ENGINEERING
TOMORROW

Operating Guide

Pressure Sensor with CANopen

Type DST P10B

Contents

1 General Information

1.1 Contact

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1.2 General

The pressure transmitter DST P10B measures the physical quantity pressure.

The range depends on the sensor which is used in the transmitter and is 0 - 50 bar. The measured value is transmitted on the CAN-Bus with the CANopen protocol. The transmitter does filtering based on multiple samples and converts the raw value into the output format. The CAN interface can run up to a speed of 1 Mbit/sec with 11-bit identifiers. 29-bit identifiers are supported as 11-bit identifiers and internally zero-padded. The CAN protocol complies with the CANopen specification CiA 301, the pressure transmitter function is presented by the CANopen device profile CiA DSP 404. The possible configurations can be set with the object dictionary. Heartbeat and emergency messages guarantee high reliability. With the Layer Setting Services (LSS, CiA DSP 305 V3.0), the desired bit rate and node ID can be set easily.

1.3 CAN Interface

The device includes a CAN transceiver compatible with the ISO11898-2 high speed CAN Standards and a physical 2-wire interface layer. The wires are protected against short circuit. By adjusting the rise and fall times of the CAN signals, the noise emission is minimized. The bus termination resistor is not included in the device.

1.4 Definitions

Title	Description
COB	Communication Object Data must be sent inside a COB across a CAN network. There exist 2048 different COBs in a CAN network. A COB contains maximal 8 data bytes.
DLC	Data Length Code
LSS	Layer setting services
NMT	Network Management
OD	Object Dictionary
PDO	Process Data Object
SDO	Service Data Object
SYNC	Refers to the CANopen SYNC protocol
ASCII	American Standard Code for Information Interchange (character encoding standard for text data in electronic communication)
RO	Read only
RW	Read / Write
WO	Write only

2 CANopen communication

2.1 Summary of the CANopen functions

CAN	CAN 2.0B
Protocol	CiA DS 301, V4.2.0, CANopen slave
Profile	CiA DS 404, V2.1.0 Device profile for measuring devices and closed-loop controllers
Baud rate	20 kbit/s to 1000 kbit/s. Configurable via LSS or SDO
Node ID	1 to 127 (255 for LSS) Configurable via LSS or SDO
PDO	1 PDO (TPDO) with configurable PDO-mapping and multiple transmission types (sync, timer, event-driven)
Emergency messages	Supported
Heartbeat	Supported
Node guarding	Supported
SYNC	Supported
Layer setting services (LSS)	Supported (CiA DS 305, V3.0.0 LSS slave with fastscan support)
Event-driven transmission	Timer-event: Configurable timer with millisecond resolution. Limit-event: 2 configurable limit switches with shared hysteresis setting. Delta-event: Configurable delta setting. Supports combining multiple event types.
Output	Configurable units and offset with auto-zero capability.
Filter	Configurable moving and repeating average filter.
Datatypes	Data that supports multiple datatypes according to standard are available as IEEE-754 Floating point and 32-bit integer with configurable digit setting.
Auto-start	Configurable auto-start mode allowing for operation without CAN master.

2.2 Object dictionary

Note: Some default values might differ between product code numbers and for pre-configured devices.

2.2.1 Communication profile

Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
1000	00	Device type	Unsigned32	ro	0x00020194	Device profile 404, Analog input block
1001	00	Error register	Unsigned8	ro	0x00	
1003		Pre-defined error field				
	00	Number of errors	Unsigned8	rw	0	Write 0: Clear errors Writing other values will result in an SDO abort message: 0x06090030
	01-FE	Standard error field	Unsigned32	ro		Error history since device was powered on
1005	00	COB-ID SYNC message	Unsigned32	rw	0x80	
1008	00	Manufacturer Device Name	String	ro	DST P10B	
1009	00	Manufacturer Hardware version	String	ro	01.00	
100A	00	Manufacturer Software version	String	ro	01.02.00	
100C	00	Guard Time	Unsigned16	rw	0	The lifetime factor multiplied with the guard time gives the lifetime for the life guarding protocol.
100D	00	Life Time Factor	Unsigned8	rw	0	Write 0: Disables the life guarding (See comment for Guard Time, index 0x100C)
1010		Store parameters				
	00	Number of parameters	Unsigned8	ro	1	
	01	Save all parameters	Unsigned32	rw	1	Parameter values will be saved with the command 0x65766173 (ASCII: “save”)
1011		Restore default parameters				
	00	Number of entries	Unsigned8	ro	1	
	01	Restore default parameters	Unsigned32	rw	1	Default values will be restored with the command 0x64616F6C (ASCII: “load”). Reset of device required. **Note:** Node ID and bitrate will not be restored to default
1014	00	COB ID Emergency message	Unsigned32	ro	0x80 + Node Id	
1015	00	Inhibit Time Emergency	Unsigned16	rw	0	The value shall be given in multiple of 100 microseconds. The value 0 will disable the inhibit time

Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
1017	00	Producer heartbeat time	Unsigned16	rw	0	The heartbeat time indicates the cycle time of the heartbeat produced by the device. Value shall be given in multiple of 1ms. Write 0: Disable heartbeat
1018		Identify object (LSS address)				
	00	Number of entries	Unsigned8	ro	4	
	01	Vendor Id	Unsigned32	ro	0x0100008D	Danfoss A/S IC
	02	Product Code	Unsigned32	ro		Danfoss product code number
	03	Revision Number	Unsigned32	ro		Device firmware version
	04	Serial Number	Unsigned32	ro		Danfoss generated device serial number
1800		Transmit PDO communication parameter				
	00	Number of entries	Unsigned8	ro	5	
	01	COB Id used by PDO	Unsigned32	rw	0x180 + node Id	Writeable values: 0x180+Node Id TPDO 1 0x280+Node Id TPDO 2 0x380+Node Id TPDO 3 0x480+Node Id TPDO 4
	02	Transmission Type	Unsigned8	rw	1	
	03	Inhibit Time	Unsigned16	rw	0	
	04	Reserved		None		Any attempt to read or write to this subindex will lead to an SDO abort/ error message
	05	Event Timer	Unsigned16	rw	1000	Default: 1000ms Value shall be given in a multiple of 1ms. Write 0: disable event timer
1A00		Transmit PDO mapping parameter				
	00	Number of entries	Unsigned8	ro	2	
	01	PDO Mapping Entry 1	Unsigned32	rw	0x91300120	Pressure as integer32
	02	PDO Mapping Entry 2	Unsigned32	rw	0x91300220	Temperature as integer32
	03	PDO Mapping Entry 3	Unsigned32	rw	0	
	04	PDO Mapping Entry 4	Unsigned32	rw	0	
1F80	00	NMTStartup	Unsigned32	rw	0	0x00000000: The NMT master must start the NMT slave. 0x00000008: NMT slave will enter the NMT state "Operational" after the NMT state "Initialization" autonomously (Self-starting)

