

Modbus-RTU communication protocol



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version	date	description
A	11/2012	- Document creation
B	04/17	- Add DVX-C and DVS-C
C	12/2017	- Ta on C1 connector (8 pins)

1 INSTALLATION	5
1.1 Connection to RS485 bus.....	5
1.2 Topology, bus length and communication baud rate	6
2 USING MODBUS-RTU COMMUNICATION PROTOCOL	7
2.1 Byte format :.....	7
2.2 Modbus-RTU compatible functions.....	7
2.3 Frames structure :.....	7
2.3.1 Function (03H/04H) – read N input registers (N = 30 max) :	7
2.3.2 Function (06H) – write a single register :	7
2.3.3 Function (10H) – preset multiple registers (N = 30 max) :	7
2.3.4 Exception codes :	8
3 REGISTER MAP :.....	9
3.1 Communication settings	12
3.1.1 Slave address :.....	12
3.1.2 Protocols, functioning modes and treatment.....	12
3.1.3 Baud rate selection :	12
3.2 Calibration settings.....	13
3.2.1 Span adjusting coefficient :	13
3.2.2 Maximum capacity :	13
3.2.3 Scale interval :	13
3.2.4 User Scale coefficient :	13
3.2.5 User Calibration zero value :	14
3.2.6 Gravity coefficient (g) adjustment :.....	14
3.2.7 Calibration load :	14
3.3 Filtering parameters.....	15
3.3.1 A/D converter configuration :	15
3.3.2 Low-pass filter order and band-stop filter activation.....	15
3.3.3 Digital low-pass filter coefficients :	16
3.3.4 Digital band-stop filter coefficients :	16
3.3.5 Motion criterion and self-adaptive filter activation :	16
3.4 Logical inputs/outputs configuration.....	17
3.4.1 Logical inputs assignment :	17
Note: In checkweigher mode, if 2 inputs are configured as start new cycle, stop cycle, clear CW result, Input 1 has priority and input 2 is not active.	18
3.4.2 Inputs holding time :	18
3.4.3 Logical outputs assignment.....	18
3.4.4 Set points functions :	19
3.4.5 Set points 1 & 2 high/low and 3 & 4 high/low :	20
3.4.6 Logical inputs level :	21
3.4.7 Logical outputs level :	21
3.5 Legal for trade	21
3.5.1 Legal for trade firmware version :	21
3.5.2 Legal for trade switch :	21
3.5.3 Zero modes :	21
3.5.4 Legal for trade CRC-16 :	22
3.5.5 Legal for trade counter :	22
3.6 Checkweigher settings	23
3.6.1 Stabilization Time (Ts) in checkweigher mode :	23
3.6.2 Measuring Time (Tm) in checkweigher mode:.....	23
3.6.3 Acquisition Time and/or Dynamic zero correction :	23
3.6.4 Set point for checkweigher start cycle :	23
3.6.5 Checkweigher correction coefficient:.....	24
3.7 Other settings.....	24
3.7.1 Firmware version :	24
3.7.2 Text box :	24
3.8 Measurements.....	24
3.8.1 Status register :	24
3.8.2 Gross :	26
3.8.3 Tare :	26
3.8.4 Net :	26

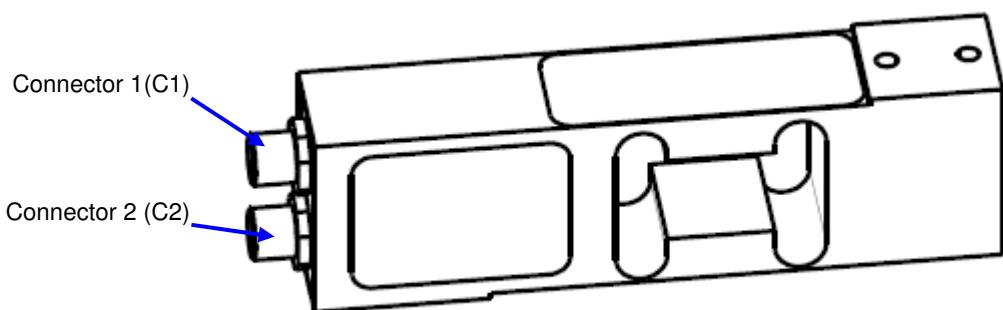
3.8.5	A/D converter points :	26
3.8.6	Number of processed cycles :	26
3.8.7	Results average value :	26
3.8.8	Checkweigher running total :	26
3.8.9	Standard deviation :	27
3.8.10	Checkweigher result quality :	27
3.8.11	Checkweigher result:	27
3.9	Functional commands	27
3.9.1	Command register :	27
3.9.2	Response register :	28
4	APPENDIX A : CRC-16 CALCULATION ALGORITHM	29

1 INSTALLATION

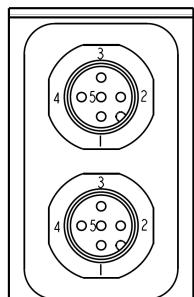
1.1 Connection to RS485 bus

Digital load cell is equipped with a RS485 (half-duplex) interface using Modbus-RTU and SCModbus communication protocols.

