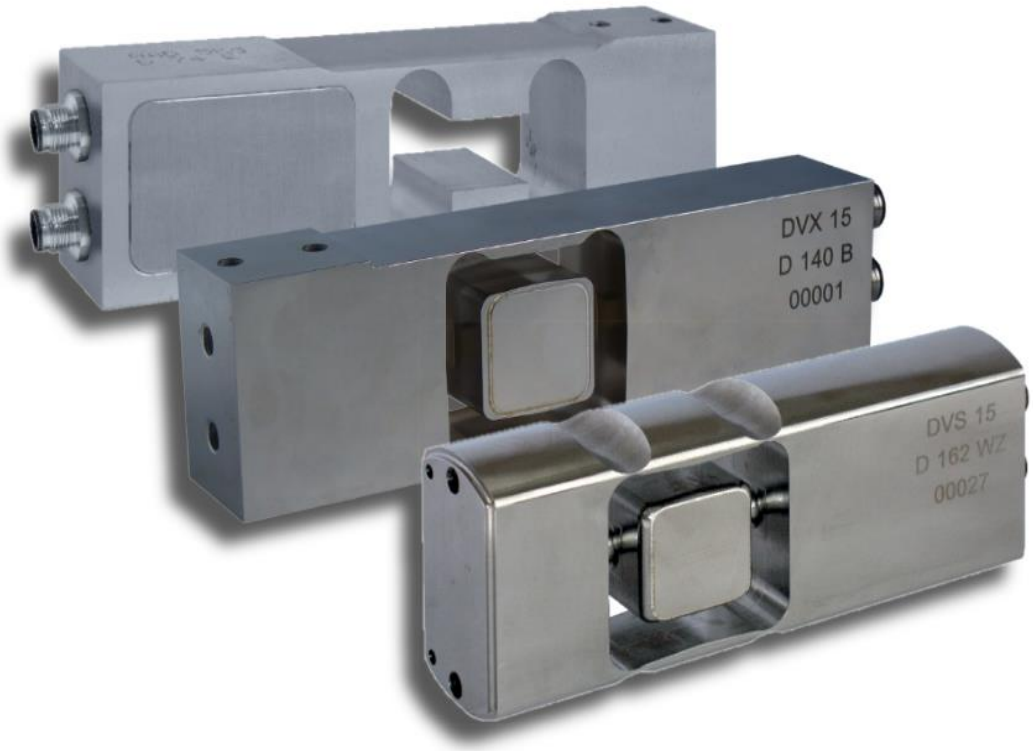
SCMbus communication protocol

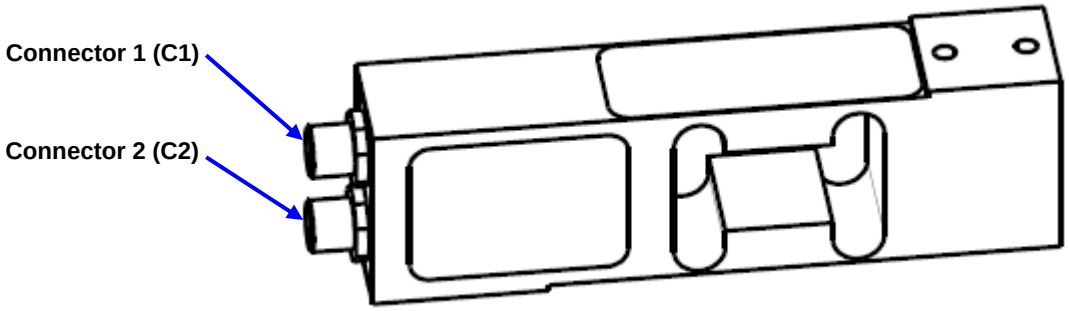


Document revisions		
version	**date**	**description**
A	12/11	- Document creation
B	04/17	- Add DVX-C and DVS-C

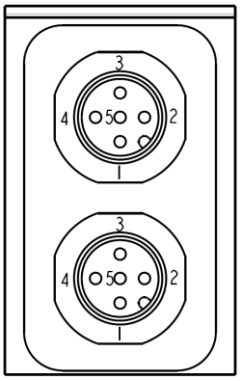
1 INSTALLATION

1.1 Connection to RS485 bus

Digital load-cell is equipped with a **RS485** (half-duplex) interface using **Modbus-RTU** and **SCMbus** communication protocols.
Digital load-cell can be connected to a RS485 bus using **TA/RA** and **TB/RB** connections which are differently located depending on the load-cell version :

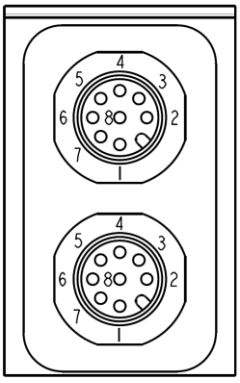


- **2 x 5-pins connectors version :**



- **TA/RA** : pin 4 of C2 connector
- **TB/RB** : pin 5 of C2 connector

- **2 x 8-pins connectors version :**



- **TA/RA** : pin 7 of C1 connector
- **TB/RB** : pin 8 of C1 connector

Note : Digital load-cell is also equipped with a CAN2.0A interface. After a reset (hardware or software), digital load-cell automatically communicates through the CAN interface. As soon as a Modbus-RTU or SCMbus valid frame is received on RS485 interface, digital load-cell automatically switches into RS485 communication mode.
By default, the baud rate for RS485 communication is **9600 bauds** and address is $\mathbf{01_H}$. It can be modified during sensor setting up phase with ***eNodView*** software.