2.2.2 Manufacturer specific profile

Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
3100		App info				
	00	Number of entries	Unsigned8	ro	0	
	01	Custom U8	Unsigned8	rw	0	PDO mappable object without any functionality besides storing a user-defined value
	02	Custom U16	Unsigned16	rw	0	PDO mappable object without any functionality besides storing a user-defined value
	03	Custom U24	Unsigned32	rw	0	PDO mappable object without any functionality besides storing a user-defined value
	04	Custom U32	Unsigned32	rw	0	PDO mappable object without any functionality besides storing a user-defined value
3110		Identity Strings				
	00	Number of entries	Unsigned8	ro	4	
	01	Serial Number	String	ro		Danfoss generated serial number as a string
	02	Danfoss Product Code	String	ro		Danfoss product code as a string
	03	Customer Product Code	String	ro		Can be set during production if customer wants a custom product code stored in the device
	04	Version Info	String	ro		Same as index 0x100A
3999		Reserved				
	00	Number of entries	Unsigned8	ro	2	
	01	Reserved	Unsigned32	wo		Reserved object
	02	Reserved	Unsigned32	rw		Reserved object
4F00	00	Bit rate	Unsigned8	rw	4	Default: 125 kbit/s See bit rate table below
4F01	00	Node ID	Unsiged8	rw	127	Range 1 – 127: Changes take effect after reset node or reboot. Can also be set to 255 to indicate an unconfigured node (typically used with LSS)

Bit rate table:

Index	Bit rate (kbit/s)
0	1000
1	800
2	500
3	250
4	125
5	reserved
6	50
7	20

2.2.3 Device profile

Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
6110		AI_Sensor_type				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Sensor_type_1	Unsigned16	ro	90	90 = Pressure sensor
	02	AI_Sensor_type_2	Unsigned16	ro	100	100 = Temperature sensor
6124		AI Input Offset				
	00	Number of entries	Unsigned8	ro	1	
	01	AI Input Offset PV 1	Float32	rw		Pressure offset; will be added to the current pressure value
6125		AI_Autozero				
	00	Number of entries	Unsigned8	ro	1	
	01	AI_Autozero_1	Unsigned32	wo		Autozero for pressure 0x6F72657A (ASCII: "zero")
6130		AI_Input_PV				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Input_PV_1	Float32	ro		Actual pressure value
	02	AI_Input_PV_2	Float32	ro		Actual temperature value
6131		AI_Physical_Unit_PV				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Physical_Unit_ PV1	Unsigned32	rw	0x004E0000	Pressure unit: 0x00AB0000: Psi 0x004E0000: Bar 0x03220000: KPa prefixes (only for psi, bar): 0xFF__0000: 10-1 (deci) 0xFE__0000: 10-2 (centi) 0xFD__0000: 10-3 (milli) Hint: Also, dependents on "decimal digits", index 0x6132
	02	AI_Physical_Unit_ PV2	Unsigned32	rw	0x002D0000	Temperature unit: 0x002D0000: °C 0x00AC0000: °F 0x00050000: K
6132		AI_Decimal_Digits				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Decimal_Dig- its_PV1	Unsigned8	rw	3	Range depends on the physical unit and prefix: [0 - 3] with unit psi [0 - 5] with unit bar [0] with unit KPa

Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
	02	AI_Decimal_Digits_PV2	Unsigned8	rw	3	[0 - 5]
6133		AI_Interrupt_Delta_Input_PV				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Interrupt_Delta_Input_PV1	Float32	rw	0	Pressure delta for delta-events (0 = disabled)
	02	AI_Interrupt_Delta_Input_PV2	Float32	rw	0	Temperature delta for delta-events (0 = disabled)
6134		AI_Interrupt_Lower_Limit_Input_PV				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Interrupt_Lower_Limit_Input_PV1	Float32	rw	-131000	Pressure lower limit for limit-events
	02	AI_Interrupt_Lower_Limit_Input_PV2	Float32	rw	-131000	Temperature lower limit for limit-events
6135		AI_Interrupt_Upper_Limit_Input_PV				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Interrupt_Upper_Limit_Input_PV1	Float32	rw	131000	Pressure upper limit for limit-events
	02	AI_Interrupt_Upper_Limit_Input_PV2	Float32	rw	131000	Temperature upper limit for limit-events
6136		AI_Interrupt_Hysteresis				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Interrupt_Hysteresis_PV1	Float32	rw	0	Pressure hysteresis for limit-events
	02	AI_Interrupt_Hysteresis_PV2	Float32	rw	0	Temperature hysteresis for limit-events
6148		AI_Span_Start				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Span_Start_PV1	Float32	rw		Default: Sensor pressure measurement range start
	02	AI_Span_Start_PV2	Float32	rw	-40	Default: Internal operating temperature range start

Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
6149		AI_Span_End				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Span_End_PV1	Float32	rw		Default: Sensor pressure measurement range end
	02	AI_Span_End_PV2	Float32	rw	125	Default: Internal operating temperature range end
6150		AI_Status				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Status_PV1	Unsigned8	ro	0	Pressure status: Bit 1 = 1: Positive overload (Press. > span end) Bit 2 = 1: Negative overload (Press. < span start)
	02	AI_Status_PV2	Unsigned8	ro	0	Temperature status: Bit 1 = 1: Positive overload (Temp. > span end) Bit 2 = 1: Negative overload (Temp. < span start)
61A0		AI_Filter_Type				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Filter_Type_PV1	Unsigned8	rw	1	0: No filter 1: Moving average 2: Repeating average
	02	AI_Filter_Type_PV2	Unsigned8	rw	1	0: No filter 1: Moving average 2: Repeating average
61A1		AI_Filter_ Constant				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Filter_ Constant_PV1	Unsigned8	rw	0	Range: 0-255
	02	AI_Filter_ Constant_PV2	Unsigned8	rw	0	Range: 0-255
7100		AI_Input_FV				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Input_FV_PV1	Integer16	ro		Raw pressure input value, unitless
	02	AI_Input_FV_PV2	Integer16	ro		Raw temperature input value, unitless
9124		AI_Input_Offset_i32				
	00	Number of entries	Unsigned8	ro	1	
	01	AI_Input_Off-set_PV1	Integer32	ro	0	Offset for pressure

