

SCMBus communication protocol



Document revisions		
version	date	description
A	01/07	creation
B	05/07	layout modification
C	10/07	polynomial correction added
D	11/07	status bits meaning correction
E	01/08	functional commands updated
F	04/08	new input assignement « allow new cycle » added
G	12/08	various fixes
H	09/09	legal for trade settings description tare bit added in the status bytes

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1. SCMBUS & FAST SCMBUS COMMUNICATION PROTOCOLS

1.1. Byte format

- 1 start bit
- 8 data bits
- no parity
- 2 stop bits

➤ ASCII bytes:

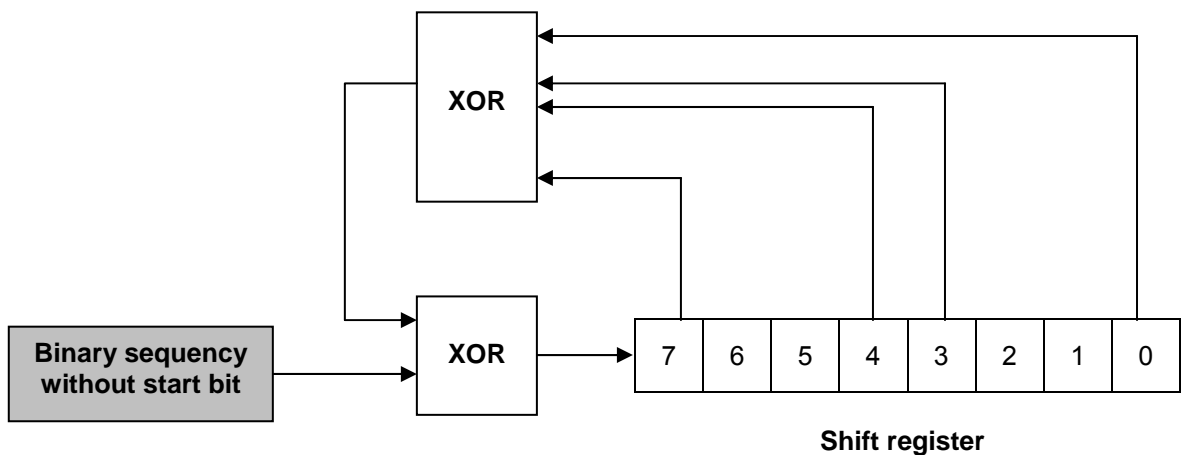
ASCII numeral characters (30_H,...39_H) and ASCII hexadecimal characters (3A_H,...3F_H).

➤ CRC byte:

CRC-8 polynomial:

$$G(x) = x^8 + x^7 + x^4 + x^3 + 1$$

The CRC-8 polynomial value can be determined by programming the algorithm corresponding to the following diagram :



Note : The frame error detection can be ignored. Value 0xFF of the CRC-8 always is admitted by eNod3-C and a received frame with such a CRC-8 is considered as a right frame without any error.

1.2. Frame format:

- Transmission order:
 - Frame: address first.
 - Byte: lsb first.
 - Multi-byte data type: MsB first.

1.2.1. Functional commands, writing commands:

Command:

Address	Command	Value	CR	CRC
1 Hexa. byte	1 Hexa. byte (command)	N ASCII hexa. bytes	1 ASCII byte (0D _H)	1 Hexa. byte

Response:

When a functional or a writing command is acknowledged by eNod3-C, the device sends back the same frame as the one that was received.

Address	Command	Value	CR	CRC
1 Hexa. byte	1 Hexa. byte (command)	N ASCII hexa. bytes	1 ASCII byte (0D _H)	1 Hexa. byte

1.3. Reading command :

Command:

Address	Command	CR	CRC
1 Hexa. byte	1 Hexa. byte (command)	1 ASCII byte (0D _H)	1 Hexa. byte

Response:

Address	Command	Value	CR	CRC
1 Hexa. byte	1 Hexa. byte (command)	N ASCII bytes hexa.	1 ASCII byte (0D _H)	1 Hexa. byte

1.4. Transmit measurement :

Command:

Address	Command	CR	CRC
1 Hexa. byte	1 Hexa. byte (command)	1 ASCII byte (0D _H)	1 Hexa. byte

▪ **Response, *standard format*:**

Address	Status	Value	CR	CRC
1 Hexa. byte	2 Hexa. bytes	N ASCII hexa. bytes	1 ASCII byte (0D _H)	1Hexa. byte

▪ **Response, *Fast format*:**

This specific format is reserved for very fast measurements transmission.

We recommend using **eNodView software** with this format. It is useful to constitute a measurement file so as to realize a dynamic analysis and to define the best parameters for the application.

Fast format is used in transmitter mode only with gross and net values and A/D counts.

STX	Status	Value	Cks	ETX
02 _H	2 Hexa. bytes	3 signed hexa. Bytes (2's complement)	Σ of previous bytes and b7=1	03 _H

Values encoding : Because values are encoded in signed hexadecimal (two's complement), some data bytes can be 02_H (STX) or 03_H (ETX) or DLE (10_H) so before those specific byte values, the DLE (10_H) encoded byte is inserted. The device address is omitted in the frame.

- The frame starts with STX (02_H) and finishes with ETX (03_H).
- Values are encoded in signed hexadecimal (two's complement).
- Cks is obtained by summing previous bytes and setting bit 7 to 1.

▪ **Status bytes:**

	b7	b6	b5	b4	b3	b2	b1	b0
0	1	error in EEPROM	zero in the ¼ of the division	stable	negative overloading	sensor signal < Input signal range	positive overloading	sensor signal > input signal range
1								
	b15	b14	b13	b12	b11	b10	b9	b8
0	1	no tare	S2 output status	S1 output status	E2 input status	E1 input status	00 = A/D converter points 01 = Net 02 = Gross 03 = Tare	
1		at least a tare has been processed						

1.5. Error frames:

Address	Error code	CR	CRC
1 Hexa. byte	1 Hexa. byte	1 ASCII byte (0D _H)	1 Hexa. byte

Error encoding:

Error Code	Designation	Description
FE _H	unknown command	
FF _H	execution command error	ex. : negative tare

