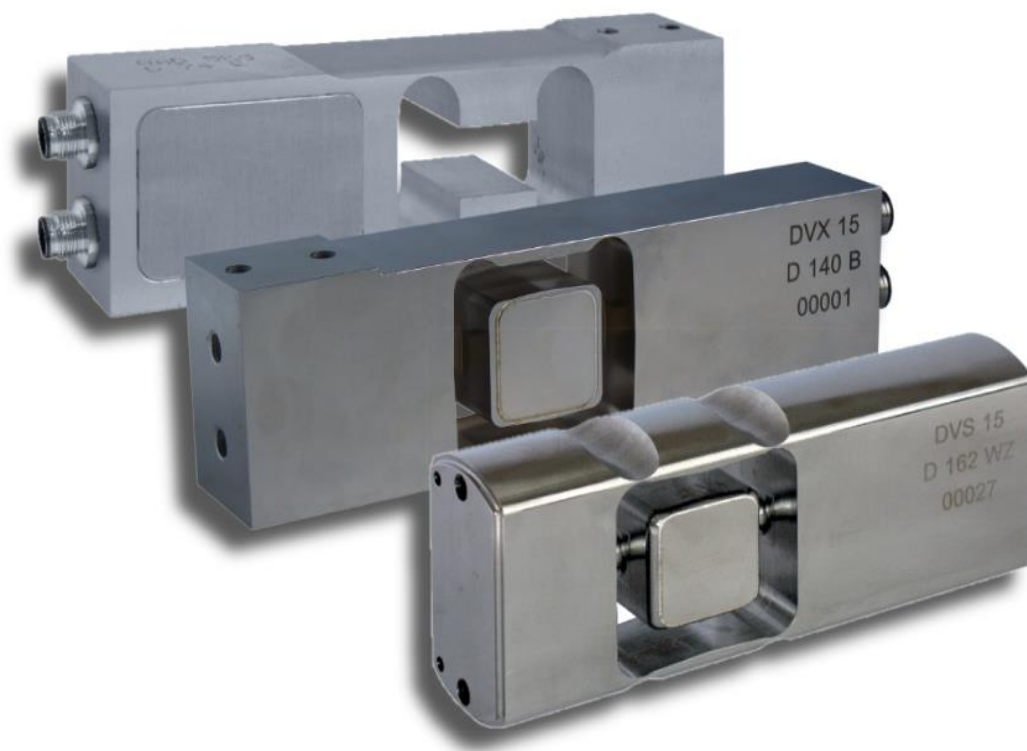


CANopen®
Communication protocol



Document revisions		
version	date	description
A	11/2012	- Document creation
B	04/2017	- Add DVX-C and DVS-C
C	11/18	- Add CAN H and L on C1 (pins 3 and 4) for DVX/DVS (2x8-pins connectors version)

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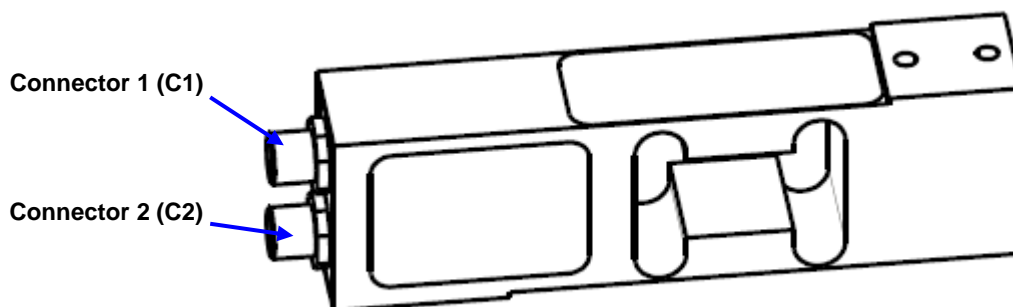
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1 INSTALLATION

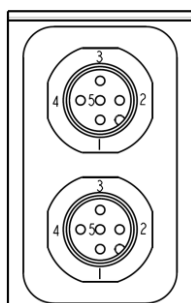
1.1 CAN bus connection

Digital load cell is equipped with a CAN 2.0A compatible interface supporting **CANopen® communication protocol**.

Digital load cell can be connected to a CAN bus using **CANH** and **CANL** connections which are differently located depending of the digital load cell version :

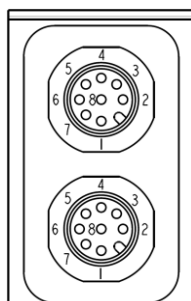


➤ 2 x 5-pins connectors version :



- CANH : pin 4 of C1 connector
- CANL : pin 5 of C1 connector

➤ 2 x 8-pins connectors version :



- CANH : pin 3 and 5 of C1 connector
- CANL : pin 4 and 6 of C1 connector

WARNING : Digital load cell is also equipped with a 2-wires RS485 output. If the digital load cell receives a valid frame (ModBus-RTU or SCMBus) by the RS485 output, it switches automatically into this communication mode (using the memorized communication protocol) and stops to transmitting on the CAN bus.

Digital load cell returns to **CANopen®** protocol after next reset (hardware or software).

By default, the baud rate for CAN communication is **125 kbauds**. It can be modified during sensor setting up phase with **eNodView** software.

1.2 Bus length and bit rate

The bit rate on the CAN bus for data transfer depends on the bus length. The following table shows the bit rates supported by digital load cell and the corresponding maximum bus length :

Bit rate	Bus max length	Nominal bit time
1 Mbit/s	25 m	1 μ s
800 kbit/s	50 m	1,25 μ s
500 kbit/s	100 m	2 μ s
250 kbit/s	250 m	4 μ s
125 kbit/s	500 m	8 μ s
50 kbit/s	1000 m	20 μ s

Notes :

- for bus whose length is greater than 200 m, using optocouplers is recommended.
- for bus whose length is greater than 1000 m, using repeaters may be necessary to ensure the quality of transmissions.

The baud rate used by digital load cell can be selected and modified either by writing a specific code in the appropriate entry of the object dictionary (cf. § 4.1.2), either by modifying the appropriate register in ModBus-RTU or SCMBus protocols (using **eNodView** makes this operation easy).

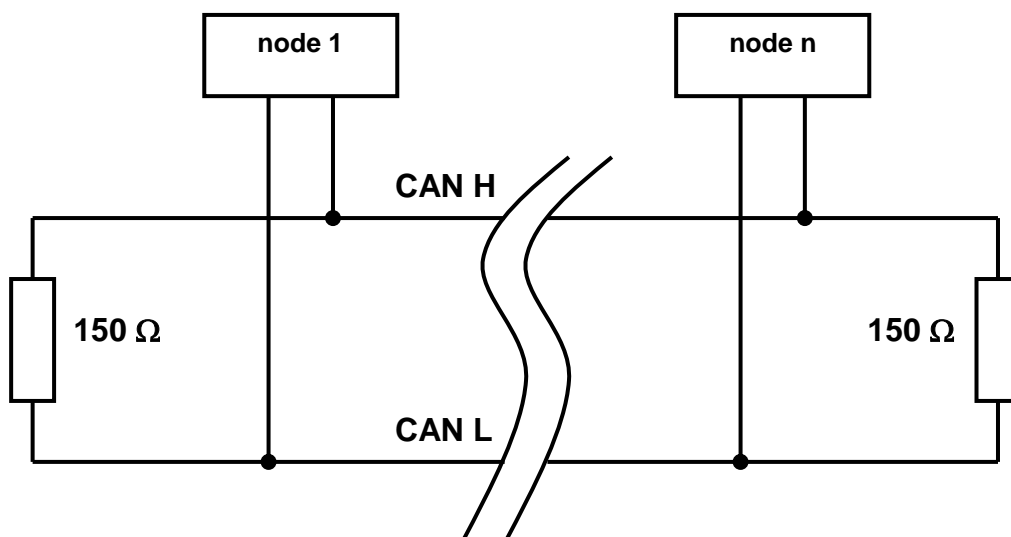
A « **bit Timing** » adapted to each baud rate is also specified by CANopen® specification. A bit is composed of **time quantas** and is characterized by the **Sample point**, which corresponds to the moment at which the bit state is taken into account.

Thus, the data transfers have to respect the following values, according to CANopen® specifications :

Bit rate	Recommended "Sample point" location	Sensor sample point location
1 Mbit/s	75% à 90%	80%
800 kbit/s	75% à 90%	68%
500 kbit/s	85% à 90%	85%
250 kbit/s	85% à 90%	87.5%
125 kbit/s	85% à 90%	87.5%
50 kbit/s	85% à 90%	87.5%

1.3 Line terminations

So as to avoid signal reflection phenomena that may lead to communication errors, the CAN bus **must** be closed through termination resistors. 150-ohm resistors must be placed at each bus extremity.



The cables, connectors and termination resistors used in CANOpen networks shall meet the requirements defined in /ISO11898-2/. In addition, here are given some guidelines for selecting cables and connectors. The following table shows some standard values for DC parameters for CANOpen networks with less than 64 nodes.

Bus length [m]	Caractéristiques du câble en DC		Termination resistance [Ω]	Bit-rate [kbit/s]
	Length-related resistance [mΩ/m]	Cross-section [mm ²]		
0 to 40	70	0.25 to 0.34	124	1000 to 40m
40 to 300	<60	0.34 to 0.6	150 to 300	≤500 to 100m
300 to 600	<40	0.5 to 0.6	150 to 300	>100 to 500m
600 to 1000	<26	0.75 to 0.8	150 to 300	>50 to 1km

Recommended cable AC parameters: 120-Ω impedance and 5-ns/m specific line delay.