Digital load cell can be connected to a RS485 bus using **TA/RA** and **TB/RB** connections which are differently located depending of the digital load cell version :

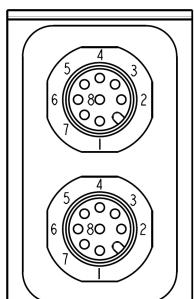


➤ 2 x 5-pins connectors version :



- **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 CAN2.0 A interface. After a reset (hardware or software), digital load cell automatically communicates through this interface. It switches into RS485 communication mode if it receives a new valid Modbus RTU frame.

By default, the baud rate for Modbus-RTU communication is **9600 bauds** and address is **01H**. It can be modified during sensor setting up phase using **eNodView** software.

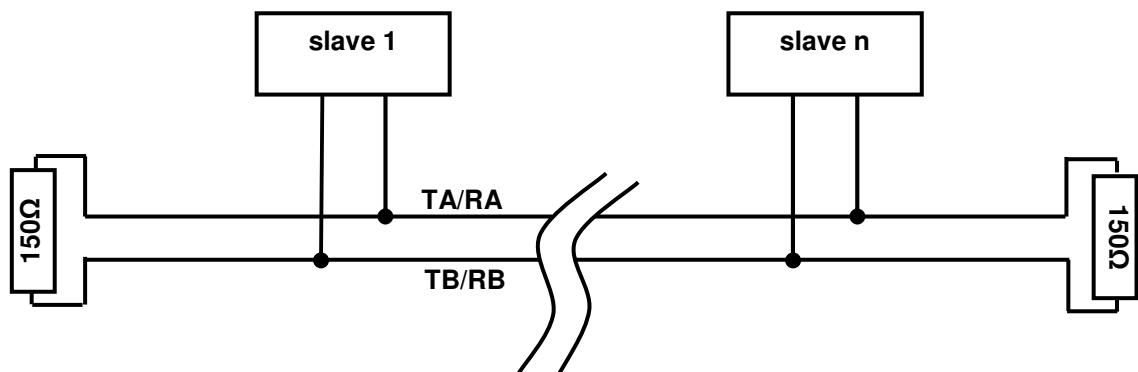
1.2 Topology, bus length and communication baud rate

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

Baud rate	Max 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 $\geq 0.22\text{mm}^2$ (24AWG).
- For bus whose length is greater than 200m, using optocoupler is recommended.
- Line termination :



2 USING MODBUS-RTU COMMUNICATION PROTOCOL

2.1 Byte format :

Bytes are coded in hexadecimal format

- *Format* :

1 start bit

8 data bits without parity

2 stop bits

- *CRC-16* :

CRC-16 polynomial :

$$G(x) = x^{16} + x^{15} + x^2 + 1$$

(cf. Appendix A : CRC-16 calculation algorithm).

2.2 Modbus-RTU compatible functions

Function	Code
read N registers*	03 _H / 04 _H
write 1 register*	06 _H
write N registers*	10 _H

* 1 register = 2 bytes

maximum admitted value for N is 30.

2.3 Frames structure :

- During a read or write transaction, the two bytes of a register are transmitted **MSB first then LSB**.
- If a data is coded on **4 bytes** (that means it requires two registers), **the two LSB are stored in the low address register and the two MSB are stored in the high address register**.

2.3.1 Function (03_H/04_H) – read N input registers (N = 30 max) :

Request command sent to the slave :

slave address	03 _H or 04 _H	starting address	N registers	CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Slave response :

slave address	03 _H or 04 _H	NB *	Data 1	...	CRC16
1 byte	1 byte	1 byte	2 bytes	2 bytes	2 bytes

* NB : number of read bytes (= N*2).

