Modbus specifications for Digital Sensors

SIGNATURES

WRITTEN BY	APPROVED BY
NAME: FREDERIC RENAUD/ FB	NAME: SEVERINE VARY

REVISION HISTORY

REVISIONS	DATE	ACTION	CHANGE IDENTIFICATION
001	15/11/2007	Issue	
002	17/01/07		Calibration validation, addition on sensor detection
003	26/03/08		Addition concerning error messages and dialogues between masters and sensors
004	28/8/2008		Example of a Modbus frame
005	9/9/2008		Modification of the addressing
006	16/10/2008		Improvement of layout
007	14/11/08		Translation in English
008	9/12/2008		Addition new Modbus adresses
009	08/01/2009		Addition of pictures
010	30/01/2009		Addition of software pictures
011	08/10/2012		Addition of OPTOD calibration for gain adjustment only
016	25/06/2013		Small corrections on the frames, float format Sensors answer to the address 255
017	17/09/2013		Correction of the Modbus adress 0x00AA to 0x0002 page 12 Adding of the frame at the address 0x004C (page 23)
018	24/06/2013		Answer of the sensors to the address 255, calibration of the annular ORP sensor and Turbidity/Sludge blanket detection sensor.
019	06/09/2016		Addition of calibrations pH in several points
020	29/03/17	Update	all the document (table of content)
021	4/4/2017		Minor correction

Table of content

1 PREAMBLE : reference documents and tools

1.1 Link protocol frame: MODBUS RTU

The link protocol must correspond to MODBUS RTU.
See documents:

- Modbus memory plane for digital sensors : ***Digital sensor Frame_xxx.xls***

--> access with http://www.ponsel.fr/cbx/s4_cat1522.htm

- The specification for the modbus-Ponsel integrator : : **Specification_Modbus_Vxxx-EN.pdf**

--> via http://www.ponsel.fr/cbx/s4_cat1522.htm

- ***Modbus_over_serial_line_V1_02.pdf***
--> access with http://www.modbus.org/specs.php

- ***Modbus_Application_Protocol_V1_1a.pdf***
--> access with http://www.modbus.org/specs.php

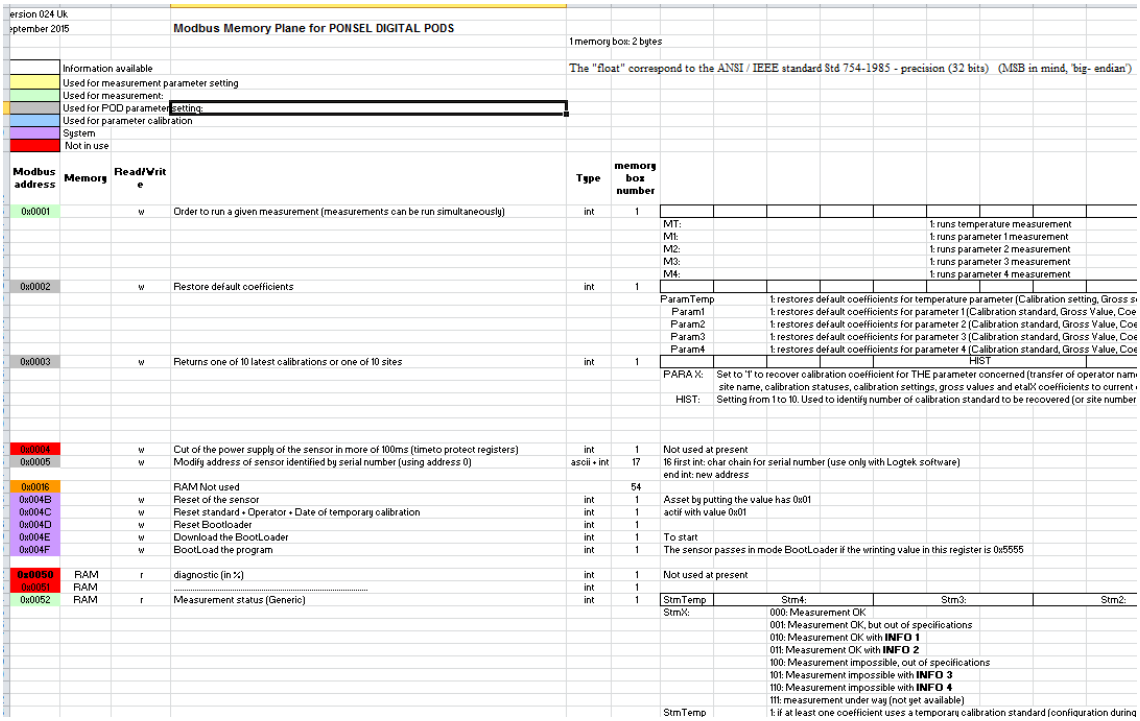
The Modbus memory plane is identical for each parameter of the sensors.

The Modbus protocol for the sensors allows you to measure the parameters, until 4 plus temperature, of the Sensor and to calibrate the parameters and temperature.
Furthermore, there are certain numbers of functions such as:

- Select the averaging value
- Read the Sensor description (serial number, hardware and software versions),
- Select the measurement range, if it is available.
- Return to default coefficients
- Modify the Sensor address,
- Use of external data for compensation
- Information on measures conducted (Out Of Specification measures, measures in progress, etc.).
- Date and name of the operator who performed the calibration,
- Log of the 10 lastest calibration data
- Call back of calibration data,
- Power supply value (available only for the lastest sensors).

1.2 Overview of the memory plane

See Modbus memory plane for digital sensors: ***Digital sensor Frame_xxx.xls***, in the « general information » sheet. In this document, one Modbus address is linked to functionality with the types of variables.