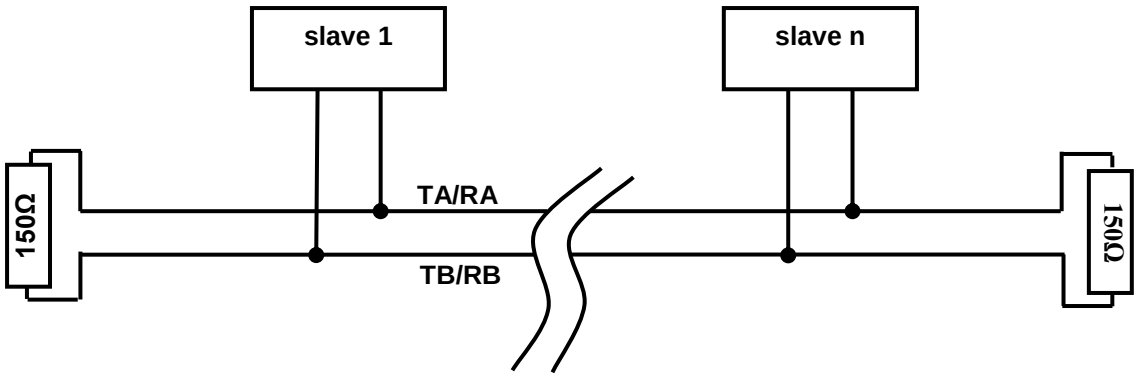
1.2 Topology, bus length and communication baud rate

Network topology is a bus topology with resistors at each end (150 Ohms recommended).
Maximal length of the bus depends on cable quality and baud rate, see following table :

Bit rate	Max bus length
115.2 kbit/s	600 m
57.6 kbit/s	1200 m
38.4 kbit/s	1200 m
19.2 kbit/s	1200 m
9.6 kbit/s	1200 m

Note :

- Table corresponds to a bus made with a shielded cable and twisted pair conductors section ≥ 0.22mm^2 (24AWG).
- For bus whose length is greater than 200m, using optocoupler is recommended.
- Line termination :
-



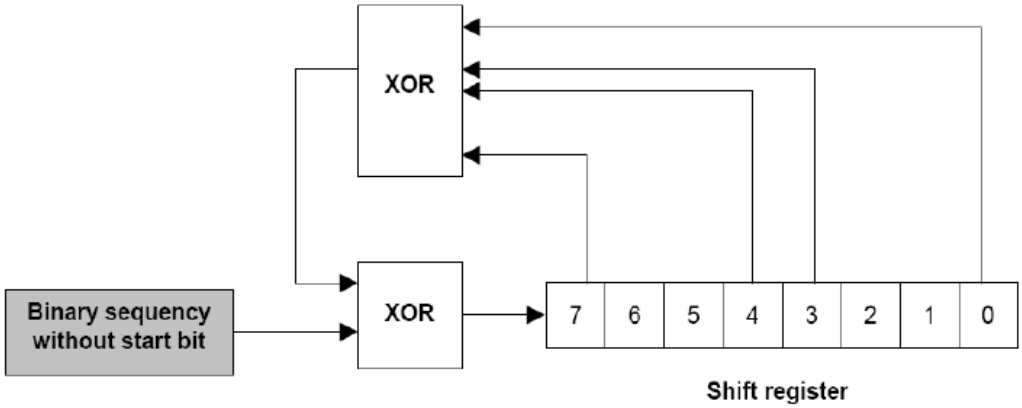
2 USING SCMBUS COMMUNICATION PROTOCOL :

2.1 Byte format:

- Format :
  - 1 start bit
  - 8 data bits without parity
  - 2 stop bits
- ASCII bytes:
  ASCII numeral characters (30_H,...39_H) and ASCII hexadecimal characters ($3A_H$,...$3F_H$).
- CRC byte :
  Generated by the following polynomial :

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

The CRC-8 polynomial result 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 digital load-cell and a received frame which is ended by such CRC-8 is considered as a frame without any error.

2.2 Frame format :

- Transmission organisation :
  - Frame : Address first.
  - Bytes : lsb first.
  - Multi-bytes data type : MSB first.

2.2.1 Functioning commands, writing commands :

Request :

Address	Command	Value	CR	CRC
1 **Hex** byte	1 **Hex** byte (command)	N **ASCII** hex bytes	1 **ASCII** byte ($0D_H$)	1 **Hex** byte

Response :
Each functioning command or writing command is acknowledged by the send back of the same frame as received or an error message.

Address	Command	Value	CR	CRC
1 **Hex** byte	1 **Hex** byte (command)	N **ASCII** Hex bytes	1 **ASCII** byte ($0D_H$)	1 **Hex** byte

2.2.2 Reading commands :

Request :

Address	Command	CR	CRC
1 **Hex** byte	1 **Hex** byte (command)	1 **ASCII** byte ($0D_H$)	1 **Hex** byte

Response :

Address	Command	Value	CR	CRC
1 **Hex** byte	1 **Hex** byte (command)	N **ASCII** Hex bytes	1 **ASCII byte** ($0D_H$)	1 **Hex** byte

2.2.3 Transmit measurement command :

Request :

Address	Command	CR	CRC
1 **Hex** byte	1 **Hex** byte (command)	1 **ASCII** byte ($0D_H$)	1 **Hex** byte

Response :

- *standard* format :

Address	Status	Value	CR	CRC
1 **Hex** byte	2 **Hex** bytes	N **ASCII** Hex bytes	1 **ASCII** byte ($0D_H$)	1 **Hex** byte

- *fast* format :

This specific format is especially dedicated to very fast measurement transmission. We recommend using the ***eNodView*** software with this format to save acquisition files. These files can be used for dynamic analysis. It allows the user to define the best settings in relation with his application.
This frame is specific, and it can only be applied to gross measurement, net measurement or A/D converter points in transmitter mode :

STX	Status word	Value	Cks	ETX
02_H	2 **Hex** bytes	3 signed **Hex** bytes (2's complement)	Σ of previous bytes and b7 set to 1	**03_H**

Measurements encoding : Because values are encoded in signed hexadecimal bytes format (2's complement) some bytes can be equal to **STX (02_H) or ETX (03_H) or DLE (10_H)** so before those specific bytes values a **DLE (10_H)** byte is inserted. Sensor address is not transmitted in the frame.

- ⇨ The frame starts with **STX (02_H)** byte and ends with **ETX (03_H)** byte
- ⇨ Values are encoded in **signed hexadecimal**
- ⇨ Checksum is obtained by summing every previous bytes and setting bit 7 to 1.