2.3.2 Function (06_H) – write a single register :

Request command sent to the slave :

slave address	06 _H	address	data	CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Slave response :

slave address	06 _H	address	data	CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes

2.3.3 Function (10_H) – preset multiple registers (N = 30 max) :

Request command sent to the slave :

slave address	10 _H	starting address	N registers	NB	Data 1	...	CRC16
1 byte	1 byte	2 bytes	2 bytes	1 byte	2 bytes	2 bytes	2 bytes

Slave response :

slave address	10 _H	starting address	N registers	CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes

2.3.4 Exception codes :

Error frame format :

slave address	function code + 80 _H	error code	CRC16
1 byte	1 byte	1 byte	2 bytes

Error codes meaning :

Error code	Meaning	description
01 _H	illegal function	Modbus-RTU function not supported by sensors
02 _H	illegal data address illegal data value	- register address requested out of sensor register table - forbidden data values
03 _H	Forbidden value	Value noted in data field are not allowed
06 _H	Sensor not ready	Sensor is not ready to answer (for example measurement request during a taring operation)

3 REGISTER MAP :

See the register description in the corresponding §.

Type :	- Uint : unsigned integer coded on 2 bytes - Ulong : unsigned long integer coded on 4 bytes - Long : signed long integer coded on 4 bytes - Float : float simple precision coded on 4 bytes - Int : signed integer coded on 2 bytes
---------------	---

Access :	- R/W : read/write - RO : read only
-----------------	---

- Data storage *** :
- 
- Y : the setting **must** be stored in EEPROM memory. Its new value will be taken into account on next reset.
 - N : The new setting value is **immediately used by the device** and has no need to be stored in EEPROM to be in use.
 - the whole set of parameters except the read-only data can be stored in EPROM. Their values are so preserved if the power supply is disconnected or if reset is requested.

Register address (Hex)	Size in bytes (n)	Type	Name	Access	Storage *
0000	2	Uint	metrological program version	RO	
0001	2	Uint	A/D converter configuration	R/W	Y
0002					
0004					
0006					
0008	26		Reserved		
0009					
000B					
000D					
000F	4	Ulong	span adjusting coefficient	R/W	Y
0011					
0013	12		Reserved		
0015					
0017	4	Ulong	maximum capacity	R/W	N
0019	2	Uint	scale interval	R/W	N
001A	4	Float	scale coefficient	RO	Y
001C					
001E	12		reserved		
0020					
0022	4	long	Zero user calibration	R/W	Y

0024	2	Uint	legal for trade	R/W	Y
0025	2	Uint	legal for trade counter	RO	
0026	2	Uint	legal for trade CRC-16	RO	
0027	2	Uint	zero modes	R/W	Y
0028	2	Uint	motion and self-adaptive filter	R/W	Y
0029	2	Uint	firmware version	RO	
002A	2	Uint	slave address	R/W	Y
002B	2	Uint	communication protocol, functioning mode and treatment	R/W	Y
002C	2	Uint	baud rate selection	R/W	Y
002D	4	Ulong	g coefficient	R/W	Y
002F	4	Ulong	calibration load	R/W	N
0031	2	Uint	text box	R/W	N
0032	4				
0034	2				
0035	2				
0036	2	Uint	logical inputs assignement	R/W	N
0037	2	Uint	logical outputs 1 & 2 assignment	R/W	N
0038	2	Uint	logical outputs 3 & 4 assignment	R/W	N
0039	4	long	set point 1 high value	R/W	N
003B	4	long	set point 1 low value	R/W	N
003D	4	long	set point 2 high value	R/W	N
003F	4	long	set point 2 low value	R/W	N
0041	4	long	set point 3 high value	R/W	N
0043	4	long	set point 3 low value	R/W	N
0045	4	long	set point 4 high value	R/W	N
0047	4	long	set point 4 low value	R/W	N
0049	2	Uint	set points functioning	R/W	N
004A	4				
004C	2				
004D	2				
004E	2				
004F	2				
0050	2				
0051	2				
0052	2		reserved		
0053	2				
0054	4				
0056	4				
0058	4				
005A	2				
005B	2				
005C	2				
005D	2				
005E	4				