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Modbus Memory Plane for PONSEL DIGITAL PODS

1 memory box: 2 bytes

Information available
Used for measurement parameter setting
Used for measurement:
Used for POD parameter setting:
Used for parameter calibration
System
Not in use

The "float" correspond to the ANSI / IEEE standard Std 754-1985 - precision (32 bits) (MSB in mind, 'big- endian')

Modbus address	Memory	Read/Write		Type	memory box number	
0x0001		w	Order to run a given measurement (measurements can be run simultaneously)	int	1	MT: 1: runs temperature measurement M1: 1: runs parameter 1 measurement M2: 1: runs parameter 2 measurement M3: 1: runs parameter 3 measurement M4: 1: runs parameter 4 measurement
0x0002		w	Restore default coefficients	int	1	ParamTemp 1: restores default coefficients for temperature parameter (Calibration setting, Gross s Param1 1: restores default coefficients for parameter 1 (Calibration standard, Gross Value, Coe Param2 1: restores default coefficients for parameter 2 (Calibration standard, Gross Value, Coe Param3 1: restores default coefficients for parameter 3 (Calibration standard, Gross Value, Coe Param4 1: restores default coefficients for parameter 4 (Calibration standard, Gross Value, Coe
0x0003		w	Returns one of 10 latest calibrations or one of 10 sites	int	1	HIST PARA X: Set to '1' to recover calibration coefficient for THE parameter concerned (transfer of operator nam site name, calibration statuses, calibration settings, gross values and etalX coefficients to current HIST: Setting from 1 to 10. Used to identify number of calibration standard to be recovered (or site number
0x0004		w	Cut of the power supply of the sensor in more of 100ms (timeto protect registers)	int	1	Not used at present
0x0005		w	Modify address of sensor identified by serial number (using address 0)	ascii + int	17	16 first int: char chain for serial number (use only with Logtek software) end int: new address
0x0016			RAM Not used		54	
0x004B		w	Reset of the sensor	int	1	Asset by putting the value has 0x01
0x004C		w	Reset standard + Operator + Date of temporary calibration	int	1	actif with value 0x01
0x004D		w	Reset Bootloader	int	1	
0x004E		w	Download the BootLoader	int	1	To start
0x004F		w	BootLoad the program	int	1	The sensor passes in mode BootLoader if the wrinting value in this register is 0x5555
0x0050	RAM	r	diagnostic (in %)	int	1	Not used at present
0x0051	RAM		.....	int	1	
0x0052	RAM	r	Measurement status (Generic)	int	1	StmTemp Stm4: Stm3: Stm2: StmX: 000: Measurement OK 001: Measurement OK, but out of specifications 010: Measurement OK with **INFO 1** 011: Measurement OK with **INFO 2** 100: Measurement impossible, out of specifications 101: Measurement impossible with **INFO 3** 110: Measurement impossible with **INFO 4** 111: measurement under way (not yet available) StmTemp 1: if at least one coefficient uses a temporary calibration standard (configuration during

Figure 1: extract of ***Digital sensor Frame_xxx.xls*** *document*

1.3 Parameters in detail

See Modbus memory plane for digital sensor: ***Digital sensor Frame_xxx.xls***, in the « *sensor* » sheet.
In this document, each sensor has a dedicated sheet, OPTOD, Conductivity-C4E, etc.

Each sheet gives detailed information about:

- Sensor description,
- Default factory address,
- Serial number format,
- Parameters and unity of the sensor,
- Useful external data for compensation,
- Measurement range description,
- Measurement status description,
- Standard solutions and coefficients for calibration steps.

	POD description	"ODO / Temperature PONSEL "
	default address	10
	serial number	SN-PODOA-xxxxx
	Default averaging value	1

		Temperature measurement	Parameter 1	Parameter 2	Parameter 3	Parameter 4
	Parameter measurement:	Temperature	Oxygen	Oxygen	Oxygen	NU
	Unit:	°C	%Sat	mg/L	ppm	NU
	Managed by history or by site:	historical	historical	historical	historical	NU
	Compensates Temperature returned by Master	These compensations are not used for this measurement.	in use, in °C, Default value (when Pod switched on: 25°C)			NU
	Compensates 1 returned by Master		Atmospheric pressure, in hPa, Default value (when Pod switched on: 1013hPa).			NU
	Compensates 2 returned by Master		Salinity, in ppt, Default value (when Pod switched on: 0 ppt).			NU
	Compensates 3 returned by Master	NU				
Measurement configuration:		In use	Used for Parameters 1, 2 and 3.	NU	NU	NU
Configures measurement type.	differed Mode in use:	NO	NO	NU	NU	NU
	corrected measurement (default value	returns measurement	returns measurement	NU	NU	NU
	corrected measurement 1:	NU				
	corrected measurement 2:	NU				
	gross measurement:	NU				
	Range configuration: CgGamme	NU				
Measurement status:		In use	In use	In use	In use	NU
Measurement status	Measurement OK with INFO 1	NU	Measurement disrupted	Measurement disrupted	Measurement disrupted	NU
	Measurement OK with INFO 2	NU	NU	NU	NU	NU
	Measurement impossible with INFO 3	NU	Tablet missing	Tablet missing	Tablet missing	NU
	Measurement impossible with INFO 4	NU	NU	NU	NU	NU

Figure 2: extract of OPTOD sensor sheet in ***Digital sensor Frame_xxx.xls*** *document ; measurement configuration*

Description of calibration coefficients : all coefficients are based on default coefficient.