Index (HEX)	Sub Index	Name	Type	Access	Default	Comment
9130		AI_Input_PV_i32				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Input_PV_PV1	Integer32	ro		Actual pressure value
	02	AI_Input_PV_PV2	Integer32	ro		Actual temperature value
9133		AI_Interrupt_Delta_ Input_PV_i32				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Interrupt_Delta_ Input_PV1	Integer32	rw	0	Pressure delta for delta-events (0 = disabled)
	02	AI_Interrupt_Delta_ Input_PV2	Integer32	rw	0	Temperature delta for delta-events (0 = disabled)
9134		AI_Interrupt_ Lower_Limit_PV_i32				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Interrupt_ Lower_Limit_PV1	Integer32	rw	- 131000000	Pressure lower limit for limit-events
	02	AI_Interrupt_ Lower_Limit_PV2	Integer32	rw	- 131000000	Temperature lower limit for limit-events
9135		AI_Interrupt_ Upper_Limit_PV_ i32				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Interrupt_ Upper_Limit_PV1	Integer32	rw	131000000	Pressure upper limit for limit-events
	02	AI_Interrupt_ Upper_Limit_PV2	Integer32	rw	131000000	Temperature upper limit for limit-events
9148		AI_Span_Start_i32				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Span_Start_PV1	Integer32	rw		Default: Sensor pressure measurement range start
	02	AI_Span_Start_PV2	Integer32	rw	-40000	Default: Internal operating temperature range start
9149		AI_Span_End_i32				
	00	Number of entries	Unsigned8	ro	2	
	01	AI_Span_End_PV1	Integer32	rw		Default: Sensor pressure measurement range end
	02	AI_Span_End_PV2	Integer32	rw	125000	Default: Internal operating temperature range end

2.3 Configuration of the transmit PDO

2.3.1 PDO Contents

Dynamic mapping:

The PDO configuration is done by the OD entry TPDO1 mapping (index 0x1A00) and its sub-indexes. The sub index 1 defines the first value (lower position) transmitted by the PDO. The sub index 2 defines the second value, the sub index 3 the third and the sub index 4 the fourth value transmitted by the PDO.

To change the mapping, the following procedure must be used:

1. Destroy the TPDO by setting bit valid to 1 of object 0x1800 sub-index 0x01.
2. Set the "Number of entries" of object 0x1A00 sub-index 0x00 to 0. The PDO is now deactivated.
3. Set the desired mapping values (0x1A00 - sub-indexes 0x00…0x04).
4. Set the "Number of entries" of object 0x1A00 - 0x00 to the desired number of mapping objects.

Default mapping:

The default values of these sub-indexes are:

Sub index	Default value	Description
1	0x91300120	Pressure, integer32
2	0x91300220	Temperature, integer32
3	0	Not activated
4	0	Not activated

That means:
The first value which will be sent by the transmit PDO is the value of the OD index 0x9130 with the subindex 0x01 and the length 0x20 bits (=>0x91300120). It is the pressure value (signed integer32 bit).
The second value of the transmit PDO is the OD index 0x9130 with the sub index 0x02 and the length 0x20 bits (=> 0x91300220). It is the temperature value (signed integer32 bit).

Example: PDO Interpretation:

For this example, the default settings are used. To summarize the relevant settings used in this example:
PDO-COB-ID: 0x180
Node-ID: 1,
Pressure unit: Bar,
Pressure digits: 3,
Temperature unit: Celsius,
Temperature digits: 3,
PDO mapped with pressure int32 and temperature int32.

As an example, let us say the following PDO is sent out by the device:

CAN-ID	LENGTH	DATA0	DATA1	DATA2	DATA3	DATA4	DATA5	DATA6	DATA7
0x181	8	0xE1	0x10	0x00	0x00	0x07	0x87	0x00	0x00

Translating the message, we can see that:

1. The CAN-ID indicates that this message is a PDO message sent by node-id 1.
   Since the CAN-ID consist of the COB-ID + Node-ID, so 0x180 + 1.
2. The length indicates that there are 8 valid data bytes in the message
3. Since the first mapped PDO value is "Pressure as Interger32" we know that the first four bytes contain the pressure value. In CANopen the LSB is always sent first.
   So our pressure value becomes 0x000010E1 = 4321.
   Since the active settings specify pressure should be represented as Bar with 3 digits, we can interpret this value further to get the actual pressure output and we end up with 4.321 Bar.
4. Using the same logic for the next four bytes (temperature), we get
   0x00008707 = 34567, Applying digits and unit we end up with 34.567 °C

Units:
The units of the pressure and temperature values can be set by writing to index 0x6131 "AI Physical unit PV" – see the "Device profile" chapter for more details.

Digits:
The digits of the pressure and temperature integer values can be set by writing to index 0x6132 "AI Decimal digits PV". A digit value of 1 means that the value is multiplied by 10, 2 means multiplied by 100, 3 means multiplied by 1000, which is the maximum. – see the "Device profile" chapter for more details.
Note: the digit setting has no influence on float values.

Hint:
Only the following object dictionary entries are mappable::

Index	Subindexes	Description	Datatype
0x6130	1,2	Pressure, Temperature	Float
0x9130	1,2	Pressure, Temperature	Interger32
0x7100	1,2	Raw pressure, raw temperature	Interger16
0x1001	0	Error register	Unsigned8
0x6150	1,2	Pressure span status, temperature span status	Unsigned8
0x3100	1,2,3,4	User-defined object	Mixed

2.4 PDO Transmission types

The object "Transmit PDO communication parameter" (index 0x1800) can be used to configure the PDO transmission settings.