0060	4					
0062	4					
0064	4					
0066	2					
0067	2					
0068	2	Uint	dynamic zero acquisition time	R/W	N	
0069	2	Uint	debounce time	R/W	N	
006A	4					
006C	2	Uint	low-pass filter order & band-stop filter activation	R/W	N	
006D	4	float	low-pass filter 1/A coefficient	R/W	N	
006F	4	float	low-pass filter B coefficient	R/W	N	
0071	4	float	low-pass filter C coefficient	R/W	N	
0073	4	float	low-pass filter D coefficient	R/W	N	
0075	4	float	low-pass filter E coefficient	R/W	N	
0077	4	float	band-stop filter X coefficient	R/W	N	
0079	4	float	band-stop filter Y coefficient	R/W	N	
007B	4	float	band-stop filter Z coefficient	R/W	N	
007D	2	Uint	status	RO		
007E	4	long	gross	RO		
0080	4	long	tare	RO		
0082	4	long	net	RO		
0084	4	long	A/D converter points	RO		
0086	4					
0088	4	long	number of complete cycles	RO		
008A	4	long	average value	RO		
008C	4	long	running total	RO		
008E	4	float	standard deviation	RO		
0090	2	Uint	command register	R/W	N	
0091	2	Uint	response register	RO		
0092	2	Uint	logical inputs state	RO		
0093	2	Uint	logical outputs state	RO		
0094	2					
0095	2					
0096	4					
0098	4					
009A	4	Float	Checkweigher result quality	RO		
009C	4	Long	Checkweigher Result	RO		
009E	4	Long	Checkweigher coefficient correction	R/W	N	
00A0	2	Uint	Stabilization time (Ts)	R/W	N	
00A1	2	Uint	Measuring Time (Tm)	R/W	N	
00A2	2	Uint	Dynamic zero acquisition time	R/W	N	
00A3	4	long	Checkweigher trigger level	R/W	N	

3.1 Communication settings

3.1.1 Slave address :

Address	N	Access	Data storage*
002A_H	2	R/W	Y

Format : Admitted values are between 01H and F7H.

Default value : 01H

Description : Sensor address on the network.

3.1.2 Protocols, functioning modes and treatment

Address	N	Access	Data storage*
002B_H	2	R/W	Y

Format :

bits b15,...b0	Function		
bits b9, b8	Protocol		
00	SCMbus	⇒ communication protocol	by default
01	Modbus-RTU		
11	SCMbus fast format		
bit b3	signal processing		
0	performed	⇒ filters activation, set points management and non-linearity correction	by default
1	skipped		
bits b1, b0	functioning mode		
00	transmitter	⇒ application	by default
01	Checkweigher transmit on demand		
10	Automatic checkweigher transmission (SCMbus only)		

Default value : 0101H

Description : this register allows to select :

- the serial communication protocol to use
- the functioning mode
- the filters activation, set points management and non-linearity correction. Skipping this signal processing does not take advantage in Modbus protocol.

3.1.3 Baud rate selection :

Address	N	Access	Data storage
002C_H	2	R/W	Y

Available for RS485 bus and CAN bus.

Format :

bits b15.....b0	Baud rate	
bits b2, b1, b0	R485 bus	
001	9600	default value
010	19200	
011	38400	
100	57600	

101	115200	
bits b10, b9, b8	CAN bus	
001	20K	
010	50K	
011	125K	default value
100	250K	
101	500K	
110	800K	
111	1000K	

Default value : 0301H

3.2 Calibration settings

3.2.1 Span adjusting coefficient :

Address	N	Access	Data storage*
000F _H	4	R/W	Y

Format : the unit for this setting is 1/1000000 (1E-6) that means 1000000d = 1. Maximal and minimal values are 1100000d and 900000d. It corresponds to coefficients equal to 1.1 and 0.9.

Default value : 1000000d

Description : The original calibration can be adjusted with this coefficient that applies on the whole calibration curve.

3.2.2 Maximum capacity :

Address	N	Access	Data storage*
0017 _H	4	R/W	N

Format : admitted values are between 0 and 1000000d.

Default value : 500000d

Description : Capacity corresponds to gross measurement at load cell max capacity, for example : 30000 counts for a 30-kg load cell. This setting is used as part of the '*theoretical scale adjustment*' command.

When the absolute value of the gross measurement plus 9 divisions exceeds the specified capacity, bit b3 of the status register (address 007D_H) is set to 1.

The zero acquisition (on request or at power-up) also is handled only if the gross value is within a ±10% range of the maximum capacity (±2% range in legal for trade).

3.2.3 Scale interval :

Address	N	Access	Data storage*
0019 _H	2	R/W	N

Format : possible value : 1_d, 2_d, 5_d, 10_d, 20_d, 50_d, 100_d.

Default value : 1_d

Description : minimal difference between two consecutive (gross/net) calibrated measurements.

3.2.4 User Scale coefficient :

Address	N	Access	Data storage*
001A _H	4	R/W	/

Format : simple precision float value.

Description : this coefficient is automatically calculated by sensor during one of the calibration procedures : '*Theoretical scale adjustment*' or '*physical scale adjustment*'.

3.2.5 User Calibration zero value :

Address	N	Access	Data storage*
0022 _H	4	R/W	/

Format : admitted values are between 0 et ±1000000d.

Description : value in A/D converter points of the zero reference.

This zero value is acquired after the functional command ‘zero adjustment’ is sent.