2. OPERATING COMMANDS:

- **SCMBUS** format with **N = 0**

Command	Code Hexa.	Description
cancel Tare	35 _H	current tare is cancelled
dynamic zero acquisition	36 _H	in checkweigher functioning mode, determines a new (volatile) zero value at the end of a configurable duration
output 1 activation	37 _H	if output 1 is assigned to the 'Level on request' function
output 2 activation	38 _H	if output 2 is assigned to the 'Level on request' function
output 1 inhibition	39 _H	if output 1 is assigned to the 'Level on request' function
output 2 inhibition	3A _H	if output 2 is assigned to the 'Level on request' function
reset eNod3-C	80_H	Similar to power on reset
storage in EEPROM	81_H	EEPROM* is totally rewritten
put in calibration mode	C8_H	1st step of physical calibration

zero calibration acquisition	C9 _H	2 ^d step of physical calibration
calibration with load num. 1	CA _H	3 ^d step of physical calibration
calibration with load num. 2	CB _H	4 th step of physical calibration if required
calibration with load num. 3	CC _H	5 th step of physical calibration if required
save calibration	CD_H	this command is necessary when the calibration (physical/theoretical) procedure is complete
EEPROM initialisation	CE _H	WARNING : restores eNod3-C default configuration, including calibration
zero	CF _H	only if stability is reached and limited to a ±10% range of capacity. zero value used with this command can't be stored in EEPROM.
tare	D0 _H	only if stability is reached
zero adjustment	D1 _H	save zero value acquired with this command the 'save calibration' command (CD _H)
clear status	D2 _H	sets bit b14 of the status to 0
abort calibration	D3 _H	stops the calibration procedure before it ends
theoretical calibration	D4_H	calibration using sensitivity and capacity of the sensor
clear	EA _H	effective in checkweigher and peak control modes, clears the values calculated by eNod3-C
start continuous measurement transmission	EF _H	transmitter mode only
stop continuous measurement transmission	F0 _H	transmitter mode only
start cycle	F1 _H	effective in checkweigher mode and triggered peak control mode
stop checkweigher cycle	F2 _H	effective in checkweigher mode

* **EEPROM storage:**
except the following commands:

- Address setting
- Baud rate setting
- Protocol modification / Functioning mode
- Analog to digital converter (A/D) setting.
- Stability criterion setting
- Global span adjusting coefficient

all other commands are immediately active. But pay attention they are not stored in EEPROM. It is necessary to send 'EEPROM storage' (81_H).

- **Note:** Read / Write cycles of EEPROM are limited to about 1,000,000. So we strongly recommend limiting EEPROM writing commands. Do not send an EEPROM writing command after each parameter setting.

3. READ / WRITE COMMANDS:

Writing commands are usually attached with an N bytes value. See the specific descriptive § for each command.

- **Note** : commands with a * are only available with a **eNod3-C** firmware version ≥ 2.60 .

Command	Coding (hexa.) WRITE	Note	Coding (Hexa.) READ	§
Communication parameters				
protocol and functioning modes	82 _H	N = 2	A5 _H	4.1.1
eNod3-C address	96 _H	N = 1	B9 _H	4.1.2
serial baud rate / CAN bus baud rate *	97 _H /60 _H *	N = 1 / N = 2 *	BA _H	4.1.3
firmware version	-	N = 5 / read only	B8 _H	4.1.4
text	99 _H	16 free bytes for the user	BC _H	4.1.5
Calibration settings				
calibration load Num. 1	86 _H	N = 7	A9 _H	4.2.1
calibration load Num. 2	87 _H	N = 7	AA _H	4.2.1
calibration load Num. 3	88 _H	N = 7	AB _H	4.2.1
number of calibration segments	89 _H	N = 1	AC _H	4.2.2
global span adjusting coefficient	8A _H	N = 7	AD _H	4.2.3
polynomial adjusting coefficient A	8B _H	N = 8	AE _H	4.2.4
polynomial adjusting coefficient B	8C _H	N = 8	AF _H	4.2.4
polynomial adjusting coefficient C	8D _H	N = 8	B0 _H	4.2.4
capacity	8E _H	N = 7	B1 _H	4.2.5
sensor sensitivity	2C _H	N = 6	E9 _H	4.2.6
sensor capacity	90 _H	N = 7	B3 _H	4.2.7
zero calibration value	91 _H	(A/D points)	B4 _H	4.2.8
scale coefficient 1	D5 _H	N = 8	D6 _H	4.2.9
scale coefficient 2	D7 _H	N = 8	D8 _H	4.2.9
scale coefficient 3	D9 _H	N = 8	DA _H	4.2.9
scale interval	8F _H	defined values	B2 _H	4.2.10
Legal for trade settings				
legal for trade version number	-	read only ; N = 5	61 _H	4.3.1
legal for trade (R76) switch	92 _H	N = 1	B5 _H	4.3.2
legal fo trade counter	-	read only ; N = 5	DC _H	4.3.3
legal for trade CRC-16	-	read only ; N = 5	DD _H	4.3.4
zero mode *	93 _H	zero tracking and initial zero setting + checkweigher automatic zero correction *	B6 _H	4.3.5

Filtering options				
analog to digital converter A/D setting	85 _H	N = 3	A8 _H	4.4.1
low-pass filter order / band-stop filter activation *	20 _H /56 _H *	N = 1 / N = 2 *	21 _H	4.4.2
low-pass filter 1/A coefficient	22 _H	N = 8	23 _H	4.4.3
low-pass filter B coefficient	24 _H	N = 8	25 _H	4.4.3
low-pass filter C coefficient	26 _H	N = 8	27 _H	4.4.3
low-pass filter D coefficient	28 _H	N = 8	29 _H	4.4.3
low-pass filter E coefficient	2A _H	N = 8	2B _H	4.4.3
self-adaptive filter	94 _H	N = 1	B7 _H	4.4.5
band-stop filter X coefficient *	51 _H	N = 8	50 _H	4.4.4
band-stop filter Y coefficient *	53 _H	N = 8	52 _H	4.4.4
band-stop filter Z coefficient *	55 _H	N = 8	54 _H	4.4.4
motion	2E _H	N = 1	B7 _H	4.4.6
Application settings				
inputs functions	83 _H	N = 2	A6 _H	4.5.1
outputs functions	84 _H	N = 2	A7 _H	4.5.2
output 1 activation duration	3C _H	N = 5	3B _H	4.5.3
output 2 activation duration	3E _H	N = 5	3D _H	4.5.3
set point 2 high value	9A _H	N = 7	BD _H	4.5.4
set point 2 low value	9B _H	N = 7	BE _H	4.5.5
set point 1 high value	9C _H	N = 7	BF _H	4.5.4
set point 1 low value	9D _H	N = 7	C0 _H	4.5.5
set points functions	9E _H	N = 2	C1 _H	4.5.6
stabilization time (Ts)	9F _H	checkweigher mode	C2 _H	4.5.7
measuring time (Tm)	A0 _H	checkweigher mode or triggered peak control mode	C3 _H	4.5.8
dynamic zero acquisition time	A1 _H	checkweigher mode	C4 _H	4.5.9
checkweigher automatic correction range *	41 _H	N = 3	40 _H	4.5.14
trigger level	A2 _H	checkweigher and Peak control modes	C5 _H	4.5.10
output measurement period	A3 _H	Transmitter mode	C6 _H	4.5.11
debounce time	A4 _H	N = 5	C7 _H	4.5.12
checkweigher correction coefficient	33 _H	N = 7	34 _H	4.5.13
Measurements				
gross	-	read only SCMBus Standard and Fast	2F _H	4.6.1
tare	-	read only	30 _H	4.6.2