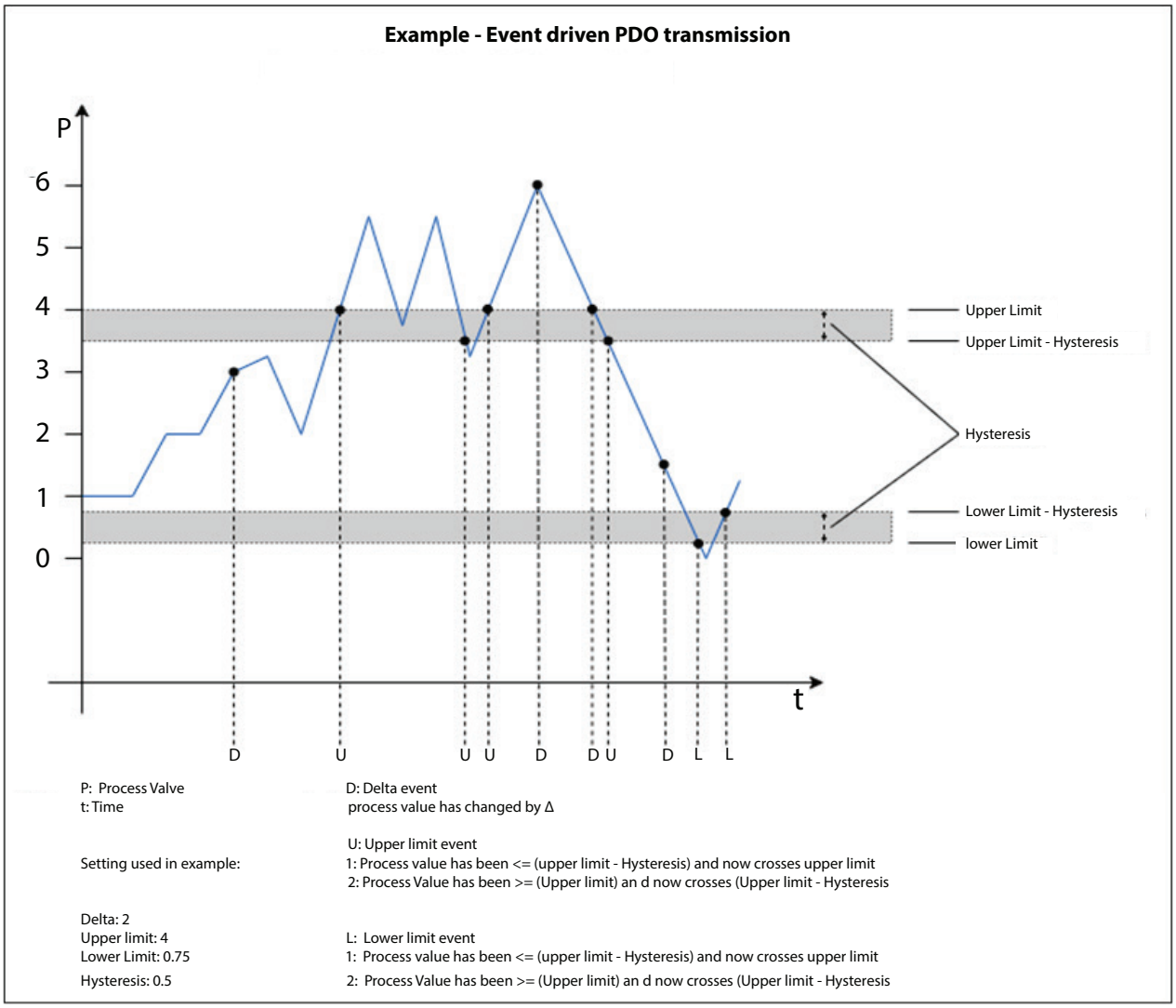
The device supports various PDO transmission settings, the common ones include SYNC and timer-driven transmission. These are very standardized features with detailed descriptions and examples are described in CiA 301.

Among the more uncommon transmission types, this device supports delta and limit event-based transmission.

The main principles are:
Delta-events: Triggers a PDO transmission when a PDO mapped process value has changed by delta or more since last PDO transmission.
Limit-events: Imitates a switch-like behavior, triggering a PDO transmission when a certain limit is crossed.

It is possible to fine tune these events to fit application needs by isolating or combining certain events.
This can be done in combination with setting up units, digits, offsets, filters, heartbeats, timers, etc.

An example is shown below where delta and two limit events (upper-limit, lower-limit, w. hysteresis) are combined to illustrate the logic of each event type.



2.5 Emergency message (Error codes)

Emergency messages show an internal device error. If the error situation of the device has changed, it will send an emergency message with the current error code.

The COB-ID of an emergency message is shown in the communication profile object dictionary, index 0x1014 (by default: 0x80 + Node ID).

Construction of the emergency message:

Data			
Byte 0			**Byte 7**
Error code LSB	Error code MSB	Error register (Index 0x1001)	Not used

Error codes:

Error codes	Explanation	Possible root cause	Possible solution
0x0000	No error	Error code 0x0000 is used to report that the device is now error free. (i.e.an error was previously reported but that error is now gone)	
0x6000	Software internal error	Error encountered during initialization routine. Error in communication between onboard devices.	Power cycle device. Check if error still appears, if so, hardware might be damaged
0x5010	Self-test error	Error encountered during sensor self-tests such as: • Open-/short circuit detected on pressure sensing element (e.g., broken wire bond) • Unable to retrieve pressure data • Device was restarted by internal watchdog due to a malfunction • Memory corruption detected	Power cycle device. Check if error still appears, if so, one should attempt a factory reset of the device. ("restore all parameters" followed by "save all parameters"). If the error continues to appear the hardware might be damaged.
0x5030	Sensor fault error	Pressure or temperature output value has reached a data-type saturation limit. Values beyond this limit cannot be presented.	Check if output configuration settings fit your application (unit, digits, offset, etc.) or adjust pressure/temperature
0x4200	Temperature limit exceeded error	Specified internal temperature operating range is exceeded. (i.e., electronics too hot/cold)	Bring the device back into the temperature operating range.

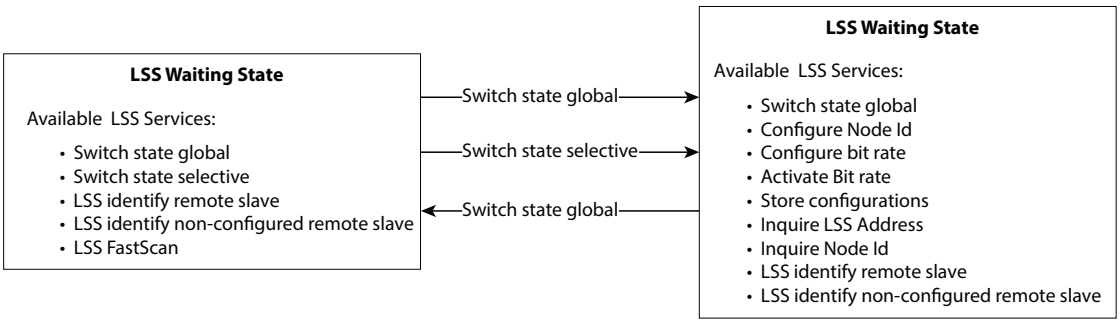
The current error situation could be read out with the object profile entry "Pre-defined Error Field" index 0x1003, sub index 0x01. Previously errors can be read out from higher sub index entries of index 0x1003.

Furthermore, for index 0x1003. Sub index 0x00 holds the number of reported errors.
Index 0x1001 is an error register for the device. It is a field of 8 bits, each of which indicates a particular type of error. If a bit is set to 1, the specified error has occurred. The generic error bit is set to 1 in case of any type of error. The bits have the following meaning:

7	6	5	4	3	2	1	0
Manufacturer specific error	Reserved	Device profile specific error	Communication error	Temperature	Voltage	Current	Generic error

3 Layer setting services (LSS)

The DST P10B with CANopen supports the Layer Setting Services.
These services and protocols are used to inquire the settings of the LSS address (object 0x1018), the bit rate and the node id. The bit rate and the node id can be configured via the LSS services.



Some requirements/hints must be observed when using LSS:

The producer heartbeat time must be 0 (default value, index 0x1017)
- In LSS configuration state, no NMT-command will be executed.
- Only a stored bit rate and node Id will appear in the object dictionary (0x4F00 and 0x4F01 respectively)
- The LSS address consists of four values:
  - Vendor-Id:
    - Object dictionary index 0x1018, sub-index 1: Always 0x0100008D (Danfoss vendor Id)
  - Product-code:
    - Object dictionary index 0x1018, sub-index 2: Order number of this DST P10B
  - Revision number:
    - Object dictionary index 0x1018, sub-index 3: Software version of this DST P10B
  - Serial-number:
    - Object dictionary index 0x1018, sub-index 4: A unique serial number.