Besides the cable impedance, the actual impedance of the connectors shall be considered, if calculating the voltage drop. The transmission resistance of one connector should be in the range of 2,5 to 10 mΩ.

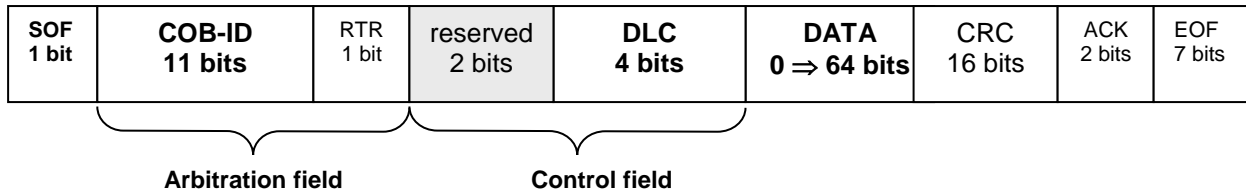
The following table defines the maximum wiring length is given for different bus cables and different number of connected bus nodes.

Wire cross-section [mm ²]	Maximum wiring length for different bus cables and different number of connected nodes		
	Nb de nœuds <32	Nb de nœuds <64	Nb de nœuds <100
0.25	200	170	150
0.5	360	310	270
0.75	550	470	410

2 **CANopen®** PROTOCOL DESCRIPTION

2.1 **CAN 2.0A frame format**

Every data frame sent on the CAN bus has the following structure :



- **Start of frame (SOF) : 1 bit**
The beginning of a request or a data frame is indicated by the transmission of one dominant bit.
- **Arbitration field : 12 bits**
This field contains the message COB-ID on 11 bits and the RTR bit, dominant for data frames and recessive for remote frames.
- **Control field : 6 bits**
The first two bits are reserved and must be transmitted as dominant. The four remaining bits encode the size of the transmitted data in bytes. This is called «**Data length code**» (**DLC**) with $0 \leq \text{DLC} \leq 8$.
- **Data : de 8 à 64 bits**
For each byte, the most significant bit (MSB) is transmitted first.
- **Cyclic Redundancy Check (CRC) : 16 bits**
The result of the CRC calculation is made up of 15 bits that guarantee the integrity of the transmitted message. The last bit is used to delimit the field and always is transmitted as dominant.
- **Acknowledgement (ACK) : 2 bits**
During two bus clock periods, the bus is available for acknowledgement of the message. All the nodes that received the message without error generate a dominant bit. Else, an error frame is generated. The second bit is always recessive.
- **End of frame (EOF) : 7 bits**
The end of the frame is represented by a sequence of 7 consecutive recessive bits.

The CANopen® layer defines particularly the content of the arbitration and the control fields and the data field structure.

2.2 **General informations**

CANopen® is a communication protocol especially dedicated to industrial applications. It allows connecting **up to 127 different devices** on a same bus giving them the possibility to access the bus at any time. Simultaneous emissions are managed by an arbitration system that uses priority levels. This control hierarchy of data transfers guarantees that there is no frame collision on the bus while ensuring a high level of reliability in communications. The low priority messages are cancelled and reissued after a delay.

The protocol defines several message types characterized by their **COB-ID** (Communication Object Identifier) that determines the message priority level. The COB-ID is composed of a **function code** and the **node identifier** (between 1 and 127).

The node identifier is the device's address on the network. The function code specifies the priority and the purpose of the message. **Assignment of a particular identifier to each device connected to the bus is mandatory.**

There are 6 different message types :

- ⇒ read/write requests : **SDO** (Service Data Object)
- ⇒ real time transfers : **PDO** (Process Data Object)
- ⇒ nodes state management : **NMT** (Network Management)
- ⇒ warnings : **EMCY** (Emergency)
- ⇒ synchronization events : **SYNC** (Synchronization)
- ⇒ node status indications : **Boot-up/Heartbeat** and **Node guarding**

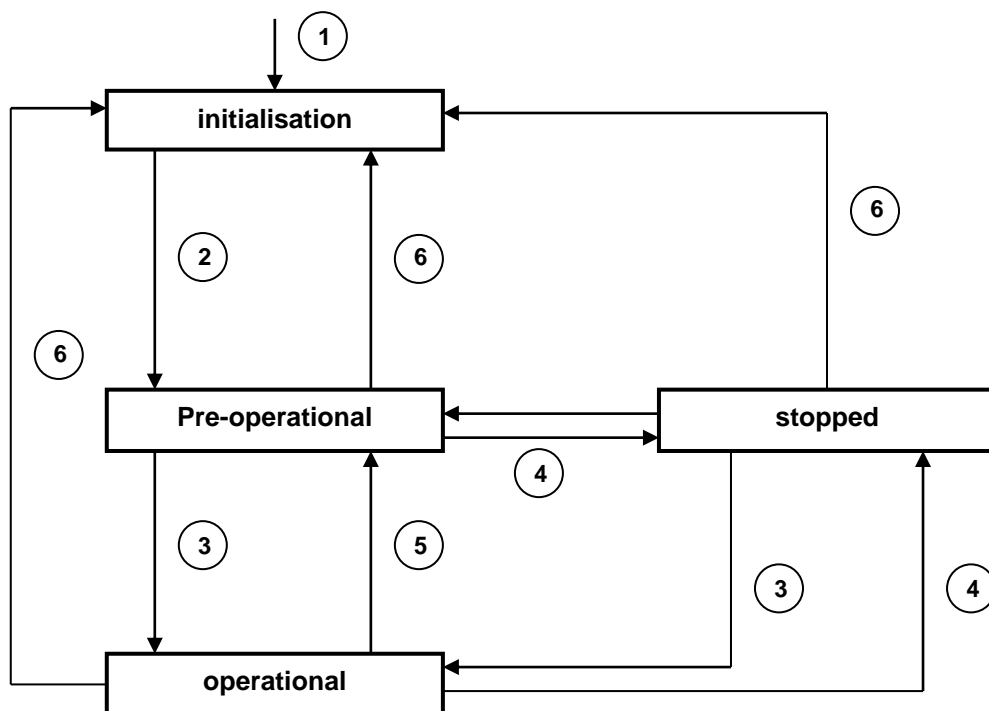
CANopen® messages	COB-ID (hex)
NMT	0
SYNC	80
EMCY	81-FF
TPDO1	181 – 1FF
RPDO1	201 – 280
TPDO2	281 – 2FF
TPDO3	381 – 3FF
SDO (Tx)	581 – 5FF
SDO (Rx)	601 – 67F
Heartbeat/Boot-up	701 – 77F

2.3 Digital load cell status management

For the CANopen® network, sensor digital load cell is considered as a **NMT slave**. It means that its state can be modified by a **NMT master** present on the bus.

As other CANopen® nodes, digital load cell can be set into one of the four existing states, allowing or forbidding the reception/emission of CAN messages.

These four states constitute the following NMT state machine :



- 1 : Sensor device power-up
- 2 : automatic transition after the end of initialization
- 3 : reception of a '**Start Node**' indication
- 4 : reception of a '**Stop Node**' indication
- 5 : reception of an '**Enter pre-operational mode**' indication
- 6 : reception of a '**Reset node**' or a '**Reset communications**' indication

Digital load cell communication capacities for each state are given in the following table :

	Initialisation	Pre-operational	Operational	Stopped
SDO		•	•	
PDO			•	
SYNC		•	•	
Emergency		•	•	
NMT		•	•	•
Boot-up	•			
Heartbeat		•	•	•

2.3.1 NMT state commands

Except during the initialisation phase, sensor digital load cell is able to handle any NMT master's requests for changing its current state. All these network management messages are constituted the same way : **a two-bytes data frame with a COB-ID equal to zero** :

COB-ID	DLC	byte 1	byte 2
0	2	NMT code	Node identifier

The 2nd byte of the data field contains the node identifier of the device concerned by the request. Its value must be between 0_H and 7F_H. The 0_H value means that the NMT command concern all the nodes of the network.

The 1st byte codes the command sent to the node. There are five existing commands supported :

- ⇒ « **Start node** » : 01_H. Digital load cell is set into **operational** state
- ⇒ « **Stop node** » : 02_H. Digital load cell is set into **stopped** state
- ⇒ « **Reset node** » : 81_H. Resets digital load cell (with the same effects as a power-up), back into **initialisation** state.
- ⇒ « **Reset communication** » : 82_H. back into **initialisation** state.
- ⇒ « **Enter pre-operational mode** » : 80_H. Digital load cell is set into **pre-operational** state

2.3.2 Synchronisation messages

SYNC messages are emitted on the bus by a producer node. This service is unconfirmed so the consumer nodes do not have to respond to SYNC messages. A SYNC message does not carry any data (DLC = 0). Digital load cell is only seen as a SYNC messages consumer whose COB-ID is equal to 80_H as it is indicated at index 1005_H, sub-index 00_H of the object dictionary.