net	-	read only SCMBus Standard and Fast	31 _H	4.6.3
A/D converter points	-	read only SCMBus Standard and Fast	32 _H	4.6.4
peak control Max	-	peak control / read only	EC _H	4.6.5
peak control Min	-	peak control / read only	ED _H	4.6.6
peak to peak	-	peak control / read only	EE _H	4.6.7
checkweigher result	-	checkweigher / read only	EB _H	4.6.8
number of cycles	-	checkweigher / read only	FB _H	4.6.9
average result	-	checkweigher / read only	FC _H	4.6.10
running total	-	checkweigher / read only	FD _H	4.6.11
standard deviation	-	checkweigher / read only	FE _H	4.6.12

4. COMMANDS DESCRIPTION :

4.1. Communication settings

4.1.1. Communication Protocols and functioning modes:

- Command: 82_H; N = 2
- Read command: A5_H

N1, N2		functionality	
N1 (W)	N1 (R)	communication protocol	
30 _H	00 _H	SCMBus	type of protocol
31 _H	01 _H	ModBus-RTU	
33 _H	03 _H	Fast SCMBus	
N2 (W)	N2 (R)	functioning mode	
30 _H	00 _H	transmitter	Application modes
38 _H	08 _H	no processing transmitter*	
31 _H	01 _H	checkweigher automatic transmission	
32 _H	02 _H	checkweigher transmission on request	
33 _H	03 _H	non-triggered peak control	
34 _H	04 _H	triggered peak control	

* **No processing transmitter:** Digital filter and self-adaptive filter are inactive, set points are not managed and there is no linearization in this mode.

Switching from one protocol/functioning mode to another requires the following steps:

- ⇒ Storage in EEPROM of the new protocol (command 81_H).
- ⇒ Doing a reset (it can be done with power off, then power on, or command 80_H).

4.1.2. eNod3-C Address:

- Command: 96_H; N = 2
- Read command: B9_H

Possible values: 01_H to FF_H. **Default value: 01_H**

00_H address is a broadcasting address. That means each **eNod3-C** responds to it. Consequently do not use it if several **eNod3-C** are connected on the network.

The new address becomes effective after the following steps:

- ⇒ EEPROM storage of the new address (command 81_H).
- ⇒ Doing a reset (it can be done with power off, then power on, or command 80_H).

4.1.3. Serial baud rate / CAN bus baud rate *:

- *Command: 97_H; N = 1 / 60_H* N = 1*
- *Read command: BA_H (N = 1 / N = 2 *)*

Coding:

N1	serial baud rate	
31 _H	9600	<i>default value</i>
32 _H	19200	
33 _H	38400	
34 _H	57600	
35 _H	115200	
N2 *	CAN bus baud rate *	
31 _H	20000	
32 _H	50000	
33 _H	125000	<i>default value</i>
34 _H	250000	
35 _H	500000	
36 _H	800000	
37 _H	1000000	

The new baud rate becomes effective after the following steps:

- ⇒ Storage in EEPROM of the new baud rate (command 81_H).
- ⇒ Doing a reset (it can be done with power off, then power on, or command 80_H)

4.1.4. Firmware version:

Read only; N = 5

- *Read command: B8_H*

Identification of **eNod3-C** firmware version.

4.1.5. Text:

- *Command 99_H; N = 16*
- *Read command: BC_H*

The text area consists in a 16 bytes free space. It can be used to store some information. For example: Calibration date, or date of the next control....

Storage in EEPROM with the command 81_H.

4.2. Calibration settings

4.2.1. Calibration loads:

- *Commands: 86_H, 87_H and 88_H; N = 1 to 7.*
- *Read commands: A9_H, AA_H and AB_H.*

Calibration loads are coded on 7 bytes ASCII. Admitted values are between 0 and 1 000 000_d. Each of them corresponds to the termination of a calibration segment.

Storage in EEPROM with the command 81_H.

4.2.2. Number of calibration segments:

- *Command: 89_H; N = 1*
- *Read command: AC_H*

The number of calibration segments can't exceed 3. Usually 1 is sufficient. 2 or 3 segments are used in case of non linearity.

Storage in EEPROM with the command 81_H.

4.2.3. Global scale adjusting coefficient:

- *Command: 8A_H; N = 7*
- *Read command: AD_H*

Initial calibration value can be modified with a global scale adjusting coefficient. Adjustment is done on the whole curve.

Gradient correction coefficient is coded on 7 ASCII bytes. The unit is 1/1000 000 (1E-6); that means 1 000 000_d = 1. Maximum and minimum values are: 1 100 000_d and 900 000_d (it corresponds to: 1.10 and 0.90).

The new global span adjusting coefficient becomes effective after the following steps:

- ⇒ Storage in EEPROM of the new coefficient (command 81_H).
- ⇒ Doing a reset (it can be done with power off, then power on, or command 80_H)

4.2.4. Polynomial adjusting coefficients:

They are 3 polynomial adjusting coefficients.

- *Commands : N = 8*
8B_H for coefficient A
8C_H for coefficient B
8D_H for coefficient C;
- *Read commands:*
AE_H for coefficient A
AF_H for coefficient B
B0_H for coefficient C

Adjusting formula:

$$\text{Adjusted measurement} = \text{Mes} - A (\text{Meas})^2 - B (\text{Meas}) - C$$

with Meas = actual measurement.

A, B and C coefficients are easily calculated using **eNodView** software.