Status bytes :

bits b15,...b0	Function	Notes
b1, b0		
00	gross measurement	
01	net measurement	
10	A/D converter points	
11	tare value	
b3,b2		
00	measurement within the admissible range	causes an output assigned to *'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 *'motion'* function to be set active
1	no motion	
bit b5		
0	measurement out of the zero ¼ of division	
1	zero in the ¼ of division	
bit b6		
0	EEPROM OK	
1	EEPROM failure	
bit b7		
1	reserved	
bit b8		
0	input 1 low level	input 1 logical state
1	input 1 high level	
bit b9		
0	input 2 low level	input 2 logical state
1	input 2 high level	
bit b10		
0	output 1 low level	output 1 logical state
1	output 1 high level	
bit b11		
0	output 2 low level	output 2 logical state
1	output 2 high level	
bit b12		
0	output 3 low level	output 3 logical state
1	output 3 high level	
bit b13		
0	output 4 low level	output 4 logical state
1	output 4 high level	
bit b14		
0	no tare	
1	At least a tare has been processed	
bit b15		
1	reserved	

2.2.4 Exception frame :

Address	Error code	CR	CRC
1 **Hex** byte	1 **Hex** byte (command)	1 **ASCII** byte ($0D_H$)	1 **Hex** byte

Error codes :

Error code	Name	Description
FE_H	unknown command	Requested command is not supported by sensor
FF_H	error during command execution	ex. : write 0x00 forbidden address

3 FUNCTIONAL COMMANDS :

3.1 Functional commands with N = 0

Command	hexa. Code	Description
reset	**$D0_H$**	⇨ smilar to power-up reset
EEPROM storage	**$D1_H$**	⇨ save the whole settings table into the sensor's EEPROM
restores sensor default configuration	**$D2_H$**	⇨ **WARNING** : all default settings are recovered including the calibration
set to zero gross measurement	**$D3_H$**	⇨ needs measurement stability, if not reached after 5 second, command is cancelled ⇨ this new zero value is the new current value, but it is not stored into EEPROM ; limited to ±10% range of the maximum capacity or ±2% in legal for trade functioning
tare request	**$D4_H$**	⇨ needs measurement stability, if not reached after 5 seconds, command is cancelled
abort calibration	**$D6_H$**	⇨ allows to leave the calibration procedure before it ends
User's span adjustment	**$D7_H$**	⇨ must be followed by the '*save calibration*' command
zero adjustment	**$D8_H$**	⇨ must be followed by the *'save calibration'* command ⇨ OR by the *'physical calibration'* command
save calibration	**DE_H**	⇨ stores the calibration parameters into EEPROM
clear	**DF_H**	⇨ stops current dosing cycle and resets all the calculated variables linked to dosing cycles
stop continuous transmission	**$E3_H$**	⇨ stop transmitter (see note §3.2)
start CW cycle	**$E4_H$**	⇨ starts a CW cycle by unloading cycle (depending on the functioning mode) if start conditions are respected
stop cycle	**$E5_H$**	⇨ stops the running CW cycle
cancel tare	**$E6_H$**	⇨ erases the current tare value
force output 1 level	**$E7_H$**	⇨ transmitter functioning mode only if logical output is set to '*programmed mode*'. ⇨ send this command a first time to set the corresponding logical output (according to chosen logic), re-send this command to unset it and so on
force output 2 level	**$E8_H$**	
force output 3 level	**$E9_H$**	
force output 4 level	**EA_H**	
erase max peak value	**EB_H**	⇨ max peak value is set to actual gross value
physical calibration	**EC_H**	⇨ must be preceded by '*zero adjustment*' command ⇨ the calibration load corresponds to the number assigned to '*calibration load*'
Dynamic zero	**ED_H**	⇨ Force to zero without stability criteria after calculating time "dynamic zero time"

3.2 Functional commands with N = 5 :

Command	Hex. Code	Description
start gross measurement continuous transmission	**$E0_H$**	⇨ gross measurements are transmitted for a duration equal to the transmitted ASCII value coded on N = 5 ⇨ measurement transmission rate is defined by the '*sampling period'* setting
start net measurement continuous transmission	**$E1_H$**	⇨ net measurements are transmitted for a duration equal to the transmitted ASCII value coded on N = 5 ⇨ measurement transmission rate is defined by the '*sampling period'* setting
start A/D converter points continuous transmission	**$E2_H$**	⇨ A/D converter points measurements are transmitted for a duration equal to the transmitted ASCII value coded on N = 5 ⇨ measurement transmission rate is defined by the '*sampling period'* setting

Note : Each of the 3 commands theoretically can be stopped by the command '*stop continuous measurement transmission'* ($E3_H$) before the end time has elpased. Because of half-duplex communication limitations, a collision is possible and the '*stop continuous measurement transmission'* command might be ignored.

4 READING/WRITING COMMANDS LIST :

Writing commands are usually followed by a reading command. Both are completed by a coded value up to N bytes. See the commands description the corresponding §.

Command	Writing hex codes	Note	Reading hex codes
Communication settings			
communication protocol, functioning mode and signal processing	21_H	N = 2	20_H
Sensor address	23_H	N = 1 (write) N = 3 (read)	22_H
serial & CAN bus baud rate selection	25_H	N = 2	24_H
Calibration settings			
calibration load	49_H	N = 7	48_H
span adjusting coefficient	39_H	N = 7	38_H
maximum capacity	41_H	N = 7	40_H
scale interval	43_H	predefined values	42_H
gravity coefficient (g)	45_H	N = 8	44_H
User scale coefficient	$0C_H$	N = 8	$0B_H$
User zero calibration	$0F_H$	in A/D converter points	$0E_H$
Filtering settings			
A/D converter configuration	51_H	N = 2	50_H
Low-pass filter order & band-stop filter activation	53_H	N = 2	52_H
low-pass filter 1/A coefficient	55_H	N = 8	54_H
low-pass filter B coefficient	57_H	N = 8	56_H
low-pass filter C coefficient	59_H	N = 8	58_H
low-pass filter D coefficient	$5B_H$	N = 8	$5A_H$
low-pass filter E coefficient	$5D_H$	N = 8	$5C_H$
band-stop filter X coefficient	89_H	N = 8	88_H
band-stop filter Y coefficient	$8B_H$	N = 8	$8A_H$
band-stop filter Z coefficient	$8D_H$	N = 8	$8C_H$
Self-adaptive filter	$5F_H$	N = 1 (write) N = 2 (read)	$5E_H$
Logical inputs/outputs configuration			
logical inputs assignment	61_H	N = 4	60_H
debounce time	63_H	N = 5	62_H
logical outputs 1 & 2 assignment	65_H	N = 4	64_H
logical outputs 3 & 4 assignment	67_H	N = 4	66_H