3.2.6 Gravity coefficient (g) adjustment :

Address	N	Access	Data storage*
002D _H	4	R/W	Y

Format : Actual value multiplied by 1000000, for example : 9.805 is written 9805000_d

Default value : 959E9E_H = 9,805470 (gravity coefficient of calibration’s place)

Description : As the digital load cell is calibrated in Annemasse (France), depending on the terrestrial geographical coordiantes where the load cell is used, the gravity difference can affect the measurement aptness. In order to compensate this error, it is possible to modify this gravity coefficient to adjust it to the using place.

3.2.7 Calibration load :

Address	N	Access	Data storage*
002F _H	4	R/W	N

Format : admitted values are between 0 and 1000000d.

Default value : 2710_H

Description : 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 scale adjustment’ procedure.

3.3 Filtering parameters

3.3.1 A/D converter configuration :

Address	N	Access	Memorisation *
0001_H	2	R/W	Y

Format/description :

bits b15.....b0	Function	
bit b4	50Hz/60Hz rejection	
0	60Hz	
1	50Hz	default configuration
b8,b7,b6,b5	A/D conversion rate (meas/s)	
	50 Hz rejection	60 hz rejection
0100	6.25	7.5
0011	12.5	15
0010	25	30
0001	50	60
0000	100	120
1100	200	240
1011	400	480
1010	800	960
1001	1600	1920

Default value : 0001_H

3.3.2 Low-pass filter order and band-stop filter activation

Address	N	Access	Data storage*
006C_H	2	R/W	N

Format :

bits b0,...b15	Function	
b2, b1, b0		
000	⇒ low-pass digital filter inactive	
010	⇒ Bessel/Butterworth 2 nd order low-pass digital filter	
011	⇒ Bessel/Butterworth 3 rd order low-pass digital filter	default value
100	⇒ Bessel/Butterworth 4 th order low-pass digital filter	
bit b8		
1	⇒ 2 nd order digital band-stop filter active	
0	⇒ 2 nd order digital band-stop filter inactive	default value

Default value : 0003_H

Description : the filter recurrence relation of these filters are as follows :

- **low-pass filter :**

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

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

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

- **band-stop filter :**

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

Both filter 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 in the same time.

3.3.3 Digital low-pass filter coefficients :

Setting	Address	N	Access	Data storage*
1/A coefficient	006DH	4	R/W	N
B coefficient	006FH	4	R/W	N
C coefficient	0071H	4	R/W	N
D coefficient	0073H	4	R/W	N
E coefficient	0075H	4	R/W	N

Format : simple precision float value.

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 and 100 A/D conversion rate, 10Hz cut off frequency).

Description : The determination of these coefficients can be easily achieved using **eNodView** simulation tools.

3.3.4 Digital band-stop filter coefficients :

Setting	Adresse	N	Access	Data storage*
X coefficient	0077H	4	R/W	N
Y coefficient	0079H	4	R/W	N
Z coefficient	007BH	4	R/W	N

Format : simple precision float value.

Default values : $X = 0,9289047$; $Y = -1,7163921$; $Z = 0,857809$ (These values fit to 400 A/D conversion rate and 50HZ central frequency and a ± 10 Hz band).

Description : The determination of these coefficients can be easily achieved using **eNodView** simulation tools.

3.3.5 Motion criterion and self-adaptive filter activation :

Address	N	Access	Data storage*
0028H	2	R/W	O

Format :

Default value : $002H$

bits b15.....b0	Function		
bits b2, b1, b0	Stability interval		
000	no motion detection	always stable	
001	0,25 d	⇒ d = scale interval	
010	0,5d		default value
011	1d		
100	2d		
bit b8	Self-adaptive filter		
0	inactive		default value
1	active		

Description : Motion is indicated by the b4 bit, set to 1, of the status register (register 007DH).

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 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

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 dosing process. The aim of this filter is to eliminate erratic measurements and to average consistent measurements.

3.4 Logical inputs/outputs configuration

3.4.1 Logical inputs assignment :

Address	N	Access	Data storage*
0036H	2	R/W	N

Format : the MSB byte is assigned to input 2 whereas the LSB byte is assigned to input 1

Default value : 0000H

Description : Depending on the sensor model (2x5-pins or 2x8-pins), there are one or two available logical inputs. Logical inputs can be assigned to the following functions :

bits b0,...b15	Functions		
bits b3 or b11	Logic	b3 = input 1 ; b11 = input 2	
0	negative logic		by default
1	positive logic		
b2, b1, b0 or b10, b9, b8	Assignment	b2, b1, b0 = input 1 / b10, b9, b8 = input 2	
000	none	⇒ inputs have no effect	by default
001	tare	⇒ tare command	
010	zero	⇒ limited to a ±10% range of the capacity or ±2% in legal metrology functioning	
011	Dynamic zero	⇒ in checkweigher mode, start the calculation of a new zero for a specified time, limited to a ±10% range of the capacity.	
100		Reserved	
101	clear	⇒ in transmitter mode, cancels current tare ⇒ in checkweigher mode, cancels results and stops current cycle.	
110	start new cycle	⇒ in checkweigher mode, starts a new cycle on trigger.	
111	stop checkweigher cycle	⇒ On trigger	

Note: In checkweigher mode, if 2 inputs are configured as start new cycle, stop cycle, clear CW result, Input 1 has priority and input 2 is not active.