Adjusting coefficients are coded on 8 ASCII bytes. The coefficients have specific values; each of them is expressed with its own unit:

The unit for coefficient A is 1/1 000 000 000 000 (1E-12); that means 1 000 000 000 000_d = 1

The unit for coefficient B is 1/1 000 000 000 (1E-9); that means 1 000 000 000_d = 1

Coefficient C is directly expressed as A/D converter points.

Storage in EEPROM with the command 81_H

4.2.5. Capacity:

- *Command: 8E_H; N = 7*
- *Read command: B1_H*

Admitted values are between 0 and 1 000 000_d.

When the absolute value of gross measurement plus 9 divisions exceed maximum capacity, bits b1 (positive overloading) or b3 (negative overloading) of the status bytes are set to 1. The capacity also defines the range on which a new zero can be acquired ($\pm 10\%$).

Storage in EEPROM with the command 81_H.

4.2.6. Sensor sensitivity:

- *Write Command: 2C_H; N = 6*
- *Read command: E9_H*

Sensor sensitivity is coded on ASCII 6 bytes. The unit is 1mV/V x 10⁻⁵. It is used to realize a theoretical calibration of the **eNod3-C**. To make the calibration it is necessary to know the sensor sensitivity and the related capacity.

Storage in EEPROM with the command 81_H.

4.2.7. Sensor capacity:

- *Command: 90_H; N = 1 to 7*
- *Read command: B3_H*

Maximum value: 1 000 000_d.

Sensor capacity is used with sensor sensitivity for a theoretical calibration.

Storage in EEPROM with the command 81_H.

4.2.8. Zero calibration value:

- *Command: 91_H; N = 1 to 8*
- *Read command: B4_H*

Zero reference in A/D converter points.

Zero calibration value corresponds to the A/D converter points value measured during the 'zero acquisition' step of a physical calibration.

For a theoretical calibration it is necessary to set this value. It can be set automatically with the command 'zero adjustment'.

Storage in EEPROM with the command 81_H.

4.2.9. Scale coefficients:

- *Commands: N = 8*
D5_H: segment 1 span coefficient
D7_H: segment 2 span coefficient
D9_H: segment 3 span coefficient
- *Read commands:*
D6_H: segment 1
D8_H: segment 2
DA_H: segment 3

Coefficients are automatically produced during calibration process. Writing these coefficients is only valid for a copy of a previous calibration.

Scale coefficients are coded floating decimal single precision (32 bits). They are organized in 8 ASCII hexadecimal bytes. See an example in **Appendix B**.

Storage in EEPROM with the command 81_H.

4.2.10. Scale interval:

- *Command: 8F_H; N = 1 to 3*
- *Read command: B2_H*

Scale interval: The difference between two consecutive indicated values.

Values: 1, 2, 5, 10, 20, 50 and 100.

Storage in EEPROM with the command 81_H.

4.3. Legal for trade settings

4.3.1. Legal for trade version number

Read only; N = 5

- *Read command: 61_H*

This number identifies the version of the part of the software that is dedicated to the metrology and the measurement exploitation.

4.3.2. Legal for trade (R76) switch

- *Command: 92_H; N = 1*
- *Read command: B5_H*

The activation or desactivation of the conditions of using **eNod3-C** to comply with OIML R76 can be done by sending :

- ⇒ 30 : legal for trade options disabled
- ⇒ 31 : legal for trade options enabled

Switching this option ON has the following consequences :

- the legal for trade counter is incremented every time a storage in EEPROM is requested if a metrological setting has been modified (cf. § 4.3.3).
- 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)
- reading a measurement during 15 seconds after power-up or a software reset is impossible (display ????????)
- taring is now impossible if gross measurement is negative
- zero acquisition range is reduced from 10% of the capacity to 2%.

- reading the net value during tare acquisition or the gross value during zero acquisition is impossible (display ????????) .
- The A/D converter is set into *unipolar* mode (cf. § 4.4.1) and can not be modified anymore. An attempt to change its value is refused and an error frame is transmitted.
- The motion criterion (cf. § 4.4.6) is forced to $0.25d$ and can not be modified anymore. An attempt to change its value is refused and an error frame is transmitted.

4.3.3. Legal for trade counter

Read only; $N = 5$

- Read command: DC_H

If the 'legal for trade' option is switched ON, this counter is incremented every time a storage in EEPROM is requested if one of these metrological settings has been modified :

- scale coefficients (directly written or after a calibration)
- global span adjusting coefficient
- non-linearity correction coefficients
- scale interval
- sensor capacity
- maximum capacity
- zero calibration in A/D converter points (directly written or after a zero adjustment)
- legal for trade switch
- initial zerosetting and zero tracking
- functioning mode
- stability criterion

4.3.4. Legal for trade CRC-16

Read only; $N = 5$

- Read command: DD_H

if the legal for trade option is switched ON, a new legal for trade CRC-16 is calculated every time a storage in EEPROM is requested if one (or several) of the settings listed in §4.3.3 has been modified.

4.3.5. Zero mode *:

- Command: 93_H ; $N = 1$
- Read command: $B6_H$

Coding for the different zero functionalities (zero tracking, initial zerosetting and checkweigher zero automatic correction*) is done on one ASCII byte representing three LSB bits.(b2, b1, b0). For example, 35_H implies $b0 = 1$, $b1 = 0$ et $b2 = 1$.

b0	zero tracking	
0	zero tracking disabled	zero tracking only valid on a $\pm 10\%$ range of the maximum capacity
1	zero tracking enabled	
b1	intial zerosetting	
0	initial zerosetting disabled	initial zerosetting only valid on a $\pm 10\%$ range of the maximum capacity
1	initial zerosetting enabled	
b2*	checkweigher zero automatic correction*	
0	automatic correction disabled	cf. §2.3.36
1	automatic correction enabled	

Storage in EEPROM with the command 81_H .