	Information:	Unit:	Coefficient used for parameter:	Comments:
Offset Temp Coefficient	Temperature offset	°C	Temperature	
Temp Slope Coefficient	Temperature slope	%	Temperature	
Coef 1	Offset ('A')	Gross Unit	Parameter 1	Coefficient can be calibrated by integrator.
Coef 2	'B'		Paramètre 1	Coefficient calculé seulement en USINE
Coef 3	'C'		Paramètre 1	Coefficient calculé seulement en USINE
Coef 4	Pente ('D')	Gross Unit	Parameter 1	Coefficient can be calibrated by integrator.
Coef 5	'E'		Parametre 1	Coefficient calculé seulement en USINE
Coef 6	'F'		Parametre 1	Coefficient calculé seulement en USINE
Coef 7	NU			Gross value for temporary use
Coef 8	NU			Gross value for temporary use
Coef 9	NU			Gross value for temporary use
Coef 10	NU			
Coef 11	NU			
Coef 12	NU			
Coef 13	NU			
Coef 14	NU			
Coef 15	NU			
Coef 16	NU			

Description of calibration standards :

	Master returns:	Unit:	Calibration standard used for parameter:	Comments:
calibration standard 1 for temperature	Calibration standard value (offset):	°C	Temperature	
calibration standard 2 for temperature	Calibration standard value (slope)	°C	Temperature	
standard 1	0x00		Parameters 1, 2 and 3 : Oxygen	Sensor must be in the sulfite at stabilized temperature T1, between 5 and 25 °C.
standard 2	0x00		Parameters 1, 2 and 3 : Oxygen	
standard 3	Calibration standard value	%	Parameters 1, 2 and 3 : Oxygen	
standard 4	0x00		Parameters 1, 2 and 3 : Oxygen	Sensor must indicate 100% (when exposed to air) at stabilized temperature T1, between 5 and 25 °C.
standard 5	0x00		Parameters 1, 2 and 3 : Oxygen	
standard 6	0x00		Parameters 1, 2 and 3 : Oxygen	
standard 7	NU			
standard 8	NU			
standard 9	NU			
standard 10	NU			
standard 11	NU			
standard 12	NU			
standard 13	NU			
standard 14	NU			
standard 15	NU			
standard 16	NU			

*Figure 3: extract of OPTD sensor sheet in **Digital sensor Frame_xxx.xls** document; coefficients and standard*

1.4 Hardware configuration:

Transmission medium:	RS485 half-duplex
Bauds rate :	9600
data bits :	8
Parity and stop bit : (modified by the Modbus address 0x00BC)	- 2 stop bit and no parity (default factory settings) - 1 stop bit and even parity, - 1 stop bit and odd parity,

IMPORTANT NOTE:
If a digital sensor is not configured 2 stop bits, it can no longer communicate with the Calsens software or an Odeon handheld meter.

1.5 Addresses:

The sensors have an address with a value between **1 and 230**.
Addresses between 231 and 247 are reserved for the manufacturer.
The Modbus protocol requires that the address 0 is not used, as well as the addresses 248 to 255.

All the sensors process information when the master calls the 0 address.
IMPORTANT NOTE:
The sensors never respond when the master sends a frame to the 0 address.

All the sensors handle the information and answer when master calls up to the address ' 255 '.
IMPORTANT NOTE:
This feature must be only used with 1 only sensor connected to the network, otherwise there will be a conflict between the various Sensors.

Each sensor has a default factory address, which is allocated by the Modbus memory plane file.

1.6 Modbus functions used:

The sensors process 4 Modbus functions:

- 0x03: Reading of n consecutive output words (from 1 to 125 bytes).
- 0x06: Writing of 1 output word.
- 0x10: Writing of n output words; use this function when there are at least 2 consecutive registers.
- 0x11: Identification reading. The Sensor returns its description (Modbus address : 0x0D00).

IMPORTANT NOTE:
The Identification function is used to perform a scan on the Modbus network. This is because the Identification function uses the shortest communication form. As such the scanning time for all the addresses is optimized.

IMPORTANT NOTE:
The "float" corresponds to the ANSI / IEEE standard Std 754-1985 - precision (32 bits); (MSB in mind, 'big- endian')

REMARK:
Integrators have access to 10 bytes in read/write in Flash. (Send: of 0x02D2 has 0x02D6 included)

1.7 Equipment useful for integrating the digital Sensors :

Basic kit:

- Tools :
  - A RS485/USB converter with 1 sensor input,
  - A stabilized power supply 5V to12V DC,
  - One digital probe.

- Documentations :
  - The Modbus memory plane : Digital sensor Frame_xxx.xls
  - This document.

IMPORTANT NOTE:

Before implementation of sensors in an already deployed measurement system (sensors network with PLC, SCADA…), the manufacturer recommends a first communication trial with a computer as master.

The manufacturer recommends the use of 4200 DIGITAL MODULE with one or two sensors inputs as RS485/USB converter.

Number of input	PONSEL Converter reference
1	NC-FIX-C-00020
2	NC-FIX-C-00021

IMPORTANT NOTE:

SENSOR consumption in standby is between 10 and 40 µA depending on the setting of the Sensor. For more information consult the datasheet of the sensor.
This can help ensure that the sensor is powered.

REMARK:

The most commonly occurring problem is the use of a not efficient RS485/USB converter regarding RTS signal management. This one permits the release of the line, move to high impedance state, for the activity of the slave (sensor).

Software tool :

The manufacturer gives access to CALSENS software. This Windows software, installed on your computer, will help you to check the communication with sensors.

This software realizes real time measurements and calibration of various parameters.

