
	2		unsigned32	const	60300110	2nd mapping parameter

Device Profile Area - DS406

Index	Subindex	Name	Typ	Attribute	Default value	Comment
6000	0	operating parameter	unsigned16	rw	0	operating parameters
6005	0	linear encoder	unsigned8	ro	2	number of objects
	1	measuring step	unsigned32	ro	100000	position measuring step in 0.001 µm
	2	settings	unsigned32	ro	100	speed measuring step in 0.01 µm
6010	0	present value	unsigned8	rw	1	number of available channels
	1		integer32	rw	xxxx	present value channel 1
6020	0	position value	unsigned8	ro	1	number of available channels
	1		integer16	ro	no	position value channel 1
6030	0	speed value	unsigned8	ro	1	number of available channels
	1		integer16	ro	no	speed value channel 1
6200	0	cyclic timer	unsigned16	rw	1	cyclic timer value in ms if value > 0
6500	0	operating status	unsigned16	ro	no	operating status
6501	0	measuring step	unsigned32	ro	100000	position measuring step in 0.001 µm

10.3.1 SDO Objects

Object 1000_h - Device Type

Index	Sub	Name	Data type	Access	Range/Value	Default
1000_h	0	Device type	unsigned32	ro	0x000A0196	0x000A0196

Object 1000_h - Error Type

Index	Sub	Name	Data type	Access	Range/Value	Default
1001_h	0	Error register	unsigned8	ro	0x000A0196	0x000A0196

For details see 8 emergency object / mal function

Object 1002_h - Manufacture Status Register

Index	Sub	Name	Data type	Access	Range/Value	Default
1002_h	0	Manufacture Status Register	unsigned8	ro		1

Different to the #2 DS301 the data type of the MH CANopen sensor is unsigned8 instead of unsigned32.
The definition of the manufacture status register is as follows:

D7	D6	D5	D4	D3	D2	D1	D0
0	T	E3	E2	E1	E0	S	N

Figure 19 Manufacturer status register definition

N:	Status	0 = sensor in error state 1 = normal running state valid position and velocity data transmitted
S:	Start up	0 = normal running state 1 = start up or internal test mode
E0:	Magnet Error	0 = one magnet detected 1 = no or more than one magnet detected
E1:	Range Error	0 = no error 1 = the calculated position is out of range when also the position and velocity value is set to zero 1 = the velocity value maybe not correct
E2:	Data flash error	0 = no error 1 = the CRC check of data flash parameter memory failed
E3:	Controller error	0 = no error 1 = the internal test routines detects an error
T:	Temperature µC	0 = T < Max temperature 1 = T > Max temperature

Object 1005_h - COB-ID Sync

Index	Sub	Name	Data type	Access	Range/Value	Default
1005_h	0	COB-ID Sync	unsigned32	rw	0…0x7FF	0x80

This Object defines the COB-ID of the Sync Message used in the NMT Operational state for PDO in Synchronous mode.
The MH CANopen Sensor expects the Sync message with this defined COB-ID. The Sync is described in 11.1.1 Synchronous Mode.

Object 1008_h - Manufacturer Device Name

Index	Sub	Name	Data type	Access	Range/Value	Default
1008_h	0	Manufacturer device name	visible string	const		C01

Object 1009_h - Manufacturer Hardware Version

Index	Sub	Name	Data type	Access	Range/Value	Default
1009_h	0	Manufacturer Hardware Version	visible string	const		1.00

Object $100A_h$ - Manufacturer Software Version

Index	Sub	Name	Data type	Access	Range/Value	Default
$100A_h$	0	Manufacturer Software Version	visible string	const		1.00

Object $100B_h$ - Node ID

Index	Sub	Name	Data type	Access	Range/Value	Default
$100B_h$	0	Node ID	unsigned32	rw	1…127	127

Object $100E_h$ - COB-ID Error Control

Index	Sub	Name	Data type	Access	Range/Value	Default
$100E_h$	0	COB-ID error control	unsigned32	rw	0…0x7FF	0x700 + Node ID

This object defines the COB-ID of the heartbeat and boot-up message (see 9 error control service).

Object 1010_h - Store parameters

Index	Sub	Name	Data type	Access	Range/Value	Default
1010_h	0	Store parameters	unsigned8	ro	1	1
	1	All parameters	unsigned32	rw	0x73617665	0x73617665

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x600 + Node ID	Rx	8	0x23	0x10	0x10	0x01	0x73	0x61	0x76	0x65
0x580 + Node ID	Tx	8	0x60	0x10	0x10	0x01	0x00	0x00	0x00	0x00

Figure 20 Store all parameters command

A valid SDO download to this objects stores all changeable parameters of the communication and device profile to the non-volatile memory of the MH CANopen sensor.