2.3.3 Emergency messages

The internal errors of digital load cell are reported via emergency frames. Two types of errors can trigger the transmission of an emergency message :

- communication errors
- A/D converter input signal range exceeded

Every emergency frame is built as follows :

COB-ID	DLC	byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
80 _H + ID sensor	8	emergency code		error register content	additional informations				

Emergency message is an unconfirmed service. A frame is emitted when a new error occurs and when it is acknowledged. The table below describes the emergency standard codes supported by digital load cell and the translation of the additional information bytes (in ASCII) :

Emergency codes (hex.)	Meaning
0	error acknowledged
3200	voltage error
8120	CAN bus communication error
8130	life guard error
8220	PDO excess length
Additional informations (hex.)	
4B4F (ASCII:OK)	no error
474C (LG)	life time has elapsed
564F (OV)	sensor signal outside of the input signal range
5054 (TP)	CAN transmitter in error passive state
5052 (RP)	CAN receiver in error passive state
4546(FE))	flow rate failure / cycle starting error
504C(LP)	PDO length error

The error register value is also part of the emergency frame (cf. § 3.2.1) so as to indicate if other internal errors have been detected.

The number of reported errors is given by an error counter in the **pre-defined error field** located at index 1003_H, sub-index 00_h and the last reported error can be read from the same entry at sub-index 01_H.

2.4 Error control services

CANopen® uses smart mechanisms to control permanently the nodes state on the bus. Digital load cell supports **Boot-up** and **Heartbeat** messages and **Node guarding protocol**. Using both services is not allowed. If both are configured so as to be functional, only the Heartbeat mechanism is used.

2.4.1 Heartbeat and Boot-up

Digital load cell state control can be done through the use of Heartbeat and boot-up mechanisms :

- **Boot-up** : this message sent by sensor means that initialisation phase is complete and that the node has entered into **pre-operational** state. It consists in the following frame :

COB-ID	DLC	byte 1
700_H + ID sensor	1	0

- **Heartbeat** : if a Heartbeat period (in ms) different from 0 is set in the entry «Producer heartbeat time» of the object dictionary, digital load cell generates at its period a frame containing its state coded on one byte. The corresponding frame is similar to the **Boot-up** mechanism frame :

COB-ID	DLC	byte 1
700_H + ID sensor	1	sensor NMT state

Sensor NMT state byte can take the different following values :

- ⇒ 04_H : the node is in the «**stopped**» state
- ⇒ 05_H : the node is in the «**operational**» state
- ⇒ 7F_H : the node is in the «**pre-operational**» state

Using Heartbeat protocol allows a NMT master to check that all nodes connected to the bus are working correctly.

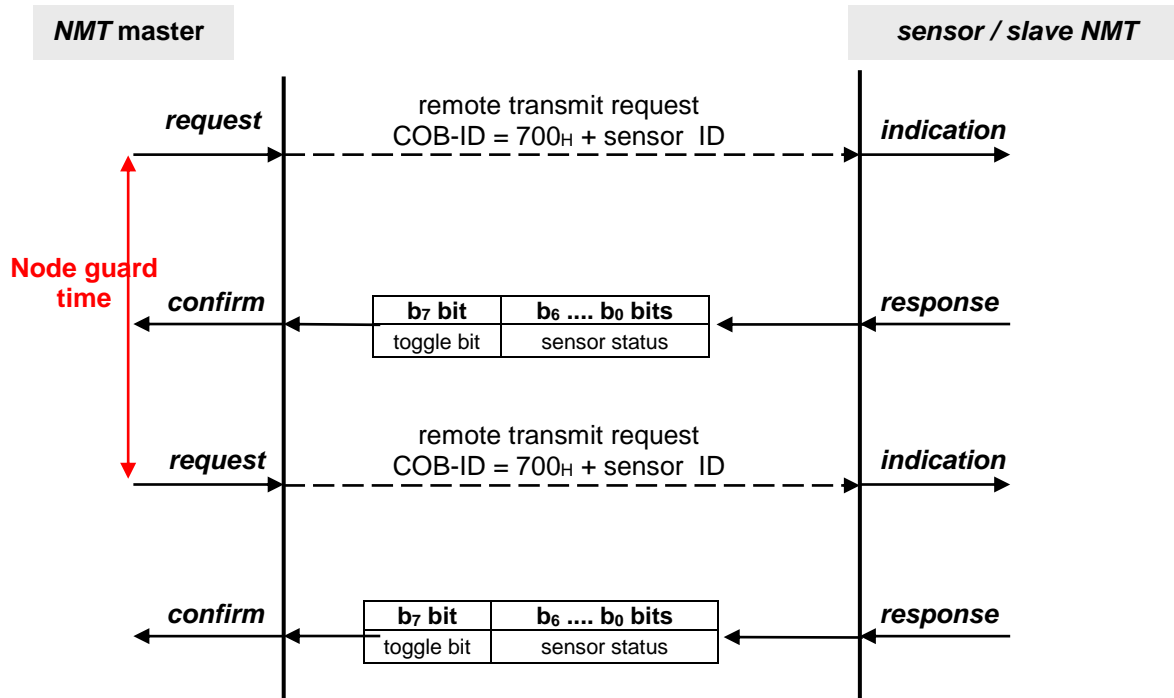
2.4.2 Node guarding

Node guarding protocol is another way to check the nodes state. But unlike Heartbeat protocol, it needs requests from a NMT master. In this case, the NMT master sends periodically a remote transmit request (remote frame) to the node with **COB-ID 700_H + ID sensor**. Digital load cell has to respond by sending a single-byte data frame with its coded state. This frame is similar to Heartbeat frame but there is an important difference. Most significant bit of the state byte is a toggle-bit. The value of this bit must alternate between two consecutive responses from the NMT slave. The value of the toggle-bit of the first response after the Guarding Protocol becomes active is 0. It is only reset to 0 when a 'reset communications' or a 'reset node' command is received. If two consecutive responses have the same value of the toggle-bit, then the new response should be handled as if it was not received by the NMT master.

Two parameters of the object dictionary are necessary to set and define node guarding protocol : the '**guard time**' and the '**life time factor**' :

- **guard time** : this parameter expressed in milliseconds indicates the period with which the node is being polled by the NMT master. This value can be different from one node to the other.
- **life time factor** : when node guarding protocol is active, **node life time** is given by multiplication of the guard time and the life time factor.

Node guarding activation is effective when guard time has been set (and if Heartbeat protocol is not used) and after reception of the first remote transmit request. If life time factor is also configured and if no remote transmit request is handled within the node life time, digital load cell **sends an emergency telegram then switches to stopped state**. The life guarding error is acknowledged when the state is changed by a NMT command and after reception of a new remote transmit request.



Switching to the stopped NMT state because of a node guarding error may cause sensor to be set into a configurable safety mode where parts of its functioning are inhibited (cf. § 4.6.8).

2.5 Access to the object dictionary

The most important element of a CANopen® compatible device is its **object dictionary (OD)**. Each node object that can be accessed via the bus is part of a table called object dictionary. The dictionary entries can be addressed by a couple of an index (2 bytes) and a sub-index (1 byte) with the following organization :

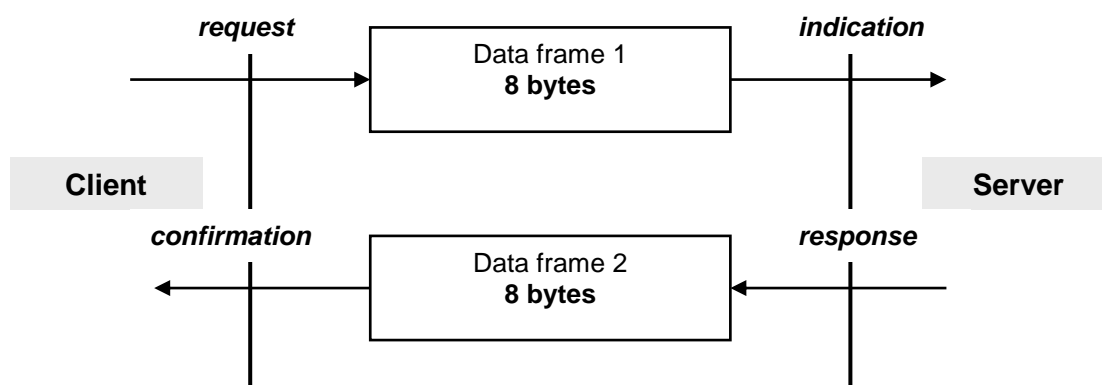
Index (hex.)	Object type
0000	reserved
0001 ⇒ 001F	static data types
0020 ⇒ 003F	complex data types
0040 ⇒ 005F	manufacturer specific complex data bytes
0060 ⇒ 007F	device profile specific static data types
0080 ⇒ 009F	device profile specific complex data types
00A0 ⇒ 0FFF	reserved
1000 ⇒ 1FFF	communication profile area
2000 ⇒ 5FFF	manufacturer specific profile area
5FFF ⇒ 9FFF	standardised device profile area
A000 ⇒ FFFF	reserved

Only the greyed elements of the table are accessible through the sensor OD.

The whole object dictionary is accessible and can be configured from usual CANopen® configuration tools. This can be done using **sensor available EDS file (named 195709_sensorName -C-X.eds)**.