set point 4 high value	69_H	N = 7	68_H
set point 4 low value	$6B_H$	N = 7	$6A_H$
set point 3 high value	$6D_H$	N = 7	$6C_H$
set point 3 low value	$6F_H$	N = 7	$6E_H$
set point 2 high value	71_H	N = 7	70_H
set point 2 low value	73_H	N = 7	72_H
set point 1 high value	75_H	N = 7	74_H
set point 1 low value	77_H	N = 7	76_H
set points functioning	79_H	N = 4	78_H
Legal for trade			
metrological version number	-	read only ; N = 5	27_H
legal for trade switch	81_H	N = 1	80_H
legal for trade counter	-	read only ; N = 5	82_H
legal for trade checksum	-	read only ; N = 5	84_H
Zero modes	87_H	N = 1	86_H
stability criterion	85_H	N = 1 (write) N = 2 (read)	$5E_H$
Checkweigher settings			
Stabilization time (Ts)	95_H	N = 5	94_H
Measuring Time (Tm)	97_H	N = 5	96_H
Dynamic zero acquisition time	$F4_H$	N = 5	$F5_H$
Checkweigher correction coefficient	$F2_H$	N = 8	$F3_H$
Trigger level	99_H	N = 8	98_H
Dynamic zero correction range	$8F_H$	N = 3	$8E_H$
Measures			
Sampling period	CB_H	N = 5	CA_H
Gross	-	SCMbus standard & rapide	10_H
Tare	-	SCMbus standard & rapide	11_H
Net	-	SCMbus standard & rapide	12_H
AD converter points	-	SCMbus standard & rapide	13_H
Checkweigher results	-	N = 8	14_H
Checkweigher numbr of cycles	-	N = 8	15_H
Mean	-	N = 8	16_H
Checkweigher running	-	N = 8	17_H
Checkweigher standard deviation	-	N = 8	18_H

Checkweigher quality results	-	N = 8	EF_H
Other settings			
text box	93_H	N = 2	92_H
Product version	-	read only ; N = 5	26_H

5 COMMANDS DESCRIPTION

The data accessible through SCMbus communication protocol are described below. For each one, this document specifies its reading or writing command, its particular format and if the data needs a storage*.

Data storage* :

- Y : The parameter **must** be saved in EEPROM. Its new value **will be taken into account at the next reset**.
- N : The new value of the parameter is **immediately taken into account** and does not need a storage before.
- **NOTE :** The whole parameters except 'read only' data can be stored into EEPROM in all cases. Then, their values are kept if the power supply is disconnected or if a reset is requested.

5.1 Communication settings :

5.1.1 Communication protocol and functioning mode:

Reading code	*Writing code*	*N*	*Data storage **
20_H	21_H	4	N

N1, N2		Function	
N1 (W)	N1 (R)	Protocol	
30	00	***SCMbus***	communication protocol
31	01	***Modbus RTU***	
33	03	***SCMbus fast format***	
N2 (W)	**N2 (R)**	**functioning mode**	
30	00	transmitter	application
31	01	Checkweigher on request	
32	02	Checkweigher auto	
38	08	fast transmitter	

Note: in "fast transmitter" functioning mode, the digital low-pass, band-stop and self-adaptive filters as well as the set points management are not taken into account.
To act the protocol change, it is mandatory to:
Store in EEPROM with $D1_H$ code **AND** Reset probe (power off or $D0_H$.code).

5.1.2 Sensor's address :

Reading code	*Writing code*	*N*	*Data storage **
22_H	23_H	3	N

Format : Writing : All values between 01_H and FF_H.
Reading : ASCII format on 3 bytes
Default value : 01_H
Description : Sensor address on the network.
00_H is a broad cast address. Do not use this address when several devices are connected to the same network.

To act the protocol change, it is mandatory to:
Store in EEPROM with $D1_H$ code **AND** Reset probe (power off or $D0_H$.code).

5.1.3 Serial & CANbus baud rate selection :

Reading code	*Writing code*	*N*	*Data storage **
24_H	***25_H***	***2***	***Y***

Format/description : Coded according to the following table :

N1	RS485 baud rate	
31	9600	by default
32	19200	
33	38400	
34	57600	
35	115200	
N2	**CAN bus baud rate**	
32	50000	
33	1250000	by default
34	250000	
35	500000	
36	800000	
37	1000000	

To act the protocol change, it is mandatory to:
Store in EEPROM with $D1_H$ code **AND** Reset probe (power off or $D0_H$.code).

5.2 Calibration settings

5.2.1 Calibration load :

Reading code	*Writing code*	*N*	*Data storage **
48_H	***49_H***	***1 to 7***	***N***

Format : Coded in ASCII (non-significant zero are not mandatory), admissible values comprised between 0 and 1000000_d.
Default value : 10000_d
Description : Digital load-cell span can be adjusted by learning using a known standard load. The equivalence between the standard load and the corresponding number of points is set by the '*calibration load'* value used during the '*physical calibration'* procedure execution.
Stored in EEPROM using $D1_H$ command.

5.2.2 Span adjusting coefficient :

Reading code	*Writing code*	*N*	*Data storage **
38_H	***39_H***	***1 to 7***	***N***

Format : Coded in ASCII (non-significant zero are not mandatory). The unit is 1/1000000 (1E-6). It means that 1000000_d = 1. Maximum and minimum values are respectively 1100000_d and 900000_d which is corresponding to 1.10 and 0.90.
Default value : 1000000_d
Description : The original calibration value could be adjusted by the '*span adjusting coefficient'*. This correction applies on the whole curve.
Stored in EEPROM using $D1_H$ command.