3.1 Supported services

All services of CiA DSP 305 V3.0 can be used. The supported parameters of the services can be found in this section. The following CAN identifiers are reserved for LSS:
- 0x7E5 for commands from LSS Master
- 0x7E4 for commands from LSS Slave

3.1.1 Switch state global

	Data							
	Byte 0							Byte 7
Command	Command specifier request	mode	reserved	reserved	reserved	reserved	reserved	reserved

Command specifier request: 0x04
Mode:
0x00 Switches to waiting state
0x01 Switches to configuration state

Hints:
- Once leaving the LSS configuration, all not stored data is no longer available.

3.1.2 Switch state selective

	Data							
	Byte 0							Byte 7
Command	Command specifier request	data LSB	data	data	data MSB	reserved	reserved	reserved
Answer	Command specifier answer	reserved	reserved	reserved	reserved	reserved	reserved	reserved

Command specifier request: 0x40 Vendor-Id
0x41 Product-code
0x42 Revision-number
0x43 Serial-number
Command specifier answer: 0x44

Hints:

- The order of command specifier request is important and must be send with Vendor-Id as the first command and Serial-number as the last.

3.1.3 Configure Node Id

	Data							
	Byte 0							Byte 7
Command	Command specifier request	Node Id	reserved	reserved	data MSB	reserved	reserved	reserved
Answer	Command specifier answer	Error code	Spec. error	reserved	reserved	reserved	reserved	reserved

Command specifier request: 0x11
Node Id : 1 - 127
Command specifier answer: 0x11
Error code: 0 Protocol successfully completed
1 Node Id out of range
Spec. error: Always 0

3.1.4 Bit rate

	Data							
	Byte 0							Byte 7
Command	Command specifier request	Table selector	Table index	reserved	data MSB	reserved	reserved	reserved
Answer	Command specifier answer	Error code	Spec. error	reserved	reserved	reserved	reserved	reserved

Command specifier request: 0x13
Table selector: 0 Standard CiA bit timing table
Table index: **Standard CiA bit timing table:**

0	1 Mbit/s
1	800 kbit/s
2	500 kbit/s
3	250 kbit/s
4	125 kbit/s
5	Reserved
6	50 kbit/s
7	20 kbit/s

Command specifier answer: 0x13
Error code:

0	Protocol successfully completed
1	Bit rate not supported

Spec. error: Always 0

3.1.5 Activate bit rate

	Data							
	Byte 0							**Byte 7**
Command	Command specifier request	switch_ delay	reserved	reserved	reserved	reserved	reserved	reserved

Command specifier request: 0x15
Switch_delay: The duration of the two periods of time to wait. Unit: milliseconds.

Hints:
- Only the last saved bit rate will be activated by this service.
- After activating the new bit rate, the CAN bus network must be configured to the same bit rate to communicate with the device

3.1.6 Store Configuration

	Data							
	Byte 0							**Byte 7**
Command	Command specifier request	reserved	reserved	reserved	data MSB	reserved	reserved	reserved
Answer	Command specifier answer	Error code	Spec. error	reserved	reserved	reserved	reserved	reserved

Command specifier request: 0x17
Command specifier answer: 0x17
Error code:

0	Protocol successfully completed
1	Node Id not supported

Spec. error: Always 0

3.1.7 Inquire LSS Address

	Data							
	Byte 0							Byte 7
Command	Command specifier request	reserved	reserved	reserved	reserved	reserved	reserved	reserved
Answer	Command specifier answer	data LSB	data	data	data MSB	reserved	reserved	reserved

Command specifier request:
0x5A Vendor Id
0x5B Product code
0x5C Revision number
0x5D Serial number

Command specifier answer: like request
Data: requested value

3.1.8 Inquire Node Id

	Data							
	Byte 0							Byte 7
Command	Command specifier request	reserved	reserved	reserved	reserved	reserved	reserved	reserved
Answer	Command specifier answer	Node id	reserved	reserved	reserved	reserved	reserved	reserved

Command specifier request: 0x5E
Command specifier answer: 0x5E
Node Id: Node Id

Hint:
- The return value of the node Id will be the valid and stored value from EEPROM.

3.1.9 LSS Identify remote slave

	Data							
	Byte 0							Byte 7
Command	Command specifier request	data LSB	data	data	data LSB	reserved	reserved	reserved
Answer	Command specifier answer	Node id	reserved	reserved	reserved	reserved	reserved	reserved

Command specifier request:
0x46 Vendor Id
0x47 Product code
0x48 Revision number low
0x49 Revision number high
0x4A Serial number low
0x4B Serial number high

Command specifier answer: 0x4F

Hints:
- The revision number low and revision number high can be ignored using 0
- To identify the slave, the shown order of the requests must be observed and followed.

3.1.10 LSS Identify non-configured remote slave

	Data							
	Byte 0							Byte 7
Command	Command specifier request	reserved	reserved	reserved	reserved	reserved	reserved	reserved
Answer	Command specifier answer	reserved	reserved	reserved	reserved	reserved	reserved	reserved

Command specifier request: 0x4C
Command specifier answer: 0x50

Hints:
- Only an unconfigured device will respond. No response means that there are no unconfigured devices on the network
- For a device to be unconfigured, its node Id must be 0xFF. The device is configured when this is in the range of 1-127 (0x01 - 0x7F)
- The device will not identify itself. Only notify the user that there is currently an unconfigured device connected to the network. For identifying the device see 0 (LSS Fastscan).

3.1.11 LSS Fastscan

	Data							
	Byte 0							Byte 7
Command	Command specifier request	data LSB	data	data	data MSB	Bit Checked	LSS Sub	LSS Next
Answer	Command specifier answer	reserved	reserved	reserved	reserved	reserved	reserved	reserved

Command specifier request: 0x51
Command specifier answer: 0x4F
Data: 32 bits that are currently checked versus the vendor Id, Product code, revision number or serial number.

Bit Checked: Defines how many of the bits in the ID number are currently checked. This is a value in the range of 0 to 31. 31 means that only bit 31 is checked, 30 means that bits 31 and 30 are checked. 0 means that all 32 bits are checked.
A value of 80h is an exception and indicates the start of a new scan cycle, all nodes supporting Fastscan reset their internal state machines.

LSS Sub: Defines which part of the 128 bit LSS Id is currently checked in the 32 bit ID number. This is a value from 0 to 3 representing Vendor Id, product code, revision number or serial number respectively.