4.4. Filtering options

4.4.1. Analog to Digital (A/D) converter setting:

Command: 85_H; N = 3

Read command: A8_H

N1, N2 and N3 ASCII Coding	assignment		
N1	analog input signal range		
30 _H	500mV/V		
31 _H	250mV/V		
32 _H	124mV/V		
33 _H	62mV/V		
34 _H	31mV/V		
35 _H	15mV/V		
36 _H	7.8mV/V		<i>default value recommended for strain gages sensors</i>
N2	type of signal and rejection		
30 _H	bipolar signal / 60HZ rejection		
31 _H	unipolar signal / 60HZ rejection		
32 _H	bipolar signal / 50HZ rejection		<i>default value</i>
33 _H	unipolar signal / 50HZ rejection		
N3	A/D conversion rate in Meas. s		
	50Hz rejection	60Hz rejection	
34 _H	6.25	7.5	
33 _H	12.5	15	
32 _H	25	30	
31 _H	50	60	
30 _H	100	120	<i>default value</i>
3C _H	200	240	
3B _H	400	480	
3A _H	800	960	
39 _H	1600	1920	

Setting up a new configuration of the Analog to Digital (A/D) converter requires the following steps:

- ⇒ Storage in EEPROM of the new configuration (command 81_H).
- ⇒ Doing a reset (it can be done with power off, then power on, or command 80_H)

4.4.2. Low-pass filter order / band-stop filter activation *:

- Command: 20_H; N = 1 / 56_H; N = 1
- Read command: 21_H (N = 1 / N = 2)

- **Low-pass (Bessel/Butterworth) filter equation:**

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

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

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

- **Band-stop filter equation:**

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

When reading, the low-pass filter order (30_H = no filter, 32_H, 33_H or 34_H) is encoded on N1 byte and the low-pass activation state (30_H = filter OFF or 31_H = filter ON) on N2 byte.

In both case, coefficients depend on the sampling frequency and on the desired cut-off frequency. Coefficients depend on Analog to Digital conversion rate and desired cut-off frequency. The coefficients can be defined using the **eNodView** software.

Storage in EEPROM with the command 81_H.

4.4.3. Digital low-pass filter coefficients:

- *Commands: N = 8*
22_H for the 1/ A coefficient
24_H for the B coefficient
26_H for the C coefficient
28_H for the D coefficient
2A_H for the E coefficient
- *Read commands:*
23_H for the 1/A coefficient
25_H for the B coefficient
27_H for the C coefficient
29_H for the D coefficient
2B_H for the E coefficient

Filter coefficients are coded as floating decimal single precision (32 bits). They are organized in 8 ASCII hexadecimal bytes. See an example in **Appendix B**.

Storage in EEPROM with the command 81_H.

4.4.4. Digital band-stop filter coefficients *

- *Commands: N = 8*
51_H for the X coefficient
53_H for the Y coefficient
55_H for the Z coefficient
- *Read commands:*
50_H for the X coefficient
52_H for the Y coefficient
54_H for the Z coefficient

Filter coefficients are coded as floating decimal single precision (32 bits). They are organized in 8 ASCII hexadecimal bytes. See an example in **Appendix B**.

Storage in EEPROM with the command 81_H.

4.4.5. Self-adaptive filter:

- *Command: 94_H; N = 1*
- *Read command: B7_H; N = 2*

This type of filter can be set in cascade after the previous filters and is particularly useful for static measurements, avoid using it in dynamic or dosing process. The aim of this filter is to eliminate erratic measurements and to average consistent measurements.

Filter is on if N1 = 31_H, filter is off if N1 = 30_H.

- **Note about reading with command B7_H:** When writing, self-adaptive filter coding is done with N = 1 but when reading N = 2. In the reading word, motion setting is coded with N1 and self-adaptive filter setting is coded with N2:

read command $B7_H$		
N1	motion criterion	
30 _H	no motion detection	motion
31 _H	0,25 d	
32 _H	0,5 d	
33 _H	1 d	
34 _H	2 d	
N2	self-adaptive filter state	
30 _H	self-adaptive filter OFF	self-adaptive filter
31 _H	self-adaptive filter ON	

4.4.6. Motion:

- Command: $2E_H$; $N = 1$
- Read command: $B7_H$; $N = 2$

Motion is indicated with the bit b4 of the status set to 0. Motion criterion is preset according to the following table:

N1 ASCII Coding	motion criterion	
30 _H	no motion detection	
31 _H	0,25 d	<i>default value</i>
32 _H	0,5 d	
33 _H	1 d	
34 _H	2 d	

d = resolution.

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/D converter conversion rate		X
50Hz rejection	60Hz 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

- **Note about reading with command B7_H:** When writing motion coding is done with N = 1 but when reading N = 2. In the reading word, motion setting is coded with N1 and self-adaptive filter setting is coded with N2.

read command B7 _H		
N1	motion criterion	
30 _H	no motion detection	motion
31 _H	0,25 d	
32 _H	0,5 d	
33 _H	1 d	
34 _H	2 d	
N2	self-adaptive filter state	
30 _H	self-adaptive filter OFF	self-adaptive filter
31 _H	self-adaptive filter ON	

Changing the motion criterion requires the following steps:

- ⇒ Storage in EEPROM of the new configuration (command 81_H).
- ⇒ Doing a reset (it can be done with power off, then power on, or command 80_H)

4.5. Logical inputs/outputs configuration

4.5.1. Logical inputs assignement

- *Command:* 83_H; N = 4, (N1 and N2 assigned to input 1, N3 and N4 assigned to input 2)
- *Read command:* A6_H

N1 & N2 or N3 & N4		assignment	functionality
N1 or N3			
negative logic	positive logic		
30 _H	38 _H	none	inputs are ignored
31 _H	39 _H	tare	tare command
32 _H	3A _H	zero	zero command limited to ±10% of the specified capacity
33 _H	3B _H	transmit measurement or dynamic zero acquisition	<u>transmitter mode</u> : induces the transmission of one measurement <u>checkweigher mode</u> : gets a new volatile zero value at the end of a configurable time
34 _H	3C _H	measurement window	<u>transmitter mode</u> : measurements are transmitted while the input is hold on the right level. <u>triggered peak control mode</u> : cycle in progress while the input is hold on the right level.
35 _H	3D _H	clear	<u>transmitter mode</u> : cancels current tare. <u>checkweigher mode</u> : clears checkweigher result, average, running total and standard deviation values <u>peak control mode</u> : sets Max and Min to current value.
36 _H	3E _H	start Checkweigher cycle or allow new cycle	<u>checkweigher mode</u> : launches a new checkweigher cycle. <u>triggered peak control mode</u> : a new cycle only can be started if this input has been previously activated (rising or falling edge according to the choosen logic)
37 _H	3F _H	stop Checkweigher cycle	
N2 or N4			
30 _H		gross	transmitted measurements are gross values
32 _H		nNet	transmitted measurements are net values
34 _H		A/D converter points	Transmitted measurements are A/D converter points

Storage in EEPROM with the command 81_H.