5.2.3 Maximum capacity :

Reading code	*Writing code*	*N*	*Data storage **
40_H	41_H	*from 1 to 7*	*N*

Format : Coded in ASCII (non-significant zero are not mandatory), admissible values comprised between 0 et 1000000_d.
Defaut value : 500000_d
Description : The *'maximum capacity'* allows to define the gross value delivered by the load-cell at its maximum capacity (ex : 30000 pts for 30 kg). The value of this setting is used as part of the *'user's span adjustment '* command.
When the absolute value of the gross measurement plus 9 divisions exceeds the specified capacity, the bit b3 of the status word associated is set to 1**.**
Stored in EEPROM using D1H command.

5.2.4 Scale interval :

Reading code	*Writing code*	*N*	*Data storage **
42_H	43_H	*1 to 3*	*N*

Format : Coded in ASCII (non-significant zero are not mandatory). Admissible values : 1, 2, 5, 10, 20, 50, 100.
Default value : 1_d
Description : minimal difference between 2 consecutive calibrated measurements.
Stored in EEPROM using D1H command.

5.2.5 User zero calibration :

Reading code	*Writing code*	*N*	*Data storage **
$0E_H$	$0F_H$	*1 to 8*	*N*

Default value : 0_d
Description : Value in A/D converter points of the zero reference.
This zero value is acquired during a functional command '*zero adjustment*.
Stored in EEPROM using D1H command.

5.2.6 User zero calibration :

Reading code	*Writing code*	*N*	*Data storage **
$0E_H$	$0F_H$	*1 to 8*	*N*

Default value : 0_d
Description : Value in A/D converter points of the zero reference.
This zero value is acquired during a functional command '*zero adjustment*.
Stored in EEPROM using D1H command.

5.2.7 User scale coefficient :

Reading code	*Writing code*	*N*	*Data storage **
$0B_H$	$0C_H$	*8*	*N*

Default value : 1.0
Format : simple precision float value (32bits).
Description : this coefficient is automatically calculated by sensor during one of the calibration procedures : 'Theoretical scale adjustment' or 'physical scale adjustment'.
Stored in EEPROM using D1H command.

5.2.8 Gravity coefficient (g) :

Reading code	*Writing code*	*N*	*Data storage **
44_H	45_H	*8*	*N*

Format : Coded in ASCII decimal. Actual value multiplied by one million (1000000), for example 9,805 is written 9805000_d
Default value : 9805470_d
Description : As digital load cell is calibrated in Annemasse (France), depending on the terrestrial geographical coordinates where the 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 load cell). This correction is taken into account after a saving in EEPROM followed by a reset, then the span adjustment is automatic.

5.3 Filtering settings

5.3.1 A/D converter configuration :

Reading code	*Writing code*	*N*	*Data storage **
50_H	**51_H**	**2**	**N**

Format/description : Coded according to the following table :

N1, N2	Function		
N1	**Signal type and rejection**		
31	Bipolar signal, 60Hz rejection		
32	**Bipolar signal, 50Hz rejection**		**Default value**
33	Unipolar signal, 50Hz rejection		
N2	**A/D conversion rate in Meas/s**		
	50Hz rejection	**60Hz rejection**	
34	6,25	7,5	
33	12,5	15	
32	25	30	
31	50	60	
30	**100**	**120**	**Default value**
3C	200	240	
3B	400	480	
3A	800	960	
39	1600	1920	

To act the converter settings change, it is mandatory to:
Store in EEPROM with $D1_H$ code **AND** Reset probe (power off or $D0_H$.code).

5.3.2 Digital filter order and band-stop filter activation :

Reading code	*Writing code*	*N*	*Data storage **
53_H	*54_H*	*1 (or 2, reading)*	*N*

Format : Coded according to the following table :

N1	Function	Note
30	Low-pass filter disabled	
32	2nd order Bessel/Butterworth digital low-pass filter	Default value
33	3rd order Bessel/Butterworth digital low-pass filter	
34	4th order Bessel/Butterworth digital low-pass filter	
N2		
31	2nd order digital stop-band filter enabled	
30	digital stop-band filter disabled	Default value

Description : the filter recurrence relations of the filters are as follows :

- **Low-pass filter :**

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

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

- **Stop-band filter:**

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

Both filters coefficients depend on the A/D conversion rate and on cut-off frequencies. The determination of these coefficients can be easily achieved using ***eNodView*** simulation tools. The order and the coefficients are linked; please modify them at the same time.

5.3.3 Low-pass filter coefficients :

Setting	*Reading code*	*Writing code*	*N*	*Data storage **
1/A coefficient	54_H	55_H	***8***	***N***
B coefficient	56_H	57_H	***8***	***N***
C coefficient	58_H	59_H	***8***	***N***
D coefficient	$5A_H$	$5B_H$	***8***	***N***
E coefficient	$5C_H$	$5D_H$	***8***	***N***

Format : Coded in ASCII hexadecimal. Low-pass digital filter coefficients are expressed in simple precision float variables (32 bits). They are coded by dividing the 32 bits in successive quartets (see example in Appendix A).
Default values : 1/A = 0.01669952 ; B = -107.652423 ; C = 73.12416882 ; D = -17.35349542 ; E = 0 these values fit to a 3rd order Butterworth low-pass filter with a 10-Hz cut-off frequency at a 100 meas/s A/D conversion rate.
Description : The determination of the coefficients can be easily achieved using ***eNodView*** simulation tools. Be careful to modify the filter order and the coefficient at the same time.