Moreover, an input assigned to the “start cycle” function has priority on set point.

3.4.2 Inputs holding time :

Address	N	Access	Data storage*
0069_H	2	R/W	N

Format : duration expressed in milliseconds comprised between 0 and 65535d

Default value : 80d

Description : holding 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.

3.4.3 Logical outputs assignment

Setting	Address	N	Access	Data storage*
outputs 1 & 2	0037_H	2	R/W	N
outputs 3 & 4	0038_H	2	R/W	N

Description : depending on the sensors models there are up to 4 logical outputs, which can be assigned to the following functions :

Format : the MSB byte is assigned to output 2 (or 4) whereas the LSB byte is assigned to output 1 (or 3).

bits b15,...b0	Functions	
bits b4 or b12	Logic	b4 assigned to output 1 (or 3) b12 assigned to output 2 (or 4)
0	negative logic	
1	positive logic	
b2, b1, b0 or b10, b9, b8	Assignment	b2, b1, b0 = output 1 (or 3) b10, b9, b8 = output 2 (or 4)
0000	set point	⇒ Set point 1 assigned to Logical output 1 ⇒ Set point 2 assigned to Logical output 2 ⇒ Set point 3 assigned to Logical output 3 ⇒ Set point 4 assigned to Logical output 4
0001	motion	
0010	Checkweigher result available	⇒ Checkweigher mode
0011	cycle in progress	⇒ Checkweigher mode
0100	defective measurement	⇒ Error warning, contain in status assigned to measure.
0101	input 1 (or 2) image	⇒ outputs 1 & 3 are assigned to input 1 ⇒ outputs 2 & 4 are assigned to input 2
0110	level on request	⇒ Level on request in transmitter mode (see command register).

Default values : logical outputs 1 and 2 = 1213_H (1 : positive logic, cycle in progress; 2 : positive logic, result available); logical outputs 3 and 4 = 1010_H (positive logic, set point; 4 : positive logic, set point)

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.

3.4.4 Set points functions :

Address	N	Access	Data storage*
0049 _H	2	R/W	N

Format : the MSB byte is assigned to output 2 (or 4) whereas the LSB byte is assigned to output 1 (or 3).

Default value : 3333_H

bits b15.....b0	Function	Note
b0, or (b8)	Commutation mode set point 1 or (3)	
0	window	
1	hysteresis	by default
b2, b1, b0 or b10, b9, b8	Comparison measurement set point 1 (or 3)	
000	gross value	
001	net value	by default
010	Checkweigher results	
011	Checkweigher running	
100	Result not OK	
b4, (or b12)	Commutation mode set point 2 (or 4)	
0	Window	
1	Hysteresis	by default
b7, b6, b5 or b15, b14, b13	Comparison measurement set point 2 or (4)	
000	gross value	
001	net value	by default
010	Checkweigher results	
011	Checkweigher running	
100	Result not OK	

3.4.5 Set points 1 & 2 high/low and 3 & 4 high/low :

Setting	Address	N	Access	Data storage*
set point 1 high	0039 _H	4	R/W	N
set point 1 low	003B _H	4	R/W	N
set point 2 high	003D _H	4	R/W	N
set point 2 low	003F _H	4	R/W	N
set point 3 high	0041 _H	4	R/W	N
set point 3 low	0043 _H	4	R/W	N
set point 4 high	0045 _H	4	R/W	N
set point 4 low	0047 _H	4	R/W	N

Format : values between 0 and ± 1000000_d

Default values : set point 1 high = 80000_d set point 1 low = 70000_d

set point 1 high = 80000_d set point 1 low = 70000_d

set point 2 high = 60000_d set point 2 low = 50000_d

set point 3 high = 40000_d set point 3 low = 30000_d

set point 4 high = 20000_d set point 4 low = 10000_d

Description : these settings give the high and low limits for each set point. The set points state also depends on the function assigned at the register address 0049_H.

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.

3.4.6 Logical inputs level :

Address	N	Access	Data storage*
0092 _H	2	RO	/

Format/description : binary. b0 bit corresponds to logical input 1, b1 bit corresponds to logical input 2. 0 means low level, 1 means High level.