4.5.2. Output functions:

- *Command: 84_H; N = 2, (N1 assigned to output 1, N2 assigned to output 2).*
- *Read command: A7_H*

N1 or N2		assignment	functionality
negative logic	positive logic		
30 _H	38 _H	set points	set point 1 assigned to output 1 set point 2 assigned to output 2
31 _H	39 _H	motion	
32 _H	3A _H	checkweigher result available	
33 _H	3B _H	cycle in progress	checkweigher & triggered peak control
34 _H	3C _H	defective measurement	see status
35 _H	3D _H	inputs image	output 1 assigned to input 1 output 2 assigned to input 2
36 _H	3E _H	level on request	output level is driven by the master requests (see §2, operating commands)

Storage in EEPROM with the command 81_H.

4.5.3. Output 1 and 2 activation duration:

- *Commands: 3C_H for output 1; 3E_H for output 2; N = 5*
- *Read commands: 3B_H for output 1; BF_H for output 2*

Values are coded on 5 ASCII bytes and expressed in milliseconds. Admitted values are between 0 and 65535_d.

Output 1 or 2 activation duration is only taken into account if the corresponding output is assigned to the function 'Level on request'. When an 'output activation' (37_H or 38_H) command is received, the output remains activated until :

- the reception of an 'output inhibition' (39_H or 3A_H) command and the output activation duration is equal to 0.
- the specified activation duration has elapsed

Storage in EEPROM with the command 81_H.

4.5.4. Set points 1 & 2, high values:

- *Commands: 9A_H for set point 2 high value; 9C_H for set point 1 high value; N = 8*
- *Read commands: BD_H for set point 2 high value; BF_H for set point 1 high value.*

Values are coded on 8 ASCII bytes. Acceptable values between 0 and ±1 000 000_d.

Storage in EEPROM with the command 81_H.

4.5.5. Set points 1 & 2, low values:

- *Commands: 9B_H for set point 2 low value; 9D_H for set point 1 low value; N = 8*
- *Read command: BE_H for set point 2 low value; C0_H for set point 1 low value.*

Values are coded on 8 ASCII bytes. Acceptable values between 0 and ±1 000 000_d.

Storage in EEPROM with the command 81_H.

4.5.6. Set point functioning:

- *Command: 9E_H; N = 2*
- *Read command: C1_H*

Byte N2 is assigned to set point 2; Byte N1 is assigned to set point 1.

N1 or N2		comparison value	note
window functioning	hysteresis functioning	see document 'User's instructions' Ref. 165 702 for the differences between the two functioning modes	
30 _H	31 _H	gross measurement	whatever the mode is
32 _H	33 _H	net measurement	
34 _H	35 _H	max value	peak control mode
36 _H	37 _H	min value	peak control mode
38 _H	39 _H	peak to peak value	peak control mode
3A _H	3B _H	checkweigher result	checkweigher mode
3C _H	3D _H	checkweigher running total	checkweigher mode

Storage in EEPROM with the command 81_H.

4.5.7. Checkweigher mode stabilization time (Ts):

- Command: 9F_H; N = 5
- Read command: C2_H

Stabilization time: Ts in milliseconds, from 0 to 65 535.

See 'checkweigher functioning mode' in the document 'User's instructions' Ref. 165 702.

Storage in EEPROM with the command 81_H.

4.5.8. Checkweigher mode or triggered peak control mode measuring time (Tm):

- Command: A0_H; N = 5
- Read command: C3_H

Measuring time: Tm in milliseconds, from 0 to 65 535.

See 'checkweigher functioning mode' and 'Peak control functioning mode' in the document 'User's instructions' Ref. 165 702.

Storage in EEPROM with the command 81_H.

4.5.9. Checkweigher mode dynamic acquisition time :

- Command A1_H; N = 5
- Read command: C4_H

Dynamic zero acquisition is coded on 5 ASCII bytes and expressed in milliseconds. Admitted values are between 0 and 65535_d.

In checkweigher mode, an input assigned to the function 'Dynamic zero' or a command sent by the master to **eNod3-C** can trigger the acquisition of a zero without any stability criterion. This new volatile zero value is obtained by averaging the measurements during the specified duration. It is only taken into account if it is included in a range of ±10 % of the capacity.

Storage in EEPROM with the command 81_H.

4.5.10. Trigger level:

- Command: A2_H; N = 8
- Read command: C5_H

'Trigger level' is a net value coded on 8 ASCII bytes. Acceptable values 0 to ±1 000 000_d.

'Trigger level' can be used in checkweigher mode or 'triggered peak control mode'.

- **Note:** In checkweigher mode if an input is assigned to 'Start checkweigher cycle', 'Trigger level' is ignored.

Storage in EEPROM with the command 81_H.

4.5.11. Output measurement period:

- Command: A3_H; N = 5

- *Read command: C6_H*

Used only in transmitter mode.

'Output measurement period' is in ms from 0 to 65535ms.

When 'output measurement period' is set to 0, the output measurement rate is synchronized on the Analog to Digital conversion period.

Storage in EEPROM with the command 81_H.

4.5.12. Debounce time:

- *Command: A4_H; N = 5*
- *Read command: C7_H*

'Debounce time' is in ms from 0 to 65535ms.

'Debounce time' corresponds to the required stabilisation time of an input after switching.

Storage in EEPROM with the command 81_H.

4.5.13. Checkweigher correction coefficient:

- *Command: 33_H; N = 7*
- *Read command: 34_H*

The coefficient is used to correct the checkweigher result.

Coefficient is coded on 7 ASCII bytes. The unit is 1/1000 000. That means 1 000 000 = 1.

Storage in EEPROM with the command 81_H.

4.5.14. Checkweigher zero correction range *:

- *Command : 41_H ; N = 3*
- *Read command : 40_H*

Admitted values are between 0 and 255_d.

This automatic correction of the zero value is only available in checkweigher functioning mode. It allows to follow the evolution of the zero in checkweigher functioning mode, for example on a conveyor belt on which there is some product accumulation. This function only is efficient when the measured signal is filtered enough with a few noise and oscillations.

When switched on (cf. §2.3.20), an average value is calculated if comprised within a the defined interval around the calibration zero. This calculation is inhibited during the weighing period and gives a virtual zero that is subtracted from the theoretical checkweigher result so as to give the final checkweigher result that is updated at the end of the item passage.

Storage in EEPROM with the command 81_H.