5.3.4 Stop-band filter coefficients :

Setting	*Reading code*	*Writing code*	*N*	*Data storage **
X coefficient	88_H	89_H	***8***	***N***
Y coefficient	$8A_H$	$8B_H$	***8***	***N***
Z coefficient	$8C_H$	$8D_H$	***8***	***N***

Format : Coded in ASCII hexadecimal. stop-band digital filter coefficients are expressed in simple precision float variables (32 bits). There are coded by dividing the 32 bits in successive quartets (see example in Appendix A).
Default values : X = 0.9289047 ; Y = -1.7163921 ; Z = 0.857809, these values fit to a 400 meas/s A/D conversion rate and 50Hz central frequency and a ±10Hz band. By default this filter is disabled, before activating it please set coefficients fitting to the application.
Description : The coefficients determination can be easily achieved using ***eNodView*** simulation tools.
Saved in EEPROM using D1H command.

5.3.5 Self-adaptive filter :

Reading code	*Writing code*	*N*	*Data storage **
$5E_H$	***$5F_H$***	***2 (read) 1 (write)***	***N***

Format : although the filter activation is done with N = 1, reading its state is done with N = 2. The filter state is coded on N2. (N1 is dedicated to the stability criterion)

N2	Self-adaptive filter	
30	**self-adaptive filter disabled**	**Default value**
31	self-adaptive filter enabled	

Description : ***self-adaptive filter*** : The self-adaptive filter can be set in cascade with previous filters.
The aim of this filter is to eliminate erratic values and to average consistent measurements. It is particularly useful in static measurements, avoid using it in dynamic or dosing process.

5.3.6 Stability criterion :

Reading code	*Writing code*	*N*	*Data storage **
84_H	***85_H***	***2 (read) 1 (write)***	***N***

Format ASCII *;* although the stability criterion is modified with N = 1, reading is done with N = 2. The stability criterion is coded on N1 (N2 is dedicated to the self-adaptive filter activation cf. § 5.3.5)
Description : motion is indicated by bit b4 of the status bytes (b4 = 1 if no motion). The stability criterion can be set according to the following table (d = scale interval) :

N1	Stability interval	Notes
30	no motion detection	⇨ always stable (impossible if legal for trade enabled)
31	0.25 d	**by default and if legal for trade enabled**
32	0.5 d	⇨ impossible if legal for trade enabled
33	1 d	
34	2 d	

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

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

5.4 Logical inputs/outputs configuration

5.4.1 Logical inputs assignment :

Reading code	*Writing code*	*N*	*Data storage **
60_H	***61_H***	***4***	***N***

Format/description : Coded according to the following table :
The bytes N1 and N2 correspond to the logical input 1 and the bytes N3 and N4 correspond to the logical input 2.

N1 and N2 or N3 and N4		Assignment	Function
N1 ou N3			
negative logic	positive logic		
30	38	none	⇨ logical inputs have no effect
31	39	tare	⇨ tare command
32	3A	zero	⇨ limited to ±10% range of the maximum capacity or ±2% in legal for trade functioning.
33	3B	Send measure/ Dynamic zero acquisition	⇨ in transmitter mode, send a measurement on the falling or rising entry edge. ⇨ in CW mode, get a new zero value limited to ±10% of maximum capacity after a time that can be configured.
34	3C	measurement window	⇨ in transmitter mode, send measurements while the input is maintained
35	3D	clear	⇨ in transmitter mode, cancels the tare ⇨ in checkweigher mode, cancel the checkweigher result.
36	3E	start cycle or enable start cycle	⇨ in checkweigher mode, start a cycle on trigger level.
37	3F	stop CW cycle	⇨ on trigger level
N2 or N4			
30		gross	sent measurements are gross measurements
32		net	sent measurements are net measurements
34		A/D converter points	sent measurements are A/D converter points

Note: In CW mode, if 2 inputs are set as “start new cycle”, “stop cycle”, “clear”, Input 1 has priority and input 2 is disabled. For “start cycle”, input has priority on trigger level (which is then disabled).
Stored in EEPROM using D1H command.

5.4.2 Debounce time :

Reading code	*Writing code*	*N*	*Data storage **
62_H	***63_H***	***1 to 5***	***N***

Format : Coded in ASCII (non-significant zero are not mandatory). Duration expressed in ms, comprised between 0 and 65535 ms.
default value : 80_d

Description : Debounce time corresponds to the minimum required stabilization time of the logical inputs before their activation. If the input level varies within this interval, it is ignored.
Stored in EEPROM using D1H command.

5.4.3 Logical outputs 1&2 and 3&4 assignment :

Settings	*Reading code*	*Writing code*	*N*	*Data storage **
outputs 1&2	64_H	65_H	***4***	***N***
outputs 3&4	66_H	67_H	***4***	***N***

Format : The bytes N1 and N2 correspond to the output 1 (or 3) and the bytes N3 and N4 correspond to the output 2 (or 4).
Default values : logical outputs 1 and 2 = 36313731_H (1 : positive logic, FF ; 2 : positive logic, CF); logical outputs 3 and 4 = 38313931_H (positive logic, emptying/reloading ; 4 : positive logic, result out of tolerances)
Descripton : Depending on the version, digital load-cell includes up to 4 logical outputs which can be configurated in different way as described in the following table :
Note : Digital load-cell in its 2 x 5-pins version connectors does not include logical outputs on the connectors. Nethertheless these outputs are managed and can be accessible by the communication bus.
Stored in EEPROM using D1H command.

N1 or N2		Assignment	Notes
Negative logic	**Positive logic**		
30	38	set points	⇨ 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
31	39	motion	
32	3A	Checkweigher result available	⇨ Checkweigher mode
33	3B	cycle in progress	⇨ Checkweigher mode
34	3C	defective measurement	⇨ errors description contained in the status word associated to the measure
35	3D	logical input1 (or2) image	⇨ Image of the input 1 on outputs 1 and/or 3 ⇨ Image of the input 2 on outputs 2 and/or 4
36	3E	Level on request	⇨ Level on request in transmitter mode (see command register).

Note :

- Sensor 2x5-pins connector version does not have available logical output on its connectors. Nevertheless logical outputs are managed and can be accessible by the communication bus.
- When several output are assigned to “cycle in progress” or “available result”, only the output with the highest number will be assigned to this function.