3.4.7 Logical outputs level :

Address	N	Access	Data storage*
0093 _H	4	RO	/

Format/description : binary. b0 bit corresponds to output 1, b1 bit corresponds to output 2, b2 bit corresponds to output 3 and b3 bit corresponds to output 4.

0 means low level, 1 means High level.

3.5 Legal for trade

3.5.1 Legal for trade firmware version :

Address	N	Access	Data storage*
0000 _H	2	RO	/

Format : Value between 1 and 6535_d

Description: Identification of the firmware version dedicated to measure and legal for trade.

Default value : 0_H

3.5.2 Legal for trade switch :

Address	N	Access	Data storage*
0024 _H	2	R/W	Y

Format : the activation of the settings related to the use of sensor in compliance with legal for trade utilisation is done by **b0 bit setting to 1**.

Default value : 0_H

Description : the activation of this switch has the following effects on the behaviour of the device :

- the legal metrology counter is incremented every time a storage in EEPROM is requested if a metrological setting has been modified.
- a new legal metrology 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 (sensor sends the constant value -1).
- zero acquisition range is reduced from 10% of the capacity maximum to 2%.
- Stability interval is set to 0.25d. It cannot be modified.

Default value : 0_H

3.5.3 Zero modes :

Address	N	Access	Data storage*
0027 _H	2	R/W	Y

Default value : 00_H

Format/description :

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.

3.5.4 Legal for trade CRC-16 :

Address	N	Access	Data storage*
0026H	2	RO	/

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 § 3.5.5 has been modified.

3.5.5 Legal for trade counter :

Address	N	Access	Data storage*
0025H	2	RO	/

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

3.6 Checkweigher settings

See user manual (195752) for more information

3.6.1 Stabilization Time (Ts) in checkweigher mode :

Address	N	Access	Data storage*
00A0H	2	L/E	N

Format : Time Ts in milliseconds, between entre 0 et 65 535_d

Default value: 10000_d

Description : Stabilization time is effective without EEPROM saving.

3.6.2 Measuring Time (Tm) in checkweigher mode:

Address	N	Access	Data storage*
00A1H	2	L/E	N

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.

3.6.3 Acquisition Time and/or Dynamic zero correction :

Address	N	Access	Data storage*
00A2H	2	L/E	N

Format : Time in ms, between 0 and 65535_d. In legal for trade mode, this time could not be less than 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 calculates 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.

Acquisition time is effective without EEPROM saving.

3.6.4 Set point for checkweigher start cycle :

Address	N	Access	Data storage*
00A3H	4	L/E	N

Format : Values between 0 and $\pm 1\ 000\ 000_d$

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.

3.6.5 Checkweigher correction coefficient:

Address	N	Access	Data storage*
$009E_H$	4	L/E	N

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.

3.7 Other settings

3.7.1 Firmware version :

Address	N	Access	Data storage*
0029_H	2	RO	/

Format : read-only value between 1 et 65535_d.

Description : This number identifies the version of the sensor firmware.

3.7.2 Text box :

Address	N	Access	Data storage*
0031_H	2	R/W	N

Format : 2 bytes ASCII values.

Default value : 2020_H

Description : Reserved for the user. Very useful for storage of calibration date or next verification date.

3.8 Measurements

3.8.1 Status register :

Address	N	Access	Data storage*
$007D_H$	2	RO	/

Format: see table below

Description :It gives information on errors, measure status and I/O level.

bits b15,...b0	Function	Notes
b1, b0		
xx	Reserved	
b3,b2		
00	measurement within the admissible range	
01	negative overloading	
10	positive overloading	
11	analog signal out of range	
bit b4		
0	motion	
1	no motion	
bit b5		
0	measurement out of the 1/4 of division	
1	zero in the 1/4 of division	
bit b6		
0	EEPROM OK	
1	EEPROM failure	
bit b7		
1	reserved	
bit b8		
0	input 1 logical state	logical input 1 image
1		
bit b9		
0	input 2 logical state	logical input 2 image
1		
bit b10		
0	output 1 logical state	logical output 1 image
1		
bit b11		
0	output 2 logical state	logical output 2 image
1		
bit b12		
0	output 3 logical state	logical output 3 image
1		
bit b13		
0	output 4 logical state	logical output 4 image
1		
bit b14		
0	no tare	
1	at least a tare has been processed	
bit b15		
1	reserved	

3.8.2 Gross :

Address	N	Access	Data storage*
007E _H	4	RO	/

Format : signed hexadecimal (two's complement).

Description : current gross measurement value.