4.6. Measurements

4.6.1. Gross:

Read only; N = 8

- *Read command: 2F_H*

Gross measurement is coded on :

- 8 ASCII bytes in **SCMBus** protocol
- 3 signed hexadecimal bytes in **Fast SCMBus** protocol.

4.6.2. Tare:

Read only; N = 8

- *Read command: 30_H*

Tare value is coded on 8 ASCII bytes.

4.6.3. Net:

Read only; N = 8

- *Read command: 31_H*

Net measurement is coded on:

- 8 ASCII bytes in **SCMBus** protocol
- 3 hexadecimal bytes in **Fast SCMBus** protocol.

4.6.4. A/D converter points:

Read only; N = 8

- *Read command: 32_H*

A/D converter points value is coded on:

- 8 ASCII bytes in **SCMBus** protocol

- 3 hexadecimal bytes in *Fast SCMBus* protocol.

4.6.5. Peak control maximum value (Max):

Read only; N = 8

- *Read command: EC_H*

Peak control maximum value is coded on 8 ASCII bytes. This value can be reset by the 'Clear' command or by an input assigned to this function.

4.6.6. Peak control minimum value (Min):

Read only; N = 8

- *Read command: ED_H*

Peak detection minimum value is coded on 8 ASCII bytes. This value can be reset by the 'Clear' command or by an input assigned to this function.

4.6.7. Peak to peak:

Read only; N = 8

- *Read command: EE_H*

Peak to peak value is coded on 8 ASCII bytes. This value can be reset by the 'Clear' command or by an input assigned to this function.

4.6.8. Checkweigher result:

Read only; N = 8

- *Read command: EB_H*

The checkweigher result is coded on 8 ASCII bytes.

Reading resets automatically checkweigher result to ????????. When a checkweigher cycle is in progress, the result is also set to ????????. It can be reset by the 'Clear' command or an input assigned to this function.

4.6.9. Checkweigher number of the cycles:

Read only; N = 8

- *Read command: FB_H*

The number of checkweigher cycles is coded on 8 ASCIIbytes. This value can be reset by the 'Clear' command or an input assigned to this function.

4.6.10. Checkweigher average value:

Read only; N = 8

- *Read command: FC_H*

The checkweigher average value is coded on 8 ASCII bytes. This value can be reset by the 'Clear' command or an input assigned to this function.

4.6.11. Checkweigher running total

Read only; N = 8

- *Read command: FD_H*

The checkweigher tuning total value is coded on 8 ASCII bytes. This value can be reset by the 'Clear' command or an input assigned to this function.

4.6.12. Checkweigher standard deviation:

Read only; N = 8

- *Read command: FE_H*

The checkweigher standard deviation is coded on 8 ASCII hexadecimal bytes as a floating decimal single precision (32 bits). See an example in **Appendix B**.

This value can be reset by the 'Clear' command or an input assigned to this function.

5. APPENDIX A : EXAMPLES

5.1. Switching from ModBus-RTU protocol to SCMBus protocol:

Example **eNod3-C** with address 01_H, in transmitter mode:

command or response description	command sent to eNod3-C	response
switching to SCMBus protocol, transmitter mode	01 06 00 2B 00 00 F9 C2	
acknowledgement		01 06 00 2B 00 00 F9 C2
command register set to IDLE state	01 06 00 74 00 00 C9 D0	
acknowledgement		01 06 00 74 00 C9 D0
EEPROM storage	01 06 00 74 00 81 09 B0	
acknowledgement		01 06 00 74 81 09 B0
command register set to IDLE state	01 06 00 74 00 00 C9 D0	
acknowledgement		01 06 00 74 00 C9 D0
reset. effective switching to SCMBus protocol.	01 06 00 74 00 80 CB 70	

5.2. Switching to Fast SCMBUS format:

Follow the next steps:

- 1) Configure the Analog to Digital converter:
 - choose the right input signal range. Usually, for a strain gauge load cell, it is 7.8mV/V.
 - select the appropriate conversion rate for the working place (50/60HZ). Recommended conversion rate 800/960.
- 2) Communication baud rate:
 - 115200 bauds
- 3) Output measurement period:
 - Set to 0. Output measurement period is synchronized on the Analog to Digital conversion period.

Example: **eNod3-C** with address 01_H, mains frequency 50Hz:

command or response description	Command sent to eNod3-C	response
- input signal range 7.8mV/V, unipolar signal, - A/D conversion rate = 800 mes/s	01 85 36 33 3A 0D EE	
acknowledgement		01 85 36 33 3A EE
switching to Fast SCMBus protocol and no processing transmitter mode.	01 82 33 38 0D D2	
acknowledgement		01 82 33 38 0D D2
baud rate: 115200	01 97 35 0D 1E	
acknowledgement		01 97 35 0D 1E
output measurement period synchronized on the A/D conversion period	01 A3 00 0D B2	
acknowledgement		01 A3 00 0D B2
EEPROM storage	01 81 0D 1A	
acknowledgement		01 81 0D 1A
reset. effective switching to Fast SCMBUS protocol.	01 80 0D 40	

5.3. Physical calibration:

Follow the next steps:

- 1) Configure the Analog to Digital converter. (In principle, the default configuration is suitable).
- 2) Make sure that the scale correction coefficient is set to 1 (default value).
- 3) Define the number of calibration segments (1 segment by default); 3 (maximum) segments will only be used for a non-linear installation.
 - Note: another linearization possibility is a 2nd order polynomial correction; in that case calibration is done with 1 segment.
- 4) Define the corresponding value for each calibration segment. Values are between 0 and 1000000_d.
- 5) Send the 'Put in calibration mode' command to start calibration.
- 6) Be sure that the loading platform is empty, then send the 'zero acquisition' command. This zero acquisition may take some time depending on the stability of measurements and the chosen motion criterion. Do not touch the loading platform during this sequence.
- 7) Send the 'Physical calibration with load 1' command. Like the zero acquisition, the calibration may take some time.

If necessary, continue in the same way using the 2 and the 3 calibration loads.

- 8) Send the 'save calibration' command.
 - **Note 1:** If the different calibration steps take too long, send the 'abort calibration' command and change the motion criterion.
 - **Note 2:** For tension-compression type sensors for which it was selected a bipolar signal, calibration is done only with loads to the positive direction. The negative part is assumed to be symmetrical.