2.5.1 SDO communications :

The model for SDO communication is a client/server model as described below :



The node that sends the request is the client application whereas sensor only behaves as the server application. There are two types of requests, write and read requests. Both have the same structure :

COB-ID	DLC	byte 0	byte 1	byte 2	byte 3	byte 4	byte 5	byte 6	byte 7
11 bits	1 byte	Command byte	Index		sub-index	Data			
580 _H ou 600 _H + ID sensor	8	see table	LSB	MSB	/	LSB	-	-	MSB

The client request uses the SDO(Rx) COB-ID (600_H + ID sensor) and the server uses the SDO(Tx) COB-ID (580_H + ID sensor).

The **command byte** depends on the requested data length :

Client request	Server response
read data \Rightarrow 40 _H	43 _H \Rightarrow 4-bytes data
	4B _H \Rightarrow 2-bytes data
	4F _H \Rightarrow 1-byte data
write 4-bytes data \Rightarrow 23 _H	60 _H
write 2-bytes data \Rightarrow 2B _H	
write 1-byte data \Rightarrow 2F _H	

For a read request, the value of the four last bytes of the frame (data) does not matter.

If an error occurs during a SDO communication, digital load cell responds with the command byte 80_H and the four data bytes contain one of the following SDO abort codes. The data transfer is aborted.

Error code (hex.)	Description
6010001	unsupported access to an object
6010002	attempt to write a read-only object
6020000	the object does not exist in the object dictionary
6040042	the number and length of the objects to be mapped would exceed PDO length
6040047	impossible operation (for example reading a net/gross value during a tare or a zero)
6090011	Sub-Index does not exist
6090012	data type does not match, length of service parameter too high
6090013	data type does not match, length of service parameter too low
6090030	value range of parameter exceeded
6090031	value of parameter written too high
6090032	value of parameter written too low
8000020	data cannot be stored to the application
8000022	data cannot be transferred or store to the application because of the present device state

2.5.2 PDO communications

SDO protocol is not the only way to access the object dictionary. PDO allows to transfer data without including the index and sub-index in the frame. Both are stored in an OD specific field called PDO mapping.

The model used for PDO transmissions is also different. It is a Producer/Consumer model in which data are sent by a producer node (TPDO) to a consumer node (RPDO) without any confirmation.

Each PDO is described by a combination of two parameters of the OD : the **PDO communication parameters** and the **PDO mapping**. The PDO communication parameters describe the functioning of the PDO and the PDO mapping describes its content. Digital load cell uses **3 TPDO** (2 are programmable) and **1 RPDO**.

The PDO transmission mode can be set in the corresponding object with the following attributes :

\Rightarrow **Synchronous** : PDO transmission is triggered by the reception of one ore more SYNC messages. Several options are available :

- cyclic : PDO is sent after reception of n ($1 \leq n \leq 240$) SYNC messages.

- acyclic : PDO is sent at reception of the first SYNC message following a specific device event (activation of a logical input assigned to 'send TPDO' or data variation superior to +/- delta)
- on remote transmit request : PDO is sent after the first SYNC message following a remote transmit request frame with the PDO COB-ID.

⇒ **Asynchronous** : PDO transmission does not depend on the SYNC messages on the CAN bus. Several options are available :

- on remote transmit request : PDO is sent at reception of a remote transmit request frame with the PDO COB-ID.
- activation of a logical input assigned to 'send TPDO' or data variation superior to +/- delta
- on a timer event : PDO is sent periodically (with an adjustable period).

The following table recaps the trigger modes that can be chosen by entering the hexadecimal code in the PDO communication parameter.

Code (hex)	cyclic	acyclic (event)	synchronous	asynchronous	remote transmit request	Effect
00		X	X		X	PDO transmission after a SYNC message following one of these events : - activation of a logical input assigned to « send TPDO » - mapped object variation superior to +/- delta
01 – F0 (= n)	X		X		X	PDO transmission after n SYNC messages
F1 - FB	reserved					
FC			X		X	data update at reception of a remote transmit request and PDO transmission after reception of a SYNC message
FD				X	X	data update and PDO transmission at reception of a remote transmit request
FE				X	X	PDO transmission is triggered by one of these events : - activation of a logical input assigned to « send TPDO » - mapped object variation superior to +/- delta
FF				X	X	Periodic PDO emission. Period can be configured (min = 1 ms).

CANopen® OBJECTS DICTIONNARY : COMMUNICATION OBJECTS

Index	Max sub-index	Description	Access	mappable (PDO)	Type
0x1000	0	device profile	RO	N	unsigned32
0x1001	0	error register	RO	N	unsigned8
0x1003	1	pre-defined error field	variable	N	/
0x1005	0	SYNC messages COB-ID	RO	N	unsigned32
0x1008	0	device name	CO	N	visible string
0x1009	0	hardware version	CO	N	visible string
0x100A	0	software version	CO	N	visible string
0x100C	0	life guard	R/W	N	unsigned16
0x100D	0	life time factor	R/W	N	unsigned8
0x1010	1	store parameters	variable	N	/
0x1014	0	emergency messages COB-ID	RO	N	unsigned32
0x1017	0	producer heartbeat time	R/W	N	unsigned16
0x1018	1	device identity	RO	N	/
0x1400	2	RPDO1 communication parameter	RO	N	/
0x1600	1	RPDO1 mapping parameter	CO	N	/
0x1800	2	TPDO1 communication parameter	RO	N	/
0x1801	5	TPDO2 communication parameter	variable	N	/
0x1802	5	TPDO3 communication parameter	variable	N	/
0x1A00	1	TPDO1 mapping parameter	CO	N	/
0x1A01	3	TPDO2 mapping parameter	R/W	N	/
0x1A02	3	TPDO3 mapping parameter	R/W	N	/

- R/W : Read/Write
- RO : Read Only
- CO : Constant value
- Y : Yes
- N : No
- / : the sub-index of the entry have different sizes

2.6 Device identification

2.6.1 0x1000 : Device profile

This entry describes the device and if it respects a standard profile.

Access : Read only

Default value : 00000000_H

Digital load cell does not follow any CIA® standardised profile

2.6.2 0x1008 : Device name

The device name is coded as a 4-bytes string (ASCII).

Access : Read only

Default value : 44445841_H

MSB - 0x44 ⇒ **D**
 - 0x44 ⇒ **D**
 - 0x58 ⇒ **X**
 LSB - 0x41 ⇒ **A**

2.6.3 0x1009 : Hardware version

The device hardware version is coded as a 4-bytes string (ASCII).

Access : Read only

Default value : 31302E31_H

MSB - 0x31 ⇒ **1**
 - 0x30 ⇒ **0**
 - 0x2E ⇒ **.**
 LSB - 0x31 ⇒ **1**

2.6.4 0x100A : Software version

The device software current version is coded as a 4-bytes string (ASCII).

Access : Read only

Default value : 34312E31_H

MSB - 0x33 ⇒ **4**
 - 0x31 ⇒ **1**
 - 0x2E ⇒ **.**
 LSB - 0x31 ⇒ **1**

2.6.5 0x1018 Product identifier

This index includes SCAIME « **vendor ID** » supplied by CAN in Automation (CiA®).

Sub-index	Description	Access	Default value	mappable (PDO) ?	Type
0x00	index max	RO	0x01	N	unsigned8
0x01	Vendor-ID	RO	0x00000142	N	unsigned32

2.7 [CANopen® settings](#)

2.7.1 0x1001 : Error register

The device internal errors are indicated by flag bits of this byte.

Access : Read only

Default value : /

bit set to 1	Meaning
b0	generic error detected
b1	reserved (0)
b2	A/D converter input voltage error
b3	reserved (0)
b4	CAN bus communication error

b5	reserved (0)
b6	reserved (0)
b7	EEPROM error

Bit 0 (generic error) is set to 1 if at least one error is detected.

2.7.2 0x1003 : Pre-defined error field

This entry of the OD stores the errors that have been reported by emergency telegrams.

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	reported errors counter	R/W	0	N	unsigned 8
0x01	last reported error	RO	0	N	unsigned 32

The reported errors counter (sub-index 00_H) is accessible through write or read request but 0 is the only allowed value for writing transactions. By writing a zero to this sub-index, the error counter is reset and the last reported error (sub-index 01_H) is erased.

For the writing of all other values, digital load cell transmits the error code 0x06090030.

2.7.3 0x1005 : Synchronization messages COB-ID

This object contains the messages COB-ID value supported by digital load cell as synchronization messages (Used for PDO activating).

Access : Read only

Default value: 80_H

2.7.4 0x100C : Life guard

The life guard is one of the two parameters used by the node guarding protocol (errors detection). When Heartbeat is inactive and Life guard is different from 0, digital load cell responds to NMT master periodic (period equal to life guard) remote transmit requests.

Access : Read/Write

Default value : 0_H

2.7.5 0x100D : Life time factor

By multiplying the life guard by the life time factor the node life time (cf. §2.4.2) can be determined. When node guarding is active, if the node has not been polled within this duration (in ms), sensor state is set to **stopped**. Sensor behaviour while stopped can be configured via the object at index 0x4800.

Access : Read/write

Default value: 0_H

2.7.6 0x1010 : Store parameters

This entry can be used to store in non-volatile memory (EEPROM) sensor current settings. It allows keeping them despite a power failure and some of them only apply after storage in EEPROM followed by a reset (hardware or software) procedure. The entry has two sub-indexes.

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	largest sub-index	RO	0x01	N	unsigned8
0x01	save all parameters	R/W	0x01	N	unsigned32

Storing all settings in EEPROM requires writing the ASCII string « save » (65766173_H) to sub-index 01_H.