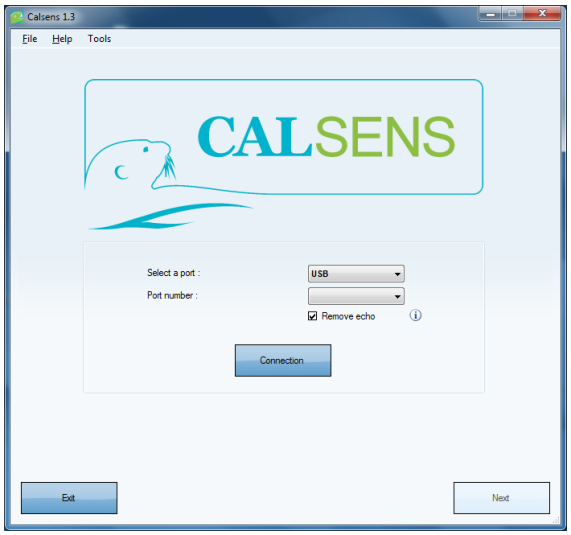
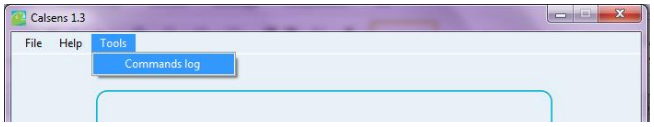


Figure 4 : view of CALSENS software

REMARK:
Don't forget the driver installation of the converter 4200 DIGITAL MODULE. This driver is delivered with the converter on the compact disk.

REMARK:
Please check the communication port used for the converter. See system in the configuration panel.

In order to facilitate integration of digital sensor in the system, you could see the frames generated by the computer and the request from the sensor in a dedicated window. In that way, choose in the CALSENS menu, *Tools/Commands log*.



Example:

In the figure below, in the red square, you could see the frames of the description of a conductivity sensor during a scan of the network.

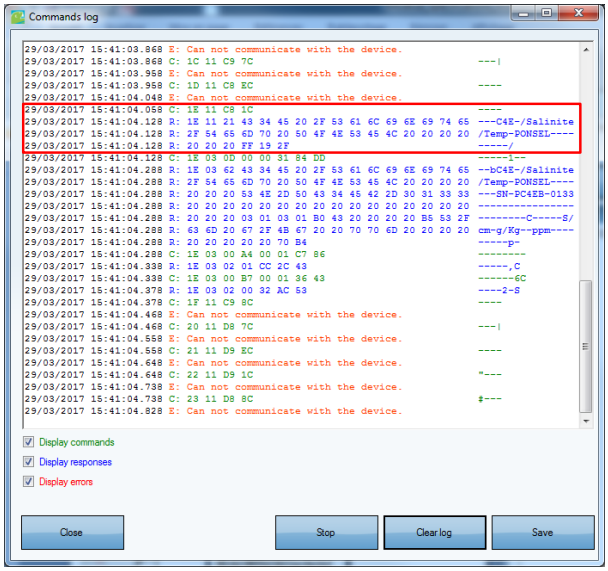


Figure 5: extract of CALSENS software ; Commands log

This specification explains a Calibrations, Measures, ... as short as possible.
Calsens is more complete because it displays additional information, more advanced. (more frame modbus)

1.8 Modbus error messages:

For the error codes, used:

- When the sensor returns the error code “FF”. There is a communication problem.
- When the sensor returns the error code “01”. The function code is not recognized by the Sensor.
- When the sensor returns the error code “02”. The address is not valid.
- When the sensor returns the error code “03”. The data format is incorrect.
- When the sensor returns the error code "04". The sensor is in failure mode (supply voltage too low, ...)

2 Basic measurement: sequence and frame

2.1 Sampling delay:

This is the time between measurement command and new data availability

For a defined sensor, this delay does not change. In a general point of view, this delay is less than 2 seconds.

At Initialization step, you should request the sampling delay to obtain all the measures (value in ms):

@ 0x00A4

In the file "Digital sensor Frame_xxx.xls"

0x00A4	Flash	r	Approx Time needed to obtain all measurements	int	1	in ms

2.2 Measurement command

To obtain a measure from the sensor, the master must realized a sequence of communication.

Measurement command for a defined parameter

In the file "Digital sensor Frame_xxx.xls" : **@ 0x0001**

0x0001		w	Order to run a given measurement (measurements can be run simultaneously)	int	1								
						MT:				1: runs temperature measurement			
						M1:				1: runs parameter 1 measurement			
						M2:				1: runs parameter 2 measurement			
						M3:				1: runs parameter 3 measurement			
						M4:				1: runs parameter 4 measurement			

Waiting the known sampling delay

The master must wait a **minimum delay to obtain a measure**. This delay is the value at **@ 0x00A4** address. This delay is the necessary time for the sensor to realize the measurements.

Measurement collecting

In the file "Digital sensor Frame_xxx.xls" : **@ from 0x0053 to 0x005B**

0x0053	RAM	r	Temperature measurement	float	2
0x0055	RAM	r	Parameter 1 measurement	float	2
0x0057	RAM	r	Parameter 2 measurement	float	2
0x0059	RAM	r	Parameter 3 measurement	float	2
0x005B	RAM	r	Parameter 4 measurement	float	2

Example:

In this case, the master collects the delay value, 500ms (0x01F4)
It sends the order for 5 measures (0x001F)
It waits the necessary delay: *10:58:39:550 - 10:58:38:970 =* ***580ms.***
It collects the five measures:
(0x41A9C710-0x41034BE8-0x00000000-0xC2826508-0x00000000**)**
Temperature: 21.22°C
Parameter #1: 8.206
Parameter #2: 0.00
Parameter #3: -65.197
Parameter #4: 0.00