Object 1011_h - Restore default parameters

Index	Sub	Name	Data type	Access	Range/Value	Default
1011_h	0	Restore default parameters	unsigned8	ro	1	1
	1	All parameters	unsigned32	rw	0x6C6F6164	0x6C6F6164

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x600 + Node ID	Rx	8	0x23	0x11	0x10	0x01	0x6C	0x6F	0x61	0x64
0x580 + Node ID	Tx	8	0x60	0x11	0x10	0x01	0x00	0x00	0x00	0x00

Figure 21 Restore default parameters command

A valid SDO Download to this object restores all changeable parameters of the communication and device profile in the non-volatile memory of the MH CANopen sensor. The new restored values become active after any reset of the MH CANopen Sensor. The restore values are defined in the # 2 DS301 and # 3 DS406.

Object 1014_h - COB-ID emergency

Index	Sub	Name	Data type	Access	Range/Value	Default
1014_h	0	COB-ID emergency	unsigned32	rw	0…0x7FF	0x80 + Node ID

This object defines the COB-ID of the emergency message (see 8 emergency object / mal function).

Object 1017_h - Producer heartbeat time

Index	Sub	Name	Data type	Access	Range/Value	Default
1017_h	0	Producer heartbeat time	unsigned16	rw	0…65535	0

With this object you can set the producer heartbeat time of the error control function of the MH CANopen sensor. The value is given in ms. Value 0 disables the heartbeat function. (see 9 Error Control Service)

Object 1018_h - Identity object

Index	Sub	Name	Data type	Access	Range/Value	Default
1018_h	0	Number of entires	unsigned8	ro	4	4
	1	Vendor-ID	unsigned32	rw	0x40	0x40
	2	Product code	unsigned32	rw	0x43787800	0x43787800
	3	Revision number	unsigned32	rw	0x312E3031	0x312E3031
	4	Serial number	unsigned32	rw		

The identity object contains general information about the MH CANopen sensor.
This information are also used as the LSS address when using the 'Switch mode selective' command.

Object 1200_h - 1st Server SDO parameter

Index	Sub	Name	Data type	Access	Range/Value	Default
1200_h	0	Number of entires	unsigned8	ro	2	2
	1	COB-ID client -> server (Rx)	unsigned32	ro		0x600 + Node ID
	2	COB-ID server -> client (Tx)	unsigned32	ro		0x580 + Node ID

Object 1800_h - 1st PDO parameter

Index	Sub	Name	Data type	Access	Range/Value	Default
1800_h	0	Largest subindex	unsigned8	ro	5	5
	1	COB-ID PDO	unsigned32	rw		0x180 + Node ID
	2	Transmission type	unsigned8	rw	0…255	254
	5	Event timer	unsigned16	rw	0…65535	1

Subindex 1 contains the COB-ID of the PDO. The PDO can also be disable with this parameter.

Bit number	Value	Meaning
31 (MSB)	0	PDO exists/valid
	1	PDO does not exist / is not valid
10-0 (LSB)	X	Bits of PDO COB-ID

Table 8 Description of PDO COB-ID entry

The transmission type (sub-index 2) defines the transmission character of the PDO.

Transmission type	PDO Transmission synchronous	PDO Transmission asynchronous	RTR only
0 - 240	X		
254; 255		X	
252; 253		X	X
241 - 251	not valid reserved		

Table 9 Transmission type values

For details about the PDO transmission mode see 11.1
If the transmission type is set to 254 or 255 the PDO transmission is asynchronous from the sync object. The PDO transmission rate is defined by the event timer or cyclic timer (Index 6200; 2).

Event timer	Meaning
0	PDO transmission disabled
1 - 65535	PDO transmission in [ms]

Table 10 Event timer

Object 1A00$_h$ - 1st transmit PDO mapping

Index	Sub	Name	Data type	Access	Range/Value	Default
1A00$_h$	0	Largest Subindex	unsigned8	const	2	2
	1	1st mapping parameter	unsigned32	const	60200120h	60200120h
	2	2nd mapping parameter	unsigned32	const	60300110h	60300110h

Object 6000$_h$ - Operating parameter

Index	Sub	Name	Data type	Access	Range/Value	Default
6000$_h$	0	Operating parameter	unsigned16	rw		0

This object is not supported by the MH CANopen sensor.

Object 6005$_h$ - Measuring steps

Index	Sub	Name	Data type	Access	Range/Value	Default
6500$_h$	0	Largest Subindex	unsigned8	ro	2	2
	1	Position measuring steps	unsigned32	ro		100000
	2	Speed measuring steps	unsigned16	ro		100

The position measuring steps are given in 0.001 µm. The default resolution of the MH CANopen sensor is 100 µm.
The speed measuring steps are given in 0.01 mm/s. This object is for user information.

Object 6010$_h$ - Present value

Index	Sub	Name	Data type	Access	Range/Value	Default
6010$_h$	0	Number of available channels	unsigned8	rw	1	1
	1	Present value channel 1	integer32	rw		

With the Preset function you can change the position output value of the actual magnet position to the downloaded preset value. The preset value can be read until the next reset. The preset value is not stored in the non-volatile memory. Only the calculated offset is stored in the non-volatile memory.