- 0x65 ⇒ **e**
- 0x76 ⇒ **v**
- 0x61 ⇒ **a**
- 0x73 ⇒ **s**

When accessing to sub-index 1 with a read request, digital load cell responds with value of 1 that means that parameters are stored in non-volatile memory only on request.

2.7.7 0x1014 : Emergency COB-ID

The COB-ID of emergency messages transmitted by sensor is stored at this index.

Its value is automatically updated if the node identifier is modified.

Access : read only

Default value : 81_H

2.7.8 0x1017 : Producer heartbeat time

If a period different from 0 is written to this index, sensor periodically generates a Heartbeat frame (see §2.4.1). It is expressed in ms and must be comprised between 1 and 65535.

Access : Read/write

Default value : 0_H

2.7.9 0x1400 : RPDO1 communication parameters

This entry contains information concerning the data transmission made by PDO to the digital load cell. It includes three sub-indexes :

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	largest sub-index	RO	0x02	N	unsigned8
0x01	COB-ID RPDO1	RO	0x00000200+ ID sensor	N	unsigned32
0x02	Transmission type	RO	0xFF	N	unsigned8

- The RPDO1 messages COB-ID is automatically updated when sensor identifier is modified.
- The transmission type for RPDO1 messages cannot be overwritten. A value of FF_H means that the RPDO are taken into account by sensor upon reception.

2.7.10 RPDO1 mapping parameters (constant)

The RPDO1 mapping parameter contains the index (byte 3, byte 2), the sub-index (byte 1) and the size of the mapped object (byte 0) where received data are automatically transferred.

This entry has two sub-indexes :

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Size
0x00	number of mapped objects	CO	0x01	N	unsigned8
0x01	1 st object mapping	CO	0x20030008	N	unsigned32

The data stored in sub-index 01_H must be read as :

- 0x2003 ⇒ OD entry index
- 0x00 ⇒ OD entry sub-index
- 0x08 ⇒ 8-bits size

This RPDO is especially dedicated to accept functional commands coded on one byte such as '**Tare**' or '**Zero**'. The possible commands are listed below :

Code (hex.)	Effect	Note
00	set command register to IDLE state	⇒ no command to execute
D0	reset	⇒ Same as boot up
D1	EEPROM saving	⇒ Save all factory parameters in sensor EEPROM
D2	Initialize sensor to default parameters	⇒ WARNING! All factory parameters are restored included node address, bit rate and calibration.
D3	zero acquisition	⇒ requires measure stability, if stability is not reached after 5 seconds, the command is cancelled ⇒ this new zero value will be the new current value but won't be stored into EEPROM ; limited to a $\pm 10\%$ range of the maximum capacity or $\pm 2\%$ in legal for trade
D4	tare request	⇒ requires measure stability, if stability is not reached after 10 seconds, the command is cancelled
D6	Cancel current command	⇒ Cancel current command (tare, zero adjustment, physical calibration)
D7	user's span adjustment	⇒ must be followed by the « <i>save calibration</i> » command
D8	zero adjustment	⇒ must be followed by the « <i>save calibration</i> » command ⇒ OR by the « <i>physical calibration</i> » command
EC	physical calibration	⇒ allows to physically adjust the span by using a calibration load, must be preceded by the « <i>zero adjustment</i> » command and must be followed by the « <i>save calibration</i> » command (the calibration load corresponds to the number assigned to ' <i>calibration load</i> ')
DE	save calibration	⇒ stores the calibration into EEPROM
DF	clear	⇒ Reset all the variables computed during Checkweigher cycle and stops current cycle.
E4	start CW cycle	⇒ starts a checkweigher cycle
E5	Stop CW cycle	⇒ stops the current checkweigher cycle
E6	cancel tare	⇒ erases last tare value

E7	forcing output 1 state	⇒ only in « <i>transmitter</i> » <i>functioning mode</i> , if the concerned output is assigned to 'level on request' ⇒ send this command to activate the corresponding output (depending of the chosen logic), resend this command again to inhibited it and so on.
E8	forcing output 2 state	
E9	forcing output 3 state	
EA	forcing output 4 state	
EB	erase max peak value	⇒ max peak = current gross value
ED	dynamic zero	⇒ zero determination without stability criterion calculated during the 'dynamic zero time'

2.7.11 0x1800 : TPDO1 communication parameters

The information concerning the data sent by sensor via PDO communication is stored in this entry of the OD. This entry has three sub-indexes :

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	largest sub-index	RO	0x02	N	unsigned8
0x01	COB-ID TPDO1	RO	0x00000180+ ID sensor	N	unsigned32
0x02	transmission type	RO	0xFE	N	unsigned8

- The TPDO1 messages COB-ID is automatically updated when sensor identifier is modified.
- The transmission type for TPDO1 messages cannot be overwritten. A value of FE_H means that the TPDO is sent upon a variation of the mapped value.
- This PDO is sent by the digital load cell to signal the current state of the functional command to execute (in progress, complete, error).

2.7.12 0x1A00 : TPDO1 mapping parameters (constant)

The TPDO1 mapping parameter contains the index (byte 3, byte 2), the sub-index (byte 1) and the size of the mapped object (byte 0) that is sent. The corresponding entry manages the current state of the last functional command :

- ⇒ 0x01 ⇒ **command execution in progress**
- ⇒ 0x02 ⇒ **command execution complete**
- ⇒ 0x03 ⇒ **error during command execution**

This entry has two sub-indexes :

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	number of mapped objects	RO	0x01	N	unsigned8
0x01	1 st object mapping	RO	0x20040008	N	unsigned32

The mapped object corresponds to the answer register of the sensor.

The content of the sub index 01_H is:

- 0x2004 ⇒ Object index
- 0x00 ⇒ Object Sub-index
- 0x08 ⇒ Object size (8 bits length)

2.7.13 0x1801/0x1802 : TPDO2/TPDO3 communication parameters

Both objects are similar and aim at describing transmits PDO they are assigned to. Each object is constituted by 4 sub-indexes :

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Size
0x00	largest sub-index	RO	0x05	N	unsigned8
0x01	TPDO2 or TPDO3 COB-ID	R/W	0x00000280 ou 0x00000380 + ID sensor	N	unsigned32
0x02	transmission type	R/W	0x01 ou 0xFE	N	unsigned8
0x05	timer event	R/W	0	N	unsigned16

- The TPDO2 and TPDO3 messages COB-ID is automatically updated when sensor identifier is modified. **Both TPDO can be enabled/disabled by setting to 0 bit 31 of their COB-ID (sub-index 01_H).**
- By default, TPDO2 and TPDO1 are enabled.
- The transmission type and the timer event duration can be chosen according to the table in § 2.5.2

2.7.14 0x1A01 : TPDO2 mapping

The TPDO2 mapping parameter contains the index (byte 3, byte 2), the sub-index (byte 1) and the size of the mapped object (byte 0) included in TPDO2 frames. **Up to 3 objects can be mapped in the same PDO but the total data length cannot exceed 8 bytes.**

This entry has four sub-indexes :

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	number of mapped objects	R/W	0x01	N	unsigned8
0x01	1 st object mapping	R/W	0x50010020	N	unsigned32
0x02	2 nd object mapping	R/W	0	N	unsigned32
0x03	3 rd object mapping	R/W	0	N	unsigned32

- ❑ The object mapped at sub index 0x01 correspond to the object “gross measure” of index 0x5001, sub index 00h, 32 bits size (20h).
- ❑ **Note :** TPDO2 mapping can only be modified in pre-operational state. First, it is necessary to switch to 1 bit b31 of its COB-ID (cf. 3.2.13) and force sub-index 0x00 to 0 (Number of objects transmitted equal to 0).

2.7.15 0x1A02 : TPDO3 mapping

The TPDO3 mapping parameter contains the index (byte 3, byte 2), the sub-index (byte 1) and the size of the mapped object (byte 0) included in TPDO3 frames. **Up to 3 objects can be mapped in the same PDO but the total data length cannot exceed 8 bytes.**

This entry has four sub-indexes :

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	number of mapped objects	R/W	0x02	N	unsigned8
0x01	1 st object mapping	R/W	0x50040220	N	unsigned32
0x02	2 nd object mapping	R/W	0x50050210	N	unsigned32
0x03	3 rd object mapping	R/W	0	N	unsigned32

- ❑ **Note** : TPDO3 mapping can only be modified in pre-operational state. First, it is necessary to switch to 1 bit b31 of its COB-ID (cf. 3.2.13) and to force sub-index 0 to 0.
- ❑ The object mapped at sub index 0x01 is "gross measure": index 0x5004, sub index 02h, 32 bits size (20h).
- ❑ The object mapped at sub index 0x02 is "quality information": index 0x5005, sub index 00h, 32 bits size (20h).
- ❑ TPDO3 mapping can only be modified in pre operational state. First it is necessary to disabled (bit31 of its COB-ID, cf 3.2.13) and force sub-index 0x00 to 0 (Number of objects transmitted equal to 0).