5.4.4 Set points high & low values :

Settings	*Writing code*	*Reading code*	*N*	*Default value **
set point 1 high level	***75_H***	***74_H***	***1 to 8***	***80000d***
set point 1 low level	***77_H***	***76_H***	***1 to 8***	***70000d***
set point 2 high level	***71_H***	***70_H***	***1 to 8***	***60000d***
set point 2 low level	***73_H***	***72_H***	***1 to 8***	***50000d***
set point 3 high level	***$6D_H$***	***$6C_H$***	***1 to 8***	***40000d***
set point 3 low level	***$6F_H$***	***$6E_H$***	***1 to 8***	***30000d***
set point 4 high level	***69_H***	***68_H***	***1 to 8***	***20000d***
set point 4 low level	***$6B_H$***	***$6A_H$***	***1 to 8***	***10000d***

Format : Coded in ASCII (non-significant zero are not necessary). Value between 0 and ±1000000_d.
default values : Set point 1 high level = 80000_d ; set point 1 low level = 70000_d
Set point 2 high level = 60000_d ; set point 2 low level = 50000_d
Set point 3 high level = 40000_d ; set point 3 low level = 30000_d
Set point 4 high level = 20000_d ; set point 4 low level = 10000_d
Description : these settings give the high and low limits for each set point. The set points state also depends on functioning mode '*window*' or '*hysteresis*' (see § 5.4.5).
Set point 1 corresponds to output 1, set point 2 to output 2, set point 3 to output 3 and set point 4 to output 4.

5.4.5 Set points functioning

Reading code	*Writing code*	*N*	*Data storage **
78_H	***79_H***	***4***	***N***

Format : Coded according to the following table :
The byte N1 corresponds to set point 1 (output 1), N2 to set point 2 (output 2), N3 to set point 3 (output 3) and N4 to set point 4 (output 4).

N1 or N2		Function
Window commutation	Hysteresis commutation	
30	31	set point on gross measurement, any mode
32	33	set point on net measurement, any mode
34	/	set point on CW results in range
36	37	CW running
38	/	set point on CW results out of range

Hysteresis commutation does not apply on "set point on CW results in range" and "set point on CW results out of range".

Stored in EEPROM using $D1_H$ command.

5.5 Legal for trade

5.5.1 Metrological version number :

Reading code	*Writing code*	*N*	*Data storage **
27_H	***/***	***5***	***/***

Format : Coded in ASCII.
Description : Identify the version of the part of the software that is dedicated to the metrology and the measurement exploitation.

5.5.2 Legal for trade switch :

Reading code	*Writing code*	*N*	*Data storage **
80_H	81_H	*1*	*Y*

Format : the activation of the settings related to the use of sensor in compliance with legal for trade use is done by setting N :

- ⇨ 30 : legal for trade disabled (default value)
- ⇨ 31 : legal for trade enabled

Default value : 30_H
Description : The activation of legal for trade 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
- 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
- taring is now impossible if gross measurement is negative.
- reading a measurement during 15 seconds after power-up or a software reset is impossible (digital load-cell returns ????????)
- 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 (returns ????????).
- The stability criterion is forced to *0.25d* and cannot be modified anymore. An attempt to change its value is refused, sensor transmits an error frame.

5.5.3 Legal for trade counter :

Reading code	*Writing code*	*N*	*Data storage **
82_H	*/*	*5*	*/*

Format : read-only value between 1 et 65535d.
Description : if the legal for trade option is switched ON, the legal for trade counter is incremented every time a storage in EEPROM is requested if one (or several) of these settings has been modified :

- Analog to digital configuration
- Span coefficient
- Span adjusting coefficient
- Scale interval
- Maximum capacity
- Zero calibration in converter points
- Legal for trade switch
- Zero modes
- Motion settings

5.5.4 Legal for trade CRC-16 :

Reading code	*Writing code*	*N*	*Data storage **
84_H	*/*	*5*	*/*

Format : read-only hex. value between 0000H and FFFFH.
Description : if the legal metrology option is switched ON, a new legal metrology CRC-16 is calculated every time a storage in EEPROM is requested if one (or several) of the settings listed in § 5.5.3 has been modified.

5.5.5 Zero modes :

Reading code	*Writing code*	*N*	*Data storage **
86_H	87_H	*1*	*Y*

Format/description : Coded according to the following table :

Bits B15 ... b0	Function	Note
bit b0	**Zero tracking**	
1	zero tracking enabled	⇨ effective on ±10% range of the maximum capacity or ±2% in legal for trade functioning
0	zero tracking disabled	by default
bit b1	**Zero after reset**	
1	initial zero setting enabled	⇨ effective on ±10% range of the maximum capacity or ±2% in legal for trade functioning
0	initial zero setting disabled	by default
bit b2	**CW automatic zero correction**	
1	CW automatic zero correction in specified range	cf. description in user manual réf. 195752
0	No automatic correction	by default
b15 ... b8	**Correction range**	
0 to 255	Positive and negative zero correction in CW mode.	Only if b2 is set to 1 0 by default

The value is between 0 and 255. It defines the correction range from 0 to 255d.
In legal for trade, this value is automatically limited to ±5d.

The automatic zero correction in checkweigher correct 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.

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

5.6 Checkweigher settings

See user manual (195752) for more information

5.6.1 Stabilization Time (Ts) in checkweigher mode :

Reading code	*Writing code*	*N*	*Data storage **
94_H	95_H	5	Y

Format : Time Ts in milliseconds, between entre 0 et 65 535_d
Default value: 10000_d
Description : Stabilization time is effective without EEPROM saving.
Stored in EEPROM using $D1_H$ command.

5.6.2 Measuring Time (Tm) in checkweigher mode:

Reading code	Writing code	N	Data storage *
96_H	97_H	5	Y

Format : Time Tm in milliseconds, between 0 and 65 535_d
Default value : 200_d
Description : Time needed to calculate the checkweigher result. Measuring time is effective without EEPROM saving.
Stored in EEPROM using D1H command.