LSS Next: Defines which part of the 128 bit LSS Id will be checked towards the 32 bit Id number in the next cycle. This is a value from 0 to 3 representing Vendor Id, product code, revision number or serial number respectively.
A value of 4h indicates the last check.

Hints:
- Only an unconfigured device will respond. No response means that there are no unconfigured devices on the network or the current bit checked does not match the bit of the device (Read simplified example).
- For a device to be unconfigured, its node Id must be 0xFF. The device is configured when this is in the range of 1-127 (0x01 - 0x7F)
- When the LSS address is identified using LSS Fastscan, one can use this LSS Address to perform a "Switch State Selective" command (See 3.1.2) of this specific device and configure its bit rate and node id to fit the network.

Simplified LSS Fastscan example:

No.	Service	CAN-Id	DLC	Data								Dir	Comment
				D0	D1	D2	D3	D4	D5	D6	D7		
1	Start LSS Fastcan	0x7E5	8	0x51	0x00	0x00	0x00	0x00	0x80	0x00	0x00	Tx	LSS Fastscan is started
		0x7E4	8	0x4F	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Rx	Device recognizes the command and reset its internal state machine.
2	Scan for Vendor Id	0x7E5	8	0x51	0x00	0x00	0x00	0x00	0x1F	0x00	0x00	Tx	Checks bit 31 of sub index 0
		0x7E4	8	0x4F	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Rx	Respond means that the bit checked matches
3	Scan for Vendor Id	0x7E5	8	0x51	0x00	0x00	0x00	0x00	0x1E	0x00	0x00	Tx	Checks bit 30 of sub index 0
		0x7E4	8	0x4F	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Rx	Respond means that the bit checked matches
	This pattern continues until the device does not respond. No response means that the bit checked did not match the bit of the device. The Master will therefore have to alter the bit checked from a 0 to a 1 and continue to check for the next bit. In this example the device will not respond when checking bit 24 (18h). The next command send from the master will therefore alter the bit as follows.												
9	Scan for Vendor Id	0x7E5	8	0x51	0x00	0x00	0x00	0x01	0x17	0x00	0x00	Tx	Checks bit 23 of sub index 0 (bit 24 is altered to 1)
		0x7E4	8	0x4F	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Rx	Respond means that the bit checked matches
	The device does not respond when checking bit 7, 3, 2 and 0 either. This will result in a last command scanning for the LSS Vendor Id as follows												
33	Scan for Vendor Id	0x7E5	8	0x51	0x8D	0x00	0x00	0x01	0x00	0x00	0x01	Tx	Vendor Id identified. Prepare the device to scan for product code (LSS Next 1h).

Direction (Dir):

Tx: Message from (NMT/LSS) Master
RX: Message from device/slave

3.2 LSS examples

3.2.1 Inquire LSS Address

This example of the usage of the Layer Setting Services shows how to inquire the LSS address of an already configured device.

Note: To identify the LSS address of an unconfigured device, make use of the LSS Service "LSS Fastscan" (See 0).

No.	Service	CAN-Id	DLC	Data								Dir	Comment
				D0	D1	D2	D3	D4	D5	D6	D7		
	NMT Boot-up	0x701	1	0x00								Rx	Boot-up message from slave
1	Switch state global: LSS configuration state	0x7E5	8	0x04	0x01	0x00	0x00	0x00	0x00	0x00	0x00	Tx	Switches all devices into configuration state
2	Inquire LSS address: Vendor Id	0x7E5	8	0x5A	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Tx	
		0x7E4	8	0x5A	0x8D	0x00	0x00	0x01	0x00	0x00	0x00	Rx	Answer: Vendor Id
3	Inquire LSS address: Product Code	0x7E5	8	0x5B	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Tx	
		0x7E4	8	0x5B	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Rx	Answer: Product Code
4	Inquire LSS address: Revision number	0x7E5	8	0x5C	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Tx	
		0x7E4	8	0x5C	0x00	0x04	0x00	0x00	0x00	0x00	0x00	Rx	Answer: Revision number
5	Inquire LSS address: Serial Number	0x7E5	8	0x5D	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Tx	
		0x7E4	8	0x5D	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Rx	Answer: Serial Number

3.2.2 Configure Node Id and Bit rate via LSS for an already configured known device

This example of the usage of the Layer Setting Services shows the changing of the node Id from 1 to 28 and the changing of the bit rate to 500 kbit/s.

Note: Vendor Id, Product code, revision number and serial number used in this example might differ from the device you are using. To identify the LSS address of your already configured device, make use of the LSS Service "Inquire LSS Address" (See 3.2.1).

No.	Service	CAN-Id	DLC	Data								Dir	Comment
				D0	D1	D2	D3	D4	D5	D6	D7		
	NMT Boot-up	0x701	1	0x00								Rx	Boot-up message from slave
1	Switch state selective: Vendor Id	0x7E5	8	0x40	0x8D	0x00	0x00	0x01	0x00	0x00	0x00	Tx	Vendor Id: 0x0100008D
2	Switch state selective: Product code	0x7E5	8	0x41	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Tx	Product Code: 0x00000000
3	Switch state selective: Revision number	0x7E5	8	0x42	0x00	0x04	0x00	0x00	0x00	0x00	0x00	Tx	Revision Number: 0x00000400

No.	Service	CAN-Id	DLC	Data								Dir	Comment
				D0	D1	D2	D3	D4	D5	D6	D7		
4	Switch state selective: Serial Number	0x7E5	8	0x43	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Tx	Serial Number: 0x00000000
		0x7E4	8	0x44	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Rx	Answer: OK
5	Configure Node Id	0x7E5	8	0x11	0x1C	0x00	0x00	0x00	0x00	0x00	0x00	Tx	Set new Node Id: 28
		0x7E4	8	0x11	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Rx	Answer: OK
6	Configure Bit rate	0x7E5	8	0x13	0x00	0x02	0x00	0x00	0x00	0x00	0x00	Tx	Set new Bit rate: 500 kbit/s
		0x7E4	8	0x13	0x00	0x02	0x00	0x00	0x00	0x00	0x00	Rx	Answer: OK
7	Store Configurations	0x7E5	8	0x17	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Tx	Store the new settings in EEPROM
		0x7E4	8	0x17	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Rx	Answer: OK
8	Activate new bit rate	0x7E5	8	0x15	0x64	0x00	0x00	0x00	0x00	0x00	0x00	Tx	Activate the new bit rate after 100ms
	Configure your network to fit the newly configured bit rate												
9	NMT Reset communication	0x000	2	0x82	0x00							Tx	Activate the new Node Id
		0x71C	1	0x00								Rx	Boot-up message from slave with new Node Id

Hint:

- After following the above example, the device will have changed its bit rate and the CAN bus network must be configured to the same to communicate with the device.
- For the Node Id to be activated a power cycle or reset node will be necessary.
- Service no. 8 and 9 can be replaced by a power cycle.