3 DIGITAL LOAD CELL SPECIFIC OBJECTS

Index	Max sub-index	Description	Access	Mappable (PDO) ?	Type
Communication parameters					
0x2000	0	functioning mode	R/W	N	unsigned8
0x2001	0	CAN bus baud rate	R/W	N	unsigned8
0x2002	0	Sensor identifier (ID)	R/W	N	unsigned16
0x2003	0	functional command register	R/W	Y (RPDO1)	unsigned8
0x2004	0	response register	RO	Y (TPDO1)	unsigned8
Calibration settings					
0x3000	0	maximum capacity	R/W	N	unsigned32
0x3001	0	scale interval	R/W	N	unsigned16
0x3002	0	global span adjusting coefficient	R/W	N	unsigned32
0x3003	0	calibration load	R/W	N	unsigned32
0x3004	0	g coefficient value	R/W	N	unsigned32
0x3005	0	User zero value (calibration)	R/W	N	integer32
0x3006	0	User scale coefficient (calibration)	R/W	N	real32
Legal for trade settings					
0x3500	0	motion	R/W	N	unsigned8
0x3501	2	zero mode	variable	N	unsigned16
0x3600	0	legal for trade switch	R/W	N	unsigned8
0x3601	3	legal metrology indicators	RO	N	/
Filtering parameters					
0x4000	0	A/D conversion frequency	R/W	N	unsigned16
0x4001	0	self-adaptive filter	R/W	N	unsigned8
0x4002	9	digital filter settings	variable	N	/
Logical Inputs/Outputs					
0x4501	3	logical inputs configuration	variable	N	/
0x4509	4	logical outputs configuration	variable	N	/
0x4601	5	set points 1 & 2 configuration	variable	N	/
0x4609	5	set points 3 & 4 configuration	variable	N	/
Checkweigher settings					
0x4700	0	Set point (CW)	R/W	N	unsigned32
0x4701	0	acquisition time T _m (CW)	R/W	N	/
0x4702	0	dynamic zero acquisition time	R/W	N	/
0x470A	0	stabilization time	R/W	N	/
0x470B	0	checkweigher correction coefficient	R/W	N	/

Other objects					
0x4800	0	safety mode	R/W	N	unsigned8
0x4900	0	delta min TPDO2	R/W	N	unsigned32
0x4901	0	delta min TPDO3	R/W	N	unsigned32
Measures					
0x5000	0	net measurement	RO	Y	integer32
0x5001	0	gross measurement	RO	Y	integer32
0x5002	0	A/D converter points	RO	Y	integer32
0x5003	0	measurement status	RO	Y	unsigned16
0x5004	6	CW results	RO	Y	/
0x5005	0	CW result quality	RO	Y	real32
0x5100	0	logical inputs state	RO	Y	unsigned8
0x5200	0	logical outputs state	RO	Y	unsigned8

Note : All the bits that are not mentioned in the description of the settings below are reserved and always set to 0.

3.1 Communication parameters

3.1.1 0x2000 : Functioning mode

This entry allows selecting one of sensor functioning modes. The settings are applied after an EEPROM saving followed by a reset. The functioning mode is coded on the bits b0 and b1. Bit b3 can be used so as to shunt digital filters, non-linearity correction and set point management.

Access : Read/Write

Default value : 01_H

bits b2, b1, b0	Functioning mode	Notes
000	transmitter	active after save and reset
001	checkweigher transmit on demand	
010	checkweigher automatic transmit	
bit b3	Signal processing	
0	treatment enabled	digital filters, set point management and non-linearity correction activation
1	treatment disabled	

3.1.2 0x2001 : CAN bus baud rate

This entry is used to choose the baud rate employed on the CAN bus. Any modification of this parameter is affective only after an EEPROM saving followed by a reset (hardware or software).

Access : Read/Write

Default value : 03_H

The codes corresponding to the different possible bit rates are given below :

- 0x02	⇒	50 kbit/s
- 0x03	⇒	125 kbit/s
- 0x04	⇒	250 kbit/s
- 0x05	⇒	500 kbit/s

- 0x06	⇒	800 kbit/s
- 0x07	⇒	1 Mbit/s

3.1.3 0x2002 : Sensor identifier (ID)

On a CANopen® network, each COB is uniquely identified by one COB-ID which depends on the node identifier. Digital load cell ID can be changed. A modification of this parameter is applied only after saving it in EEPROM followed by a reset (hardware or software). Sensor CAN identifier is equal to the address used for RS485 communication. This setting is stored at this index of the OD and can be assigned a value between 1 and 127 (01_H and 7F_H).

Access : Read/Write

Default value : 01_H

3.1.4 0x2003/0x2004 : Command/response register

For a complete description of this entry, please refer to §3.2.9 and §3.2.12.

Access : Read/write (0x2003) and Read only (0x2004)

Default value : 00_H

3.2 Calibration settings

3.2.1 0x3000 : Maximum capacity

The maximum capacity entry allows to define the gross value delivered by the digital load cell at its maximum load (for example : 30000 pts for 30 kg). This parameter value is used as part of 'user span adjustment' command (D7_H, cf §3.2.10).

When the absolute value of the gross measure exceeds this value plus 9 divisions, the b3 bit (positive overloading) or the b2 bit (negative overloading) of the status bytes associated to the measure is set to 1.

The zero acquisition (on request or at power-up) is handled only if the value is lower than ±10% range of the maximum capacity or ±2% in legal for trade. The admitted values for this parameter are contained between 0 et 1000000_d.

Access : Read/write

Default value : 7A120_H

3.2.2 0x3001 : Scale interval

The scale interval is the minimal difference between two consecutive indicated values (gross/net).

Admitted values are listed below :

- 1d	⇒	0x0001
- 2d	⇒	0x0002
- 5d	⇒	0x0005
- 10d	⇒	0x000A
- 20d	⇒	0x0014
- 50d	⇒	0x0032
- 100d	⇒	0x0064

Access : Read/write

Default value : 01_H

3.2.3 0x3002 : Global span adjusting coefficient

Initial calibration can be adjusted through to the global scale adjusting coefficient. Adjustment applies on the whole curve. The unity for this coefficient is 1E-6 that means 1000000_d = 1. Admitted values are between 900000_d and 1100000_d. A modification of this setting is only taken into account after EEPROM storage and a reset (hardware or software) procedure.

Access : Read/write

Default value : F4240_H

3.2.4 0x3003 : Calibration load

Digital load cell span can be adjusted by learning with a standard load. The equivalence between the standard load and the corresponding points number is set by the 'calibration load' value used during the physical calibration procedure (E_{CH} cf §3.2.10).

Access : Read/write

Default value : 2710_H

3.2.5 0x3004 : Gravity coefficient (g) adjustment

As digital load cell is calibrated in Annemasse (France), depending on the terrestrial geographical coordinates where digital load cell is used, the gravity difference can affect the measure aptness.

In order to compensate this error, it is possible to modify this gravity coefficient to adjust it to the using place. It is expressed without point, and multiplied by one million (for example, 9.805 is traduced by 9805000 in the digital load cell). This correction is taken in account after a saving in EEPROM followed by a reset, then the span adjustment is automatic.

Access : Read/write

Default value : 959E9E_H (= 9.805470, gravity at calibration place)

3.2.6 0x3005 : User zero value (Calibration)

A/D value of the zero. This value is determined by the "zero adjustment" command.

Access : Read/write

Default value : 0_H

3.2.7 0x3006 : User scale coefficient

The user scale coefficient is calculated by sensor *during a "user span adjustment " or a "physical calibration"*

Access : Read/write

Default value : 3F800000_H (1.0)

3.3 Legal for trade parameters

3.3.1 0x3500 : Motion

Measurement is stable if X consecutive measurements following the reference measurement are included in the stability interval (see following table) else the current measurement becomes the reference measurement. X depends on the Analog to Digital (A/D) conversion rate.

A modification of this setting is only applied after EEPROM storage and a reset (hardware or software) procedure.

bits b2 b1 b0	Stability interval	Notes
000	no motion detection	
001	0.25d	1d = 1 division
010	0.5d	
011	1d	
100	2d	

A/D conversion rate (meas/s)		X
50 Hz rejection	60 HZ rejection	
6.25	7.5	1
12.5	15	2
25	30	3
50	60	5
100	120	9
200	240	17
400	480	33
800	960	65
1600	1920	129

Access : Read/write

Default value : 02_H

3.3.2 0x3501 : Zero mode

Index	Max sub-index	Description	Access	Mappable (PDO) ?	Type
0x00	largest index	LS	0x02	N	unsigned8
0x01	Zéro type	L/E	0	N	unsigned8
0x02	Automatic zero adjustment range	L/E	0	N	unsigned8

- **Sub-index 0x01** Zero type:

bit b0	Zero tracking	Notes
1	zero tracking active	⇒ zero tracking is active in the range of $\pm 10\%$ of the maximum capacity or $\pm 2\%$ in legal for trade applications (cf. §4.3.3)
0	without zero tracking	
bit b1	Initial zero setting	Notes
1	initial zero setting enabled	⇒ initial zero setting is active in the range of $\pm 10\%$ of the maximum capacity or $\pm 2\%$ in legal for trade applications (cf. §4.3.3)
0	initial zero setting disabled	
bit b2	Automatic zero adjustment (CW mode)	Notes
1	Automatic zero adjustment (CW mode) in specific range	cf. user manual ref. 195752
0	No automatic adjustment	

- **Sub-index 0x02:** Automatic zero adjustment range

The value is between 0 and 255. It defines the correction range from 0 to 255d (cf § 3.2.2).
In legal for trade, this value is automatically limited to $\pm 5d$.

The automatic zero correction in checkweigher corrects the zero variation on a conveyor belt which get dirty (see User manual ref 195752).