Initialization
10:30:22:630 – frame sent : (8 octets) : 0x04-0x03-**0x00-0xA4**-0x00-0x01-0xC5-0xBC
10:30:22:670 – received frame : (7 octets) : 0x04-0x03-0x02-**0x01-0xF4**-0x74-0x53

Command for 5 measures
10:58:38:930 - frame sent : (11 octets) : 0x04-0x10-**0x00-0x01**-0x00-0x01-0x02-**0x00-0x1F**-0xD9-0x19
10:58:38:970 - received frame : (8 octets) : 0x04-0x10-0x00-0x01-0x00-0x01-0x50-0x5C

Measurement collecting (5 parameters) :
10:58:39:550 - frame sent : (8 octets) : 0x04-0x03-**0x00-0x53**-0x00-0x0A-0x35-0x89
10:58:39:600 - received frame : (25 octets) : 0x04-0x03-0x14-**0x41-0xA9-0xC7-0x10**-0x41-0x03-0x4B-0xE8-**0x00-0x00-0x00-0x00-0x00**-0xC2-0x82-0x65-0x08-**0x00-0x00-0x00-0x00-0x00**-0xCC-0xA8

3 Full measurement: sequence and frame

3.1 Full sequence:

Initialization, collecting the sampling delay

For a defined sensor, this delay does not change.

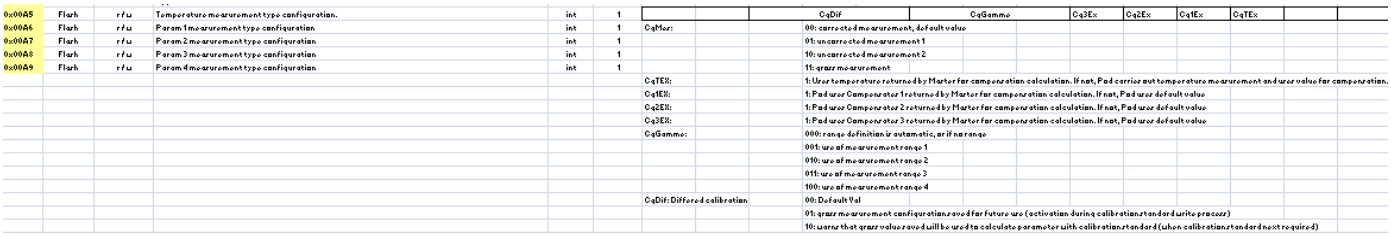
In the file "Digital sensor Frame_xxx.xls" **@ 0x00A4**

0x00A4	Flash	r	Approx Time needed to obtain all measurements	int	1	in ms

Measurement configuration

Using the registers of configuration, you can modify the measurement range and activate external values for compensation.

In the file "Digital sensor Frame_xxx.xls" : **@ from 0x00A5 to 0x00A9**



0x00A5	Flash	r/w	Temperature measurement type configuration.	int	1		CqDif	CqGamme	Cq3Ex	Cq2Ex	Cq1Ex	CqTEx		
0x00A6	Flash	r/w	Param 1 measurement type configuration.	int	1	CqMes:	00: corrected measurement, default value							
0x00A7	Flash	r/w	Param 2 measurement type configuration.	int	1		01: uncorrected measurement 1							
0x00A8	Flash	r/w	Param 3 measurement type configuration.	int	1		10: uncorrected measurement 2							
0x00A9	Flash	r/w	Param 4 measurement type configuration.	int	1		11: grazz measurement							
						CqTEX:	1: Ural temperature returned by Master for compensation calculation. If not, Pad carrier aut temperature measurement and urer value for compensation.							
						CqEX:	1: Pad urer Compensator 1 returned by Master for compensation calculation. If not, Pad urer default value							
						Cq2EX:	1: Pad urer Compensator 2 returned by Master for compensation calculation. If not, Pad urer default value							
						Cq3EX:	1: Pad urer Compensator 3 returned by Master for compensation calculation. If not, Pad urer default value							
						CqGamme:	000: range definition ir automatic, or if no range							
							001: ure af measurement range 1							
							010: ure af measurement range 2							
							011: ure af measurement range 3							
							100: ure af measurement range 4							
						CqDif: Differed calibration	00: Default Val							
							01: grazz measurement configuration zaved for future ure (activation during calibration standard urite procezz)							
							10: usene that grazz value zaved will be ured to calculate parameter with calibration standard (when calibration standard next required)							

In this case, for the master the sequence is the following??

Sending one or more external data for compensation

Write the compensation value in the suitable location.
This feature is only useful if the measure must be compensated with a external data.

In the file "Digital sensor Frame_xxx.xls" : **@ from 0x005D to 0x0061**

0x005D	RAM	r / w	Compensates Temperature returned by Master	float	2	Default Val: 25°C
0x005F	RAM	r / w	Compensates 1 returned by Master (external parameter for calculation of compensation)	float	2	
0x0061	RAM	r / w	Compensates 2 returned by Master (external parameter for calculation of compensation)	float	2	

IMPORTANT NOTE:
For activating this feature, you must make a suitable measurement configuration.

Measurement command for a defined parameter
In the file "Digital sensor Frame_xxx.xls" : **@ 0x0001**

0x0001		w	Order to run a given measurement (measurements can be run simultaneously)	int	1							
						MT:				1: runs temperature measurement		
						M1:				1: runs parameter 1 measurement		
						M2:				1: runs parameter 2 measurement		
						M3:				1: runs parameter 3 measurement		
						M4:				1: runs parameter 4 measurement		

Waiting the known sampling delay

The master must wait a minimum delay to obtain a measure. This delay is the value at **@ 0x00A4** address. This delay is the necessary time for the sensor to realize the measurements.