3.2.3 Configure Node Id and Bit rate via LSS for an already configured unknown device

This example of the usage of the Layer Setting Services shows the changing of the node Id from 1 to 28 and the changing of the bit rate to 500 kbit/s.

Note: Only one device must be connected to the CAN bus network for this to work.

No.	Service	CAN-Id	DLC	Data								Dir	Comment
				D0	D1	D2	D3	D4	D5	D6	D7		
	NMT Boot-up	0x701	1	0x00								Rx	Boot-up message from slave
1	Switch state global: LSS configuration state	0x7E5	8	0x04	0x01	0x00	0x00	0x00	0x00	0x00	0x00	Tx	Switches all devices into configuration state
2	Configure Node Id	0x7E5	8	0x11	0x1C	0x00	0x00	0x00	0x00	0x00	0x00	Tx	Set new Node Id: 28
		0x7E4	8	0x11	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Rx	Answer: OK
3	Configure Bit rate	0x7E5	8	0x13	0x00	0x02	0x00	0x00	0x00	0x00	0x00	Tx	Set new Bit rate: 500 kbit/s
		0x7E4	8	0x13	0x00	0x02	0x00	0x00	0x00	0x00	0x00	Rx	Answer: OK

No.	Service	CAN-Id	DLC	Data								Dir	Comment
				D0	D1	D2	D3	D4	D5	D6	D7		
4	Store Configurations	0x7E5	8	0x17	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Tx	Store the new settings in EE-PROM
		0x7E4	8	0x17	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Rx	Answer: OK
5	Activate new bit rate	0x7E5	8	0x15	0x64	0x00	0x00	0x00	0x00	0x00	0x00	Tx	Activate the new bit rate after 100ms
	Configure your network to fit the newly configured bit rate												
6	NMT Reset communication	0x000	2	0x82	0x00							Tx	Activate the new Node Id
		0x71C	1	0x00								Rx	Boot-up message from slave with new Node Id

Hint:

- After following the above example, the device will have changed its bit rate and the CAN bus network must be configured to the same to communicate with the device.
- For the Node Id to be activated a power cycle or reset node will be necessary.
- Service no. 5 and 6 can be replaced by a power cycle.

3.2.4 Configure Node Id to unconfigured unknown device via LSS (Node id=255)

No.	Service	CAN-Id	DLC	Data								Dir	Comment
				D0	D1	D2	D3	D4	D5	D6	D7		
1	Switch state selective: Vendor Id	0x7E5	8	0x40	0x8D	0x00	0x00	0x01	0x00	0x00	0x00	Tx	Vendor Id: 0x0100008D
2	Switch state selective: Product code	0x7E5	8	0x41	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Tx	Product Code: 0x00000000
3	Switch state selective: Revision number	0x7E5	8	0x42	0x00	0x04	0x00	0x00	0x00	0x00	0x00	Tx	Revision Number: 0x00000400
4	Switch state selective: Serial Number	0x7E5	8	0x43	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Tx	Serial Number: 0x00000000
		0x7E4	8	0x44	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Rx	Answer: OK
5	Configure Node Id	0x7E5	8	0x11	0x01	0x00	0x00	0x00	0x00	0x00	0x00	Tx	Set new Node Id: 1
		0x7E4	8	0x11	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Rx	Answer: OK
6	Store Configurations	0x7E5	8	0x17	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Tx	Store the new settings in EEPROM
		0x7E4	8	0x17	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Rx	Answer: OK
7	Switch state global: LSS Waiting state	0x7E5	8	0x04	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Tx	
		0x701	1	0x00									Boot up message

Hint:

- After following the above example, the device will have changed its node id and is thereby configured.

4 CAN communication without CANopen functionality

4.1 Basic configuration

The CAN pressure transmitter can still be used in a CAN network without CAN functionality.
However, before integrating it some basic configurations need to be set:

- Bit rate, by default = 0x04 (125 kbits/s)
- Node-Id, by default = 0x01

Additional settings can be set before use, such as physical units, decimal digits and others found in the object dictionary (refer to: 0 _Object dictionary)
Any new settings must be saved on the CAN pressure transmitter to take effect. The settings can be saved with object 0x1010, subindex 0x01 and with the data 0x65766173 (in ASCII: "save").
The settings will be stored in non-volatile memory and kept after reset.
For basic configurations, such as node-id and bitrate, refer to 4.4 Change node configuration .

4.2 Network configuration without CANopen master

After connecting the CAN pressure transmitter to the supply voltage, the transmitter sends a boot-up message with the CAN identifier 0x700 + node-id, (0x701 as default). The boot-up message contains also one data byte with value 0 if there are no errors during boot-up, or - if an error is detected - an error message will be sent together with the CAN identifier.

In the case of no errors, the CAN pressure transmitter will now be in the "Pre_Operational_State" and with the command "Start_Remote_Node" the transmitter will be activated.
The "Start_Remote_Node" command can be sent using the following frame:

			Data							
Command	**ID**	**DLC**	**Byte 0**							**Byte 7**
"Start_Remote_Node"	0x000	2	0x01	Node ID or 0x00 (All CAN-open members)	reserved					

The command will be answered with a PDO data message, along with the CAN identifier 0x180 + node id.
The CAN pressure transmitter will now cyclically (default) send PDO's with the pressure value and the status.
The status provides the user with the following information:

- Bit 1: Positive overload on process value
- Bit 2: Negative overload on process value

The pressure or temperature values can also be read from the object dictionary (SDO access) as a 32-bit integer or 32-bit float. In 5.1 Definition of IEEE 32 Bit (single precision floating point numbers, IEEE-754 standard) the floating-point format is described.

The following are some examples of how to read the pressure from the object dictionary:

Read pressure measurement (float32, SDO access):

			Data							
	ID	**DLC**	**Byte 0**							**Byte 7**
Command	0x600 + Node id	8	SDO request 0x43	Index LSB 0x30	Index MSB 0x61	Sub Index 0x01	Not used			
Answer	0x580 + Node id	8	SDO Ack. 0x43	Index LSB 0x30	Index MSB 0x61	Sub Index 0x01	Data LSB	Data	Data	Data MSB

Read pressure measurement (integer32, SDO access):

			Data							
	ID	**DLC**	**Byte 0**							**Byte 7**
Command	0x600 + Node id	8	SDO request 0x43	Index LSB 0x30	Index MSB 0x91	Sub Index 0x01	Not used			
Answer	0x580 + Node id	8	SDO Ack. 0x43	Index LSB 0x30	Index MSB 0x91	Sub Index 0x01	Data LSB	Data	Data	Data MSB

Byte 0 (SDO request) indicates the number of bytes to read from the object dictionary. The number of bytes available to read are:

- 0x43: 4 bytes
- 0x47: 3 bytes
- 0x4B: 2 bytes
- 0x4F: 1 byte

With the data type of the pressure being a 32-bit integer or float, the number of bytes to read is 4 (0x43).
The temperature can be read by changing the subindex to 0x02 (temperature).