Object 6020$_h$ - Position value

Index	Sub	Name	Data type	Access	Range/Value	Default
6020$_h$	0	Number of available channels	unsigned8	ro	1	1
	1	Position value channel 1	integer32	ro		

This object contains the position value of the MH CANopen sensor and is mapped in the PDO.

Object 6030_h - Speed value

Index	Sub	Name	Data type	Access	Range/Value	Default
6030_h	0	Number of available channels	unsigned8	ro	1	1
	1	Speed value channel 1	integer16	ro		

This object contains the speed value of the MH CANopen sensor and is mapped in the PDO.

Object 6200_h - Cyclic timer

Index	Sub	Name	Data type	Access	Range/Value	Default
6200_h	0	Cyclic timer	unsigned16	rw		1

If the transmission type is set to 254 or 255 the PDO transmission is asynchronous from the sync object. The PDO transmission rate is defined by the cyclic timer or event timer (Index1800;5).

Cyclic Timer	Meaning
0	PDO transmission disabled
1 - 65535	PDO transmission in [ms]

Object 6500_h - Operating status

Index	Sub	Name	Data type	Access	Range/Value	Default
6500_h	0	Operating status	unsigned16	ro		0

This object is not supported by the MH CANopen sensor.

Object 6501_h - Measuring step

Index	Sub	Name	Data type	Access	Range/Value	Default
6501_h	0	Measuring step	unsigned32	ro		100000

This object has the same functionality as object 6005_h subindex 1.
The measuring step is given in 0.001 µm. The default resolution of the MH CANopen sensor is 100 µm.

11 Process data

11.1 Transmission the data

With the transmission type object (Index 1800,2) you can switch between the different transmission modes.

11.1.1 Synchronous mode

When the MH CANopen sensor is in NMT operational state and the transmission type (Index 1800,2) is between n = 0 – 240 the synchronous mode is enabled. The PDO is transmitted by the MH CANopen sensor after receiving every n-th SYNC object. The SYNC object has the following format.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x080	Rx	0	-	-	-	-	-	-	-	-

Figure 22 SYNC object

Note:
The COB-ID of the SYNC object message can be individually programmed with Index 1005 (see 10.2).
So the COB-ID of the SYNC message can be different.

11.1.2 Polling with remote frames

The polling of the PDO data with remote frames is independent from the transmission type (Index 1800,2).
The PDO is transmitted by the MH CANopen sensor after receiving the corresponding PDO remote frame.
The PDO remote frame has the following format.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
PDO COB-ID + RTR bit	Rx	0	-	-	-	-	-	-	-	-

Figure 23 PDO remote frame

11.1.3 Asynchronous mode

When the MH CANopen Sensor is in NMT operational state and the transmission type (Index 1800,2) is 254 or 255 the asynchronous mode is enabled. The PDO is transmitted by the MH CANopen sensor after the event timer (Index 1800,5) or cyclic timer (Index 6200) is expired. Both objects control the same timer. The value of the timer is given in ms.

11.1.4 PDO message format

This is the format of the MH CANopen sensor PDO message.
The PDO message mapping can be seen at Index 1A00.

COB-ID	Rx/Tx	DLC	Data							
			D0	D1	D2	D3	D4	D5	D6	D7
0x180 + Node ID	Tx	6	Pos LSB	Pos	Pos	Pos MSB	Speed LSB	Speed MSB	-	-

Figure 24 PDO format

For the PDO message the actual measuring steps for the position (Pos) and speed values an be read with object linear encoder measuring step settings (Index 6005).

Note:
The COB-ID of the PDO message can be individually programmed with Index 1800, 1 (see 10.2).
So the COB-ID of the PDO message can be different.

11.1.5 PDO error behaviour

The errors that can be detected by the MH CANopen sensor are defined in the object manufacture status register (Index 1002,0).

D7	D6	D5	D4	D3	D2	D1	D0
0	T	E3	E2	E1	E0	S	N

N: Status
0 = Sensor in error state
Any error except temperature µC
1 = Normal running state
Valid position and velocity data transmitted

S: Start up
0 = Normal running state
1 = Start up or internal test mode
No PDO communication possible

E0: Magnet Error
0 = One magnet detected
Valid position and velocity data transmitted
1 = no magnet detected
Position and velocity data set to zero
1 = No or more than one magnet detected
Valid position and velocity data of the first magnet transmitted

E1: Range Error
0 = No error
1 = The calculated position is out of range
Position and velocity value is set to zero
1 = Position buffer has not 100 consecutively valid position values
Valid position data transmitted
Velocity data maybe not correct

E2: Data flash error
0 = No error
1 = The CRC check of data flash parameter memory failed
Position and velocity data set to zero

E3: Controller error
0 = No error
1 = the internal test routines detects an error
Position and velocity data set to zero

T: Temperature µC
0 = T < Max temperature
1 = T > Max temperature
Position and velocity data transmitted

12 Literature

1 CiA DS305 CANopen Layer Setting Service (LSS) V2.1.1
2 CiA DS301 CANopen Application Layer and Communication Profile V4.02
3 CiA DS406 CANopen Device profile for encoders V3.1

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