Once the correction is activated (cf sub index 0x01 Zero type) it correct the reference zero (calculated during the calibration or when sensor boot up, in successive time steps and with a defined duration (cf § 3.6.3).

In legal for trade, zero is not corrected if the measure is stable.

3.3.3 0x3600 : Legal for trade switch

This entry activates or deactivates (through the b0 bit) criteria and parameters related to the use of digital load cell in OIML compliance.

The 'legal for trade' activation leads to the following changes :

- the legal for trade counter is incremented every time a storage in EEPROM is requested if a metrological setting has been modified (cf. § 4.3.4)
- a new legal for trade CRC-16 value is calculated every time a storage in EEPROM is requested if a metrological setting has been modified (cf. §4.3.4)
- taring is now impossible if gross measurement is negative
- zero acquisition range is reduced from 10% of the capacity to 2%.
- the weight value is set to -1 during the 15 seconds that follow a digital load cell reset
- the motion criterion (cf. § 4.3.1) is forced to $0.25d$ and cannot be modified anymore. An attempt to change its value is refused and digital load cell sends a SDO error frame.

Access : Read/write

Default value : 0_H

3.3.4 0x3601 : Legal for trade indicators

If the legal for trade option is enabled (cf. §4.3.3), two indicators allow to insure the traceability during legal for trade application. The legal metrology counter and the legal metrology CRC-16 are

incremented every time a storage in EEPROM is requested if one (or several) of these settings has been modified :

- global span adjusting coefficients
- scale interval
- maximum capacity
- A/D zero value (calibration)
- Span adjusting coefficient value
- legal metrology activation
- initial zerosetting and zero tracking
- Zero type
- motion criterion

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	largest sub-index	RO	0x03	N	unsigned8
0x01	legal for trade counter	RO	0	N	unsigned16
0x02	Legal for trade CRC-16	RO	0	N	unsigned16
0x03	metrological program version	RO	3	N	unsigned16

3.4 Filtering parameters

3.4.1 0x4000 : A/D conversion rate

A modification of this setting is only taken into account after EEPROM storage and a reset (hardware or software).

The different admitted frequencies and their corresponding binary codes are listed in the following table:

bit b0	Rejection	
1	50 Hz rejection	
0	60 Hz rejection	
bits b4 b3 b2 b1	A/D conversion rate (meas/s)	
	50 Hz	60Hz
0000	100	120
0001	50	60
0010	25	30
0011	12,5	15
0100	6,25	7,5
1001	1600	1920
1010	800	960
1011	400	480
1100	200	240

Access : Read/write

Default value : 1_H

3.4.2 0x4002 : Digital filters settings

This entry gives an access to the configuration of the low-pass and band-stop digital filters that can be used by digital load cell. The low-pass filter order is configurable, possible orders are 0 (filter disabled), 2, 3 or 4. **It is coded on the b2, b1 and b0 bits.** The band-stop filter activation can be done by **setting b8 bit to 1** of the same sub-index.

The filter recurrence relation of these filters are :

- **digital low-pass filter :**

$$2^{\text{nd}} \text{ order : } S_n = 1/A(e_n + 2e_{n-1} + e_{n-2} - BS_{n-1} - CS_{n-2})$$

$$3^{\text{rd}} \text{ order : } S_n = 1/A(e_n + 3e_{n-1} + 3e_{n-2} + e_{n-3} - BS_{n-1} - CS_{n-2} - DS_{n-3})$$

$$4^{\text{th}} \text{ order : } S_n = 1/A(e_n + 4e_{n-1} + 6e_{n-2} + 4e_{n-3} + e_{n-4} - BS_{n-1} - CS_{n-2} - DS_{n-3} - ES_{n-4})$$

- **digital band-stop filter :**

$$2^{\text{nd}} \text{ order : } S_n = X(e_n + e_{n-2}) + Y(e_{n-1} - S_{n-1}) - ZS_{n-2}$$

This entry of the OD is constituted by 10 sub-indexes :

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	largest sub-index	RO	0x09	N	unsigned8
0x01	Low pass filter order/cutoff frequency activation	R/W	0x03	N	unsigned16
0x02	1/A coefficient	R/W	0x3B2F8D59 (= 0.00267871306)	N	real32
0x03	B coefficient	R/W	0xC4557BFD (= -853.937317)	N	real32
0x04	C coefficient	R/W	0x4425AF13 (= 662.735535)	N	real32
0x05	D coefficient	R/W	0xC32E1C9C (= -174.111755)	N	real32
0x06	E coefficient	R/W	0	N	real32
0x07	X coefficient	R/W	0x3F6DCC83 (= 0,92890471)	N	real32
0x08	Y coefficient	R/W	0xBEDBB2BD (= -1,7163921)	N	real 32
0x09	Z coefficient	R/W	0x3F5B995F (= 0,857809)	N	real 32

Note: With a 0 value sub index 0x01 deactivate the low pass filter.

By default, the low-pass filter is enabled and set for a 100 measures per second and a 10 Hz cut-off frequency. It is a 3rd order filter.

Cutoff frequency settings are: 400 measures per second, 50 Hz rejection in a +/- 10 Hz range. This filter is disabled by default. Before activation, be careful to update coefficients to your needs.

Coefficients could be computed with eNodView software.

3.4.3 0x4001 : Self-adaptive filter

This type of filter can be set in cascade after the previous filters. It is particularly useful for static measurements, avoid using it in dynamic or checkweigher process. The aim of this filter is to eliminate erratic measurements and to average consistent measurements. It can be enabled **by setting b0 bit to 1**.

Access : Read/write

Default value : 0_H

bit b0	Note
1	⇒ self-adaptive filter enabled
0	⇒ self-adaptive filter disabled

3.5 Logical inputs/outputs configuration

3.5.1 0x4501 : Logical inputs configuration

Depending on the version (2x5 pins or 2x8 pins), digital load cell has one or two logical inputs which can be configured in different ways described below :

bits b2 b1 b0	Input assignment	Notes
000	none	⇒ input is ignored
001	tare	⇒ tare command
010	zero	⇒ set to zero the gross measure ; limited at $\pm 10\%$ of the max capacity or $\pm 2\%$ in legal for trade applications (cf. §4.3.3)
011	send TPDO2 (IN 1) send TPDO3 (IN 2) reset max peak	⇒ in transmitter functioning mode, triggers the emission of a TPDO if it is event-triggered ⇒ in CW functioning mode, maximum stored = current gross value
100	Reserved	
101	clear	⇒ in transmitter functioning mode, cancels the tare ⇒ in checkweigher mode, cancel the results
110	start new cycle	⇒ in CW mode: cycle start on Input transition
111	stop current cycle	⇒ in CW mode: On input transition
bit b3	Logic	
0	negative	
1	positive	

Note: if 2 input are set as TPDO sending, start new cycle, end of cycle, clear, CW result, transition on input 1 has priority and input 2 is disabled

In checkweigher mode, an input allocated to the "start cycle" function has priority. Cycle starting on a set point is then disabled.

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	largest sub-index	RO	0x03	N	unsigned8
0x01	minimal holding time (ms)	R/W	0x50	N	unsigned16
0x02	input 1 assignment	R/W	0	N	unsigned8
0x03	input 2 assignment	R/W	0	N	unsigned8

The 'debounce time' corresponds to the minimum required stabilization time of the logical inputs before their activation. If the input state varies within this interval, it is ignored. This allows to eliminate possible parasites and also to eliminate possible contacts bounces.

3.5.2 0x4509 : Logical outputs configuration

Depending of the version, digital load cell includes up to 4 logical outputs which can be configured in different ways described below :

- ❑ **Note** : Digital load cell with 2 connectors 5-pins do not have digital outputs available on connectors. Nevertheless these outputs *exist in a virtual state* and can be affected for specific function management. Then, their changing of state is managed by the communication bus.

bits b3, b2, b1 et b0	Output assignment	Notes
0000	set point	⇒ set point 1 assigned to output 1 ⇒ set point 2 assigned to output 2 ⇒ set point 3 assigned to output 3 ⇒ set point 4 assigned to output 4
0001	motion	
0010	CW result available	
0011	cycle in progress	⇒ indicates that a checkweigher cycle is in progress
0100	defective measurement	⇒ error flag, contained in the status byte
0101	input (1 or 2) image	⇒ outputs 1 & 3 assigned to input 1 ⇒ outputs 2 & 4 assigned to input 2
0110	level on request	⇒ Output assigned by set active/inhibited sent commands (cf. § 3.2.10)
bit b4	Logic	
0	negative	
1	positive	

Note: When several output are assigned to current cycles or available results, only the higher number will be set to this function.