REMARK :

To avoid any risk of measurement perturbation, the manufacturer suggests to limit commands to sensors during the sampling delay.

Checking the availability of a new measure

By reading the status, you know the current state of the measurement.

- Measurement running,
- New Measure ready
- Measurement with info 1, 2, 3 or 4.
- Measurement out of range, etc.

In the file "Digital sensor Frame_xxx.xls" : **@ 0x0052**

0x0052	RAM	r	Measurement status (Generic)	int	1	StmTemp	Stm4:	Stm3:	Stm2:
						StmX:	000: Measurement OK		
							001: Measurement OK, but out of specifications		
							010: Measurement OK with **INFO 1**		
							011: Measurement OK with **INFO 2**		
							100: Measurement impossible, out of specifications		
							101: Measurement impossible with **INFO 3**		
							110: Measurement impossible with **INFO 4**		
							111: measurement under way (not yet available)		
						StmTemp	1: if at least one coefficient uses a temporary calibration standard (configuration during calibration)		

Measurement collecting

In the file "Digital sensor Frame_xxx.xls" : **@ from 0x0053 to 0x005B**

0x0053	RAM	r	Temperature measurement	float	2
0x0055	RAM	r	Parameter 1 measurement	float	2
0x0057	RAM	r	Parameter 2 measurement	float	2
0x0059	RAM	r	Parameter 3 measurement	float	2
0x005B	RAM	r	Parameter 4 measurement	float	2

Status collecting for each measurement

The status gives information about measurement (current range, calibration coefficients used).

In the file "Digital sensor Frame_xxx.xls" : **@ from 0x0064 to 0x0068**

0x0064	RAM	r	Temperature measurement status	int	1					
0x0065	RAM	r	Parameter 1 measurement status	int	1	Stm:		See StmX		
0x0066	RAM	r	Parameter 2 measurement status	int	1	StmTemp:		1: if at least one parameter coefficient uses a temporary calibration standard (configuration during calibration)		

0x0067	RAM	r	Parameter 3 measurement status	int	1	StmHF:		1: if at least one parameter coefficient is outside calibration limits
0x0068	RAM	r	Parameter 4 measurement status	int	1	StmCU:		1: if all parameter coefficients use default coefficient
						StmHIST:		1: if all parameter coefficients use history coefficient

Example :

In this case, the master collects the delay value, 500ms (0x01F4)

It configures five measures:
* temperature measurement : 0x0000 - default value => no external compensation for this measure.
* parameter 1 : 0x0210 - range 2 activated => temperature compensation activated for this measure.
* parameter 2 : 0x0200 - range 2 activated => no external compensation for this measure.
* parameter 3 : 0x0000 - default value => no external compensation for this measure.
* parameter 4 : 0x0000 - default value => no external compensation for this measure.

It transmits the temperature value from external device: **22.5°C** (0x41B40000)

It sends the order for 5 measures (0x001F)

It waits the necessary delay: 12:19:55:360 - 12:19:55:930 = **570ms.**

It checks that the measurement is done (new value ready): 0x0209
* temperature status: 0b001 - measurement ready but out of range.
* parameter 1status : 0b001 - measurement ready but out of range.
* parameter 2status : 0b000 - measurement ready and OK.
* parameter 3 status : 0b001 - measurement ready but out of range.
* parameter 4 status : 0b000 - measurement ready and OK.

It collects the five measures:
0x41C28650-0x4083475F-0x80000000-0x432D73EA- 0x00000000

Temperature : 24.32°C
Parameter #1 : 4.102
Parameter #2 : 0.00
Parameter #3 : 173.45
Parameter #4 : 0.00

It collects the status of each measurement:
0x0001-0x0221-0x0200-0x0201-0x0000
* temperature status: 0b001 - measurement OK but out of range.
* parameter 1status : 0x0221- measurement OK but out of range ; all calibration coefficients used are from factory calibration ; range 2 activated
* parameter 2 status : 0x0200- measurement OK; range 2 activated
* parameter 3 status : 0x0201- measurement OK but out of range ; range 2 activated
* parameter 4 status: 0x0000- measurement OK.

Initialization, sampling delay
12:19:55:139 - frame sent : (8 octets) : 0x04-0x03-**0x00-0xA4**-0x00-0x01-0xC5-0xBC
12:19:55:160 - received frame : (7 octets) : 0x04-0x03-0x02-**0x01-0xF4**-0x74-0x53

Initialization, measurement configuration

12:19:55:180 - frame sent : (19 octets) : 0x04-0x10-**0x00-0xA5**-0x00-0x05-0x0A-**0x00-0x00-0x02-0x10-0x02-0x00-0x00-0x00-0x00-0x00**-0x26-0xF6
12:19:55:230 - received frame : (8 octets) : 0x04-0x10-0x00-0xA5-0x00-0x05-0x10-0x7C

Temperature compensation, use of external value :
12:19:55:250 - frame sent : (13 octets) : 0x04-0x10-**0x00-0x5D**-0x00-0x02-0x04-**0x41-0xB4-0x00-0x00**-0x72-0xDC
12:19:55:290 - received frame : (8 octets) : 0x04-0x10-0x00-0x5D-0x00-0x02-0xD0-0x4F

Command for 5 measures
12:19:55:310 - frame sent : (11 octets) : 0x04-0x10-**0x00-0x01**-0x00-0x01-0x02-**0x00-0x1F**-0xD9-0x19
12:19:55:360 - received frame : (8 octets) : 0x04-0x10-0x00-0x01-0x00-0x01-0x50-0x5C