3.8.3 Tare :

Address	N	Access	Data storage*
0080 _H	4	RO	/

Format : signed hexadecimal (two's complement).

Description : current tare value.

3.8.4 Net :

Address	N	Access	Data storage*
0082 _H	4	RO	/

Format : signed hexadecimal (two's complement).

Description : current net measurement value.

3.8.5 A/D converter points :

Address	N	Access	Data storage*
0084 _H	4	RO	/

Format : signed hexadecimal (two's complement).

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

3.8.6 Number of processed cycles :

Address	N	Access	Data storage*
0088 _H	4	RO	/

Format : signed hexadecimal (two's complement).

Description : The number of complete cycles can be read through this register. This value can be reset by the 'clear' command.

3.8.7 Results average value :

Address	N	Access	Data storage*
008A _H	4	RO	/

Format : signed hexadecimal (two's complement).

Description : The results average value can be read through this register. This value can be reset by the 'clear' command.

3.8.8 Checkweigher running total :

Address	N	Access	Data storage*
008C _H	4	RO	/

Format : signed hexadecimal (two's complement).

Description : The sum of the results is calculated each end of cycle. This value can be reset by the 'clear' command.

3.8.9 Standard deviation :

Address	N	Access	Data storage*
008E _H	4	RO	/

Format : simple precision float value.

Description : The results standard deviation is calculated after each complete cycle. This value can be reset by the 'clear' command, or an input assigned to this function.

3.8.10 Checkweigher result quality :

Address	N	Access	Data storage*
009A _H	4	RO	/

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.

3.8.11 Checkweigher result:

Address	N	Access	Data storage*
009C _H	4	RO	/

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.

3.9 Functional commands

3.9.1 Command register :

Address	N	Access	Data storage*
0090 _H	2	R/W	/

Format/description : the command register is used to send functional commands. To accept a new command, this register must be set in idle state (by writing 00_H), see also response register.

Code	Function	Note
0000 _H	set the command register into the IDLE state	⇒ Important : must be written before any other functional command
00D0 _H	reset	⇒ similar to the power-up
00D1 _H	EEPROM storage	⇒ saves the whole settings table into the EEPROM memory
00D2 _H	restores sensor default configuration	⇒ Warning : all the default settings are recovered including the stored calibration
00D3 _H	zero	⇒ Measurements must be stable, if stability is not got after 5 s, command is aborted. ⇒ limited to a ±10% range of the maximum capacity or ±2% in legalfor trade functioning
00D4 _H	tare	⇒ Measurements must be stable, if stability is not got after 5 s, command is aborted.
00D6 _H	abort calibration	⇒ allows to leave the calibration procedure

00D7H	Theoretical scale adjustment	⇒ must be followed by the 'save calibration' command (00DEH)
00D8H	zero adjustment	⇒ calibration zero acquisition ; must be followed by the 'save calibration' command (00DEH) ⇒ or by the 'physical calibration adjustment' command
00ECH	physical calibration adjustment	⇒ must be preceded by 'zero adjustment' command ⇒ the calibration load corresponds to the number assigned to 'calibration load'
00DEH	save calibration (end of calibration procedure)	⇒ stores the calibration values into EEPROM
00DFH	clear	⇒ stops current cycle and resets all the calculated variables
00E4H	start CW cycle	⇒ starts a new cycle
00E5H	stop CW cycle	⇒ Stops current cycle
00E6H	cancel tare	⇒ erases last tare value
00E7H	set logical output 1	⇒ Transmitter functioning mode only if logical output is set to 'programmed mode'
00E8H	set logical output 2	⇒ To send this command a first time sets corresponding logical output (according to chosen state), a second command toggles it and so on.
00E9H	set logical output 3	
00EAH	set logical output 4	
00EDH	dynamic zero	⇒ zero determination without stability criterion calculated during the 'dynamic zero time' ⇒ limited to a ±10% range of the maximum capacity

3.9.2 Response register :

Address	N	Access	Data storage*
0091H	2	RO	N

Format/description : indicates the functional command state.

The idle mode (see command register @ 0090H) clear this register. It is recommended to put sensor in idle mode before to execute any other command.

This register gives the opportunity to follow the sequence of a non-determinist command (Zero or tare for example).

Code	Function	Note
0000H	command register in IDLE state	see command register @ 0000H
0001H	command execution in progress	
0002H	command execution complete	
0003H	Error/ unable to achieve requested command	

4 APPENDIX A : CRC-16 CALCULATION ALGORITHM

Note : the CRC-16 is calculated on the whole frame. Contrary to the bytes contained in the frame the first transmitted byte of the CRC-16 is the LSB.