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	largest sub-index	RO	0x04	N	unsigned8
0x01	output 1 assignment	R/W	0x13	N	unsigned8
0x02	output 2 assignment	R/W	0x12	N	unsigned8
0x03	output 3 assignment	R/W	0x10	N	unsigned8
0x04	output 4 assignment	R/W	0x10	N	unsigned8

Default values:

- ➔ Output 1 assigned to "cycle in progress", positive logic level
- ➔ Output 2 assigned to "Available result", positive logic level
- ➔ Output 3 assigned to "Set point", positive logic level
- ➔ Output 4 assigned to "Set point", positive logic level

3.5.3 0x4601/0x4609 : Set points configuration

Set point 1 is assigned to output 1 and set point 2 to output 2. Each set point is defined by a functioning defined at sub-index 1 and by high and low limit values (sub-index 2 to 5). The coding corresponding to the different functioning possible is provided in the following table :

bit b0	Set point 1 commutation mode	Note
1	hysteresis	Gross, net, Add only
0	window	In or Out of range only
bit b3, b2, b1	Set point 1 comparison measurement	
000	gross	
001	net	
010	CW result in range	
011	Add	
100	CW result out of range	
bit b4	Set point 2 commutation mode	Note
1	hysteresis	Gross, net, Add only
0	window	In or Out of range only
bit b7, b6, b5	Set point 2 comparison measurement	
000	gross	
001	net	
010	CW result in range	
011	Add	
100	CW result out of range	

➤ **0x4601 : set points 1 & 2 configuration :**

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	largest sub-index	RO	0x05	N	unsigned8
0x01	set points 1 & 2 settings	R/W	0x33 (Set point 1 & 2 on net and hysteresis)	N	unsigned8
0x02	set point 1 low value	R/W	0x00011170 (70000 _d)	N	integer32
0x03	set point 1 high value	R/W	0x00013880 (80000 _d)	N	integer32
0x04	set point 2 low value	R/W	0x0000C350 (50000 _d)	N	integer32
0x05	set point 2 high value	R/W	0x0000EA60 (60000 _d)	N	integer32

➤ **0x4609 : set points 3 & 4 configuration :**

Sub-index	Description	Access	Default value	Mppable (PDO) ?	Type
0x00	largest sub-index	RO	0x05	N	unsigned8
0x01	set points 3 & 4 settings	R/W	0x83 (set point 3 on net and hysteresis – set point 4 on result out of range)	N	unsigned8
0x02	set point 3 low value	R/W	0x00007530 (30000 _d)	N	integer32
0x03	set point 3 high value	R/W	0x00009C40 (40000 _d)	N	integer32
0x04	set point 4 low value	R/W	0x00002710 (10000 _d)	N	integer32
0x05	set point 4 high value	R/W	0x00004E20 (20000 _d)	N	integer32

3.6 Checkweigher settings

See description on user manual ref 195752

3.6.1 **0x4700 : Set point**

Set point is used in checkweigher mode. When the object arrives on the weighing device, weight determination could start either:

- With an input assigned to “cycle start”
- With a threshold value

Possible values for this parameter are between 0 and 1000000_H

Access : Read/write

Default value : 2710_H

Size : unsigned 32

3.6.2 **0x4701 : Measuring time**

This time is used in checkweigher mode.

It defines the duration (in ms) used to calculate checkweigher result.

Access : Read/write

Default value : C8_H

Size : unsigned 16

3.6.3 **0x4702 : Acquisition time and / or zero dynamic adjustment.**

In ms, value between 0 and 65535_d. In legal for trade this time cannot be less than 1000_d (1s).

Zero Dynamic acquisition. In checkweigher mode, when an input assigned to the “zero dynamic” function is enabled or when an zero dynamic acquisition command is received, sensor calculate the mean of the measures during the specified time. A new zero is used if the result is in the range $\pm 10\%$ of the maximum capacity or $\pm 2\%$ in legal for trade mode. Motion is not necessary.

Zero Dynamic adjustment. In checkweigher mode, if the automatic zero adjustment is enabled; this time is the time used to calculate the zero adjustment.

Access : Read/write

Default value : 64_H

Size : unsigned 16

3.6.4 **0x470A : Motion time (checkweigher).**

During the motion time T_s (in ms) measures are not considered if signal is disrupted.

Access : Read/write

Default value : 64_H

Size : unsigned 16

3.6.5 0x470B : Checkweigher correction coefficient (checkweigher).

Checkweigher result (index 5004h, sub-index 02h) can be adjusted with a coefficient (unit: 1/1000000). For example, a value of 1000000 means a coefficient of 1.0.

Access : Read/write

Default value : F4240_H

Size : unsigned 32

3.7 Other settings

3.7.1 0x4800 : Safety mode

This entry defines digital load cell functioning when in stopped NMT state. The safety mode is used when the bit b0 of the byte is set to 1. The functioning modes (checkweigher) are then inhibited and outputs logical level are given by b1, b2, b3 and b4 bits. Digital load cell leaves the safety mode upon reception of a new NMT command.

Access : Read/write

Default value : 0_H

Size: unsigned 32

b0	Effect	Notes
0	safety mode disabled	only valid in stopped state
1	safety mode enabled	
b1		
0	output 1 inhibited	depending on the chosen logic
1	output 1 set active	
b2		
0	output 2 inhibited	depending on the chosen logic
1	output 2 set active	
b3		
0	output 3 inhibited	depending on the chosen logic
1	output 3 set active	
B4		
0	output 4 inhibited	depending on the chosen logic
1	output 4 set active	

3.7.2 0x4900 : Delta min TPDO2

If TPDO2 transmission type is 'event-triggered' (codes 0x00 or 0xFE) and if input 1 is not assigned to 'send TPDO2' function then TPDO2 is sent when the value **of the first mapped object** (32 bits) varies from \pm delta.

Note: If the size of the first object mapped in TPDO2 is less than 32 bits, the comparison will be on the first four objects transported.

Access : Read/write

Default value : 64_H

Size: unsigned 32.

3.7.3 0x4901 : Delta min TPDO3

If TPDO3 transmission type is 'event-triggered' (codes 0x00 or 0xFE) and if input 1 is not assigned to 'send TPDO3' function then TPDO3 is sent when the value **of the first mapped object** (32 bits) varies from \pm delta.

Note: If the size of the first object mapped in TPDO3 is less than 32 bits, the comparison will be on the first four objects transported.

Access : Read/write

Default value : 1_H

Size: unsigned 32.

3.8 Measurement

3.8.1 0x5000/0x5001/0x5002 : Current measurement

These three entries contain the current measurement value (net, gross and A/D converter points). All these variables can be mapped into a PDO.

Access : Read/write

Default value : /

➤ 0x5000 : Net measurement :

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	net measurement	RO	/	Y	RO

➤ 0x5001 : Gross measurement :

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	gross measurement	RO	/	Y	integer32

➤ 0x5002 : A/D converter points :

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	A/D converter points	RO	/	Y	integer32

3.8.2 0x5003 : Current measurement status

Internal errors and other information are coded on two bytes that can be mapped into a PDO. There are coded in accordance with the following table :

bits b15,...b0	Function	Notes
b1, b0		
XX	non-significant	
b3,b2		
00	measurement within the admissible range	causes an output assigned to the 'defective measurement' function to be set active
01	negative overloading	
10	positive overloading	
11	analog signal out of range	
bit b4		
0	motion	causes an output assigned to the 'motion' function to be set active
1	no motion	

bit b5		
0	measurement out of the $\frac{1}{4}$ of division	
1	zero in the $\frac{1}{4}$ of division	
bit b6		
0	EEPROM OK	
1	EEPROM failure	
bit b7		
1	reserved	
bit b8		
0	IN1 low level	copy of input 1 logical level
1	IN1 high level	
bit b9		
0	IN2 low level	copy of input 2 logical level
1	IN2 high level	
bit b10		
0	OUT1 low level	copy of output 1 logical level
1	OUT1 high level	
bit b11		
0	OUT2 low level	copy of output 2 logical level
1	OUT2 high level	
bit b12		
0	OUT3 low level	copy of output 3 logical level
1	OUT3 high level	
bit b13		
0	OUT4 low level	copy of output 4 logical level
1	OUT4 high level	
bit b14		
0	no tare	
1	at least a tare has been processed	
bit b15		
1	reserved	

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	status word	RO	/	Y	unsigned16

3.8.3 0x5004 : Results

This entry divided into 6 sub-indexes contains the different measurement results calculated by digital load cell during checkweigher cycles (by filling or unloading). It also contains the tare value in A/D converter points.

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	max sub-index	RO	0x06	N	unsigned8
0x01	tare value	RO	/	Y	integer32
0x02	result	RO	/	Y	integer32
0x03	number of cycles	RO	/	Y	integer32
0x04	average value	RO	/	Y	integer32
0x05	running total	RO	/	Y	integer32
0x06	standard deviation	RO	/	Y	real32

The standard deviation is calculated from all checkweigher result. Its value is updates every new cycle.

This value can be initialized with the “clear” command, or the input affected to this function. It interrupts the running cycle and initialized all the results.

3.8.4 0x5005 : Checkweigher result quality

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	Checkweigher result quality	RO	/	Y	real32

Checkweigher result quality corresponds to the standard deviation of the measures recorded during the acquisition time.

We have a better precision when the Checkweigher result quality is lower.

3.8.5 0x5100 : Logical inputs level

This entry contains inputs 1 & 2 logical level.

bit b0	input 1 state
0	low
1	high
bit b1	input 2 state
0	low
1	high

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	logical inputs level	RO	/	Y	unsigned8

3.8.6 0x5200 : Logical outputs state

This entry contains outputs 1, 2, 3 and 4 logical level.

bit b0	output 1 level
0	Low
1	High
bit b1	output 2 level
0	Low
1	High
bit b2	output 3 level
0	Low
1	High
bit b3	output 4 level
0	Low
1	high

Sub-index	Description	Access	Default value	Mappable (PDO) ?	Type
0x00	logical outputs level	RO	/	Y	unsigned8