5.6.3 Acquisition Time and/or Dynamic zero correction :

Reading code	Writing code	N	Data storage *
$F5_H$	$F4_H$	5	Y

Format : Time in ms, between 0 and 65535_d. In legal for trade mode, this time could not be less that 1000_d (1s)
Default value : 100_d
Description *:*

- 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 ± 10% of the maximum capacity or± 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.

Acquisition time is effective without EEPROM saving.
Stored in EEPROM using D1H command.

5.6.4 Checkweigher correction coefficient:

Reading code	Writing code	N	Data storage *
$F3_H$	$F2_H$	5	Y

Format : in hexadecimal, Values between 900 000_d and 1 100 00_d
Default value : 1 000 000_d
Description *:* Checkweigher result can be adjusted with a coefficient (unit: 1/1000000).For example, a value of 1000000 means a coefficient of 1.0.
Stored in EEPROM using D1H command.

5.6.5 Set point for checkweigher start cycle :

Reading code	Writing code	N	Data storage *
98_H	99_H	5	Y

Format : Values between 0 and ± 1 000 000_d
Default value : 10000_d
Description *:* 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

Note : In checkweigher mode, if an input is configured as “start checkweigher cycle”, the “set point” is ignored.
Set point is effective without EEPROM saving.

5.7 Measurements

5.7.1 Sampling period (transmitter mode) :

Reading code	*Writing code*	*N*	*Data storage **
CA_H	CB_H	*from 1 to 5*	*Y*

Format : ASCII; duration expressed in ms, comprised between 0 and 65535_d.
Default value : 00_H
Description : the *'sampling period'* setting defines the measurements transmission period on the bus when continuous transmission is active (*'measurement window'* or after a *'start continuous transmission'* command).
If this setting is set to 0, **measurements transmissions are synchronized on the A/D conversion period** (for example at a 400 meas/s conversion rate, a measurement is transmitted every 2.5 ms).
Stored in EEPROM using D1H command.

5.7.2 Gross :

Reading code	*Writing code*	*N*	*Data storage **
10_H	/	*8 or 3*	/

Format : the current gross measurement is coded on :
- 8 ASCII bytes in ***SCMbus standard format.***
- 3 hexadecimal bytes in ***SCMbus fast format.***

Description : Current gross measurement value.
If the *'legal for trade'* option is switched ON, during the **15 seconds** that follow the power-up, this variable is set to **????????** as for a zero request.

5.7.3 Tare :

Reading code	*Writing code*	*N*	*Data storage **
11_H	/	*8 or 3*	/

Format : the last tare value is coded on :
- 8 ASCII bytes in ***SCMbus standard format.***
- 3 hexadecimal bytes in ***SCMbus fast format.***

Description : Current tare value.

5.7.4 Net :

Reading code	*Writing code*	*N*	*Data storage **
12_H	/	*8 or 3*	/

Format : the current net measurement is coded on :
- 8 ASCII bytes in ***SCMbus standard format.***
- 3 hexadecimal bytes in ***SCMbus fast format.***

Description : Current net measurement value.
If the *'legal for trade'* option is switched ON, during the **15 seconds** that follow the power-up, this variable is set to **????????** as for a zero request.

5.7.5 A/D converter points :

Reading code	*Writing code*	*N*	*Data storage **
13_H	/	*8 or 3*	/

Format : the measurement in A/D converter points is coded on :
- 8 ASCII bytes in ***SCMbus standard format.***
- 3 hexadecimal bytes in ***SCMbus fast format.***

Description : Current A/D converter points value. Gives a non calibrated measurement.

5.7.6 Checkweigher result:

Reading code	*Writing code*	*N*	*Data storage **
14_H	/	8	/

Format : signed hexadecimal (two's complement).
Description : Checkweigher result is a net result. If the result is not valid, the register contains 0xFFFFFFFF. This value can be initialized thanks to the command "clear" or an input assigned to this function.

5.7.7 Number of processed cycles :

Reading code	*Writing code*	*N*	*Data storage **
15_H	/	8	/

Format : ASCII.
Description : : in dosing functioning modes, the number of complete cycles can be read through this command. This value can be reset by the *'clear'* command.

5.7.8 Average value :

Reading code	*Writing code*	*N*	*Data storage **
16_H	/	8	/

Format : ASCII.
Description : : in dosing functioning modes, the average dosing value is calculated at the end of each dosing cycle during the whole process. The average value can be read through this command. This value can be reset by the *'clear'* command.

5.7.9 Checkweigher running total :

Reading code	*Writing code*	*N*	*Data storage **
17_H	/	8	/

Format : ASCII.
Description : The sum of obtained CW results is calculated at the end of each cycle during the whole process. In CW functioning modes, the cumulated value of the CW results can be read through this register. This value can be reset by the *'clear'* command..

5.7.10 Standard deviation :

Reading code	*Writing code*	*N*	*Data storage **
18_H	/	8	/

Format : ASCII hexadecimal ; the standard deviation is expressed as single precision float variables (32 bits). Its value is divided into successive quartets (cf. example in appendix A).
Description : in dosing functioning modes, the standard deviation on the results is calculated and updated after each complete cycle. This value can be reset by the *'clear'* command or a logical input to this function.

5.7.11 Checkweigher result quality :

Reading code	*Writing code*	*N*	*Data storage **
EF_H	/	8	/

Format : simple precision float value.
Description : 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.

5.8 Other settings

5.8.1 Product version :

Reading code	*Writing code*	*N*	*Data storage **
26_H	/	5	/

Format : Coded in ASCII.
Description : Identifies sensor firmware version.

5.8.2 Text box :

Reading code	*Writing code*	*N*	*Data storage **
92_H	93_H	from 1 to 2	Y

Format : a 16-bytes free memory area for ASCII codes storage.
Default value : 2020_H
Description : this is a user memory space that can be used to store some information like the last calibration date.
Stored in EEPROM using D1H command.

6 APPENDIX A : EXAMPLE FOR CODING A SINGLE PRECISION FLOAT PARAMETER

Example of a coefficient to transmit :

- Value (floating) : 1,64780235
- Corresponding value in hexadecimal : 3FD2 EB30

⇨ Coded in SCMBUS : **333F 3D32 3E3B 3330**