SDO abort codes

If the SDO access fails, the CAN pressure transmitter will answer with an abort code.
The following are possible SDO abort codes:

SDO Abort Code	Description
0x06010001	Attempt to read a write only object
0x06010002	Attempt to write to a read only object
0x06020000	Object does not exist in the object dictionary
0x06040041	Object cannot be mapped to the PDO
0x06040042	The number and length of the objects to be mapped would exceed PDO length
0x06040043	General parameter incompatibility reason
0x06060000	Access failed due to a hardware error
0x06070012	Data types do not match, length of service parameter too high
0x06070013	Data types do not match, length of service parameter too low
0x06090011	Sub index does not exist
0x06090030	Value range of parameter exceeded (Only for objects with write access)
0x06090031	Value of parameter written too high
0x06090032	Value of parameter written too low

4.3 Cyclically sending

The CAN pressure transmitter can send the values of its measurements (PDO) cyclic at an interval that is programmable.

Activate event timer (SDO) access):
The event timer is activated by writing 0xFF to the object 0x1800, subindex 0x02 (transmission type):

			Data					
	ID	**DLC**	**Byte 0**					**Byte 7**
Command	0x600 + Node id	8	SDO request 0x2F	Index LSB 0x00	Index MSB 0x18	Sub Index 0x02	Transmission type 0xFF	Not used
Answer	0x580 + Node id	8	SDO Ack. 0x60	Index LSB 0x00	Index MSB 0x18	Sub Index 0x02	Not used	

Set event timer (SDO access):

The event timer interval is written to the same object (0x1800), subindex 0x05 and the value is set in units of 1 ms. The available range for the timer interval is from 0 ms (stops the event timer) to 65535 ms.

The event timer interval is set the following way:

			Data						
	ID	**DLC**	**Byte 0**						**Byte 7**
Command	0x600 + Node id	8	SDO request 0x2B	Index LSB 0x00	Index MSB 0x18	Sub Index 0x05	Timer LSB	Timer MSB	Not used
Answer	0x580 + Node id	8	SDO Ack. 0x60	Index LSB 0x00	Index MSB 0x18	Sub Index 0x05	Not used		

Get event timer (SDO access):

It is possible to retrieve the event timer as well for the user to see what the current timer interval is set to.
This is done by changing the SDO write to SDO read with the correct number of bytes to be read:

			Data						
	ID	**DLC**	**Byte 0**						**Byte 7**
Command	0x600 + Node id	8	SDO request 0x4B	Index LSB 0x00	Index MSB 0x18	Sub Index 0x05	Not used		
Answer	0x580 + Node id	8	SDO Ack. 0x4B	Index LSB 0x00	Index MSB 0x18	Sub Index 0x05	Timer LSB	Timer MSB	Not used

4.4 Change node configuration via SDO

Basic configurations of the CAN pressure transmitter can be set through the objects in the object dictionary. This can be done through the objects 0x4F01 (Node id) and 0x4F00 (Bitrate).

Set Node ID:

The node id of a transmitter can be set using the following command:

			Data					
	ID	**DLC**	**Byte 0**					**Byte 7**
Command	0x600 + Node id	8	SDO request 0x2F	Index LSB 0x01	Index MSB 0x4F	Sub Index 0x00	Node ID byte	Not used
Answer	0x580 + Node id	8	SDO Ack. 0x60	Index LSB 0x01	Index MSB 0x4F	Sub Index 0x00	Not used	

Set CAN Bitrate:

The CAN bitrate of a transmitter can be set using the following command:

			Data					
	ID	**DLC**	**Byte 0**					**Byte 7**
Command	0x600 + Node id	8	SDO request 0x2F	Index LSB 0x00	Index MSB 0x4F	Sub Index 0x00	Bitrate index byte	Not used
Answer	0x580 + Node id	8	SDO Ack. 0x60	Index LSB 0x00	Index MSB 0x4F	Sub Index 0x00	Not used	

Hint:

- Activation of new node id or bit rate will take effect after power cycle or the NMT state change "Reset Node".

4.5 Reserved CAN Identifiers

The CAN protocol has some reserved CAN identifiers which can be found in the table below:

CAN Identifier (11-bit), HEX	Description
0x000	NMT, network management
0x080	SYNC, synchronization message, not used in asynchronous mode
0x080 + Node ID Max range 0x081 - 0x0FF	Emergency message
0x180 + Node ID Max range 0x181 - 0x1FF	PDO1 TX, message with the value of pressure measurement
0x580 + Node ID Max range 0x581 - 0x5FF	SDO TX, CANopen configuration message
0x600 + Node ID Max range 0x601 - 0x67F	SDO RX, CANopen configuration message
0x700 + Node ID Max range 0x701 - 077F	CANopen node guarding, heartbeat and boot-up

5 Appendix

5.1 Definition of IEEE 32 Bit (single precision floating point numbers, IEEE-754 standard)

Single precision floating point numbers cover a value range from $-3.4.10^{38}$ to $3.4.10^{38}$

32-bit floating-point numbers need 4-byte (32 bit) storage memory. The following table shows the IEEE 32-bit implementation of floating-point numbers:

Bit position	31 (1 bit)	30 – 23 (8 bits)	22 – 0 (23 bits)
Function	S (sign bit)	exponent	mantissa

The value can be calculated with this formula: $(-1)^{S}.2^{(exponent-127)}.(1 + mantissa)$

The mantissa starts behind the comma (position 2-1). The first number in front of the comma (position 20) is always 1 and will not be stored in the mantissa.

5.2 Example

Hex: 400C $CCEA_{HEX}$
Binary: 0100 0000 0000 1100 1100 1100 1110 1010_{BIN}

Sign bit = 0

Exponent = 10000000BIN = 128_{DEC}
Mantissa = $00011001100110011101010_{BIN}$
$= 0.2^{-1} + 0.2^{-2} + 0.2^{-3} + 1.2^{-4} + 1.2^{-5} + \ldots + 1.2^{-22} + 0.2^{-23} = 0.100003481_{DEC}$

$400C\ CCEA_{HEX} = (-1)0.2^{(128-127)}.(1 + 0.100003481) = 2.200007_{DEC}$

5.3 References

Title	Description
CiA DS 102	Physical layer for industrial applications
CiA DS 301	Application Layer and Communication Profile
CiA DS 302-2	Additional Application Layer Functions Part 2: Network Management
CiA DS 303-1	Cabling and Connector Pin Assignment
CiA DS 303-2	CANopen representation of SI Units and Prefixes
CiA DS 305	Layer setting services (LSS) and protocols
CiA DS 404	Device Profile for Measuring Devices and Closed-Loop Controllers
ISO11898-2	Road vehicles - Controller area network (CAN) - Part 2: High-speed medium access unit