Status collecting basic measurements :
12:19:55:930 - frame sent : (8 octets) : 0x04-0x03-**0x00-0x52**-0x00-0x01-0x25-0x8E
12:19:55:960 - received frame : (7 octets) : 0x04-0x03-0x02-**0x02-0x09**-0xB5-0x22

Measurement collecting (5 parameters) :
12:19:55:980 - frame sent : (8 octets) : 0x04-0x03-**0x00-0x53**-0x00-0x0A-0x35-0x89
12:19:56:040 - received frame : (25 octets) : 0x04-0x03-0x14-**0x41-0xC2-0x86-0x50**-0x40-0x83-0x47-0x5F-**0x80-0x00-0x00-0x00**-0x43-0x2D-0x73-0xEA-**0x00-0x00-0x00-0x00**-0x17-0xCB

Full status collecting :
12:19:56:060 - frame sent : (8 octets) : 0x04-0x03-**0x00-0x64**-0x00-0x05-0xC4-0x43
12:19:56:110 - received frame : (15 octets) : 0x04-0x03-0x0A-**0x00-0x01**-0x02-0x21-**0x02-0x00**-0x02-0x01-**0x00-0x00**-0xC4-0x62

3.2 Measurement Averaging frame

REMARK:
No averaging for Temperature parameter. Averaging value is applied to parameters 1 to 4.
Averaging value is in the range 1 to 50.
When the master changes the averaging value, the sensor initializes all the data in the averaging table. But, in contrast, when power supply is shutting down, the sensor saves data in order to process averaging.

In the file "Digital sensor Frame_xxx.xls" : **@ from 0x00AA**

0x00AA	Flash	r / w	Averaging value for all parameters except temperature.	int	1

Example:
The master modifies the averaging value to 10. (0x000A)

10:38:17:860 – frame sent : (11 octets) : 0x04-0x10-**0x00-0xAA**-0x00-0x01-0x02-**0x00-0x0A**-0x01-0x0D 10:38:17:900 – received frame : (8 octets) : 0x04-0x10-0x00-0xAA-0x00-0x01-0x21-0xBC

3.3 Restore default calibration coefficients frame

In the file "Digital sensor Frame_xxx.xls" : **@ from 0x0002**

0x0002		w	Restore default coefficients	int	1

This feature permits to come back to default calibration coefficients *i.e.* factory calibration coefficients. It could be useful when an error has been done during calibration process.

Example:
The master restores default coefficients for parameter #1 only. (0x0002)

11:09:08:520 – frame sent : (11 octets) : 0x04-0x10-0x00-0x02-0x00-0x01-0x02-**0x00-0x02**-0x19-0x23 11:09:08:570 – received frame: (8 octets) : 0x04-0x10-0x00-0x02-0x00-0x01-0xA0-0x5C

4 Sensor calibration: sequence and frame

4.1 General comments :

For full calibration or calibration of a single coefficient, the coefficient(s) to be modified are only processed by the Sensor when the master sends the name of the operator and the date in the Temporary calibration.

The measures sent by the sensor are processed using "current coefficients". As long as the calibration process was not validated, the new coefficients are stored in "temporary calibration".

4.2 Modbus frames

For more details, see annex 1.

- 170 : Calculate a given calibration point.
- 180 : Special case of a calibration, offset of ORP, request for forced electronic zeroing of ORP.
- 190 : Special case of the calibration point, offset of ORP, request calculate the calibration coefficient and to remove forcing of electronic zeroing.
- 200 : Special case of a calibration, offset of ORP, enables to go out of the calibration point without changing anything and remove forcing of electronic ZERO
- 210 : Validate calibration coefficients.
- 230 : Fill out the list of "temporary coefficients to be used for the measurement".
- 231 : Resets all "Temporary" calibration data. And the measurements use only current coefficients.
- 300 : Frame to inform the site name to calibrate
- 310 : Frame to call back a site or a history
- 320 : Frame for delayed calibration – configuration for measurement recording
- 321 : Frame for delayed calibration – configuration for dry weight collecting

4.3 Temperature calibration: typical sequence

A typical sensor calibration sequence proceeds in the following order:

Temperature calibration:
1st step: Calculate offset
Sensor fully immersed in an ice/water bath.
•231

Calibration standard value: 0.00 °C
Measurement: 0.12 °C
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •170 and •230 (when putting to '1' the coefficient corresponding to the temperature offset)

0.00°C: this corresponds to information supplied by the operator.
0.12°C: this corresponds to information returned by the Sensor.

If the operator wishes to exit the calibration without considering anything (no matter which of the 3 steps) : •231.

Temperature calibration:
2nd step: Calculate gradient
Sensor fully immersed in a bath heated at 25°C for example.

Calibration standard value: 25.00°C
Measurement: 22.48°C
Looped measurement command, to refresh the value on the display.
When the operator validates this step: •170 and •230 when putting to '1' the coefficient corresponding to the oxygen offset and to the temperature slope).

Temperature calibration:
Validation of entire calibration

Operator's name: J. Doe
Date: 01/10/08

Validation by the operator: •210, •231.

4.4 OPTOD sensor calibration :

Calibration in 2 points:

OPTOD calibration:
1st step: Calculate offset
Place the sensor in an aqueous solution of 2% sodium sulfite at ambient temperature.
•231

Calibration standard value: 0.00%
Measurement: 0.12%
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •170 and •230 when putting to '1' the coefficient corresponding to the oxygen

0.00: this corresponds to information supplied by the operator.
0.12: this corresponds to information returned by the Sensor.

Note: The master does not return the calibration standard value, so the value is necessarily set at 0.00%.

If the operator wishes to exit the calibration without considering anything (no matter which of the 3 steps) : •231

OPTOD calibration:
2nd step: Calculate gradient
Place the sensor in 100% saturated air.