Example: **eNod3-C** with address 01_H, from step 3):

command or response description	command sent to eNod3-C	response
3 segments	01 89 33 0D 4C	
acknowledgement		01 89 33 0D 4C
1 st calibration load value = 17000	01 86 31 37 30 30 30 0D FF	
acknowledgement		01 86 31 37 30 30 30 0D FF
2 nd calibration load value = 39200	01 87 33 39 32 30 30 0D B6	
acknowledgement		01 87 33 39 32 30 30 0D B6
3 rd calibration load value = 54800	01 88 35 34 38 30 30 0D 87	
acknowledgement		01 88 35 34 38 30 30 0D 87
put in calibration mode	01 C8 0D 13	
acknowledgement		01 C8 0D 13
zero acquisition	01 C9 0D 49	
acknowledgement		01 C9 0D 49
calibration with load 1	01 CA 0D A7	
acknowledgement		01 CA 0D A7
calibration with load 2	01 CB 0D FD	
acknowledgement		01 CB 0D FD
calibration with load 3	01 CC 0D 7B	
acknowledgement		01 CC 0D 7B
save calibration	01 CD 0D 21	
acknowledgement		01 CD 0D 21

- **Note:** If necessary a scale correction coefficient can be used to correct the initial calibration. The whole curve is adjusted.

5.4. Theoretical calibration:

Example: **eNod3-C** with address 01_H. Characteristics of the sensor:
 - sensitivity: 2,3450mV/V
 - corresponding capacity: 11725g

command or response description	command sent to eNod3-C	response
capacity 11725	01 90 31 31 37 32 35 0D 1F	
acknowledgement		01 90 31 31 37 32 35 0D 1F
sensor sensitivity (2.34500mV/V)	01 2C 32 33 34 35 30 30 0D E1	
acknowledgement		01 2C 32 33 34 35 30 30 0D E1
theoretical calibration	01 D4 0D 0B	
acknowledgement		01 D4 0D 0B
zero adjustment	01 D1 0D 39	
acknowledgement		01 D1 0D 39
save calibration	01 CD 0D 21	
acknowledgement		01 CD 0D 21

5.5. Correction of the initial calibration value:

Example: **eNod3-C** with address 01_H, correction: + 0,025%:

command or response description	command sent to eNod3-C	response
setting of the scale correction coefficient to 1,025	01 8A 31 30 32 35 30 30 30 0D 9C	
acknowledgement		01 8A 31 30 32 35 30 30 30 0D 9C
EEPROM storage	01 81 0D 1A	
acknowledgement		01 81 0D 1A

5.6. Transmitter mode:

Example: **eNod3-C** with address 01_H, **SCMBus** standard format. Reading a net measurement:

command or response description	command sent to eNod3-C	response	frame meaning
reading net measurement	01 31 0D FC		
transmit measurement		01 96 80 30 30 30 32 34 38 33 34 0D 6B	Measurement: +0024834 stable, net, S2 = 1, S1 = 0, E2 = 1, E1 = 0

Example: **eNod3-C** with address 01_H, **SCMBUS** fast format. Reading a net measurement:

command or response description	command sent to eNod3-C	response	frame meaning
reading net measurement	01 31 0D FC		
transmit measurement		02 96 80 00 61 10 02 8B 03	Measurement: +24834 stable, net, S2 = 1, S1 = 0, E2 = 1, E1 = 0

5.7. Checkweigher mode:

Example:

- set to 'Checkweigher automatic transmission' mode
- trigger level = 500
- stabilization time (Ts) = 35 ms
- measurement time (Tm) = 65 ms
- inputs assignment: 'None' 'positive logic'
- S1 output assignment: 'checkweigher result available', 'positive logic'
- S2 output setting: 'cycle in progress', 'positive logic'

eNod3-C with address 01_H:

command or response description	command sent to eNod3-C	response
checkweigher automatic transmission	01 82 30 31 0D 4C	
acknowledgement		01 82 30 31 0D 4C
trigger level = 500	01 A2 35 30 30 0D A5	
acknowledgement		01 A2 35 30 30 0D A5
stabilization time (Ts) = 35ms	01 9F 33 55 0D 7D	
acknowledgement		01 9F 33 55 0D 7D
measurement time (Tm) = 65ms	01 A0 36 35 0D FA	
acknowledgement		01 A0 36 35 0D FA
E1 = E2 = None, positive logic	01 83 38 30 38 30 0D 06	
Acknowledgement		01 83 38 30 38 30 0D 06
- S1 = checkweigher result available, positive logic - S2 = cycle in progress, positive logic	01 84 3A 3B 0D E8	
acknowledgement		01 84 33 35 0D E8
EEPROM storage	01 81 0D 1A	
acknowledgement		01 81 0D 1A
reset. Effective switching to checkweigher mode.	01 80 0D 40	

5.8. Peak control mode:

Example:

- set to 'Triggered peak control' mode
- E1 input: 'Measurement window', 'positive logic'
- E2 input: 'None', 'positive logic'
- S1 output = E1, 'Positive logic'
- S2 output = 'Set point', 'positive logic'
- set point 2 high value = 55000
- set point 2 low value = 45000
- set point 2 'window functioning' set to Max.

eNod3-C with address 01_H:

command or response description	command sent to eNod3-C	response
triggered peak control	01 82 30 34 0D 7E	
acknowledgement		01 82 30 34 0D 7E
- E1 = 'measurement window', 'positive logic' - E2 = 'None', 'positive logic'	01 83 3C 30 38 30 0D 8F	
acknowledgement		01 83 3C 30 38 30 0D 8F
- S1 = E1, 'positive logic' - S2 = 'set point 2', 'positive logic'	01 84 3D 38 0D 23	
acknowledgement		01 84 3D 38 0D 23
set point 2 high value = 55000	01 9A 35 35 30 30 30 0D 4E	
acknowledgement		01 9A 35 35 30 30 30 0D 4E
set point 2 low value = 45000	01 9B 34 35 30 30 30 0D D6	
acknowledgement		01 9B 34 35 30 30 30 0D D6
set point 2 'window functioning', set to Max	01 9E 34 34 0D 8B	
acknowledgement		01 9E 34 34 0D 8B
EEPROM storage	01 81 0D 1A	
acknowledgement		01 81 0D 1A
reset. Effective switching to Peak control mode.	01 80 0D 40	

APPENDIX B : CODING EXAMPLE OF A FLOATING VALUE

Example:

Value to be transmitted (floating): 1,64780235

Equivalent hexadecimal value: 3FD2 EB30

SCMbus coding: **333F 3D32 3E3B 3330**