Calibration standard value: 100.00%
Measurement: 102.48%
Looped measurement command, to refresh the value on the display.
When the operator validates this step: •170 and •230 (when putting to '1' the coefficients corresponding to the oxygen offset and to the oxygen slope)

Note: The master does not return the calibration standard value, so the value is necessarily set at 100.00%.

OPTOD calibration:
Validation of entire calibration

Operator's name: J. Doe
Date: 01/10/08

Validation by the operator: •210, •231.

OPTOD calibration : just the gain adjustment:

OPTOD CALIBRATION :
1st step : Calculate gradiant
Place the sensor in 100% saturated air.
•231

Calibation standard value : 100.00%
Measurement : 102.48%
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •170 and •230 (with the value set to '1' the corresponding coeff in the gain of the oxygen)

OPTOD calibration:
Validation of the calibration

Operator's name : J. Dupont
Date : 01/10/08

Validation by the operator: •210, •231

102.48 : Corresponds to an information sent back by the sensor.

If the operator wishes to go out of the calibration, without taking into account anything •231

Note : The standard is necessarily in ' 100 % ', the value is not modifiable.

4.5 Nephelometric Turbidity sensor calibration : NTU sensor

Turbidity calibration in standard solution of Formazin – NTU unit

Choose the range to be calibrated from the 4 available ranges, designated CgGamme.

Turbidity calibration:
1st step: Calculate offset
Place the sensor in demineralized water.
•231

Calibration standard value: 0.00 NTU
Measurement: 0.12 NTU
Looped measurement command, to refresh the value on the display.
When the operator validates this step: •170 with the calibration standard value for the range chosen for the measurement.
And •230 when putting to '1' the coefficient corresponding to the turbidity offset in the correct range.

0.00: This corresponds to information supplied by the operator.
0.12: This corresponds to information returned by the Sensor.

If the operator wishes to exit the calibration without considering anything (no matter which of the 3 steps) : •231

Turbidity calibration:
2nd step: Calculate gradient
Place the sensor in a Formazin standard solution.

Calibration standard value: 100.00 NTU
Measurement: 102.48 NTU
Looped measurement command, to refresh the value on the display.
When the operator validates this step: •170 with the calibration standard value for the range chosen for the measurement.
Et •230 (when putting to '1' the coefficient corresponding to offset and to the turbidity slope.

Turbidity calibration:
Validation of entire calibration

Operator's name: J. Doe
Date: 01/10/08

Validation by the operator: •210, •231

At this step, one range is calibrated.
Carry out this operation for each range to be calibrated (a maximum of 4 times).

For the gradient, use a calibration standard solution suited to the range chosen for the measurement.

Turbidity calibration in mg/l (Calibration by dry weight) – Step 1 - :

The sensor does not record the last 10 calibrations for this parameter but the sensor can save 10 different sites chosen by the operator.

Turbidity calibration in mg/l :
1st step : Calculating of the offset,
Put the sensor in clear water
•231

Value of the measure : 0.00 mg/l
Maesurement : 0.12 mg/l
Looped measurement command, to refresh the value on the display.

When the operator confirms this step : •170 with the value of measure and •230 when putting to '1' the coeff icient corresponding to the offset of turbidity.

0.00 : This corresponds to an information given by the operator
0.12 : This corresponds to an information returned by the Sensor.

If the operator wishes to exit the calibration without considering anything (no matter which of the 3 steps) : •231

Turbidity calibration in mg/l :
2nd Step : Recording of the value of the material
Put the sensor in the material.

Maesurement : 102.48 mg/l
Looped measurement command, to refresh the value on the display.

When the operator confirms this step : •320 (CgDif of param 3 to 0b01), •170 with any standard value.

The slope calibration coefficient is calculated in a delayed manner.
This step can only know the extent obtained by the sensor of the material. The real concentration value of the material is obtained by Dry Weight and then returned to the sensor.

Turbidity calibration in en mg/l :
Complete calibration validation

1- Site 1
2- Tank 1
3-
4- Tank 2
5-
6- Site 2
7-
8-
9- Tank 5
10-

Operator's name : J. Doe
Date : 01/10/08

Validation by the operator : •300, •210, •321

The operator must select the location of the site to be calibrated between 1 and 10.
The operator must appoint or reappoint the site.

REMARK :
The site names contains up to 8 characters.

Turbidity calibration in mg/l - Step 2 - calculation of slope with dry weight value :

This step enables to achieve the parameter calibration in mg /l. The operator will enter the value of the Dry Weight to allow the Sensor to calculate the real slope of the turbidity based on the sample of material.

Turbidity calibration in mg/l :
3rd Step : Value of dry weight

•231

1- Site 1
2- Tank 1
3-
4-
5- Tank 2
6-
7- Site 2
8-
9- Tank 5

Value of dry weight: 1000 mg/l

When the operator confirms this step : •310 call back the site, •321 (CgDif of param 3 to 0b10), •170 with the dry weight as standard value for the slope. •230 when putting to '1' the coefficient corresponding to the turbidity slope.

The operator must choose the site to get back.

If this site has an outstanding dry weight, we can then confirm this step (information given by the calibration status of the slope coefficient). Otherwise you have to prevent the operator to validate the step.

If the operator wishes to exit the calibration without considering anything (no matter which of the 2 steps):
•231

Turbidity calibration in mg/l :
Validation of entire calibration

Operator's name : J. Doe
Date : 01/10/08

Validation by the operator : •300, •210, •231

4.6 Four electrodes conductivity sensor calibration – C4E:

Choose the range to be calibrated from the 4 available ranges, designated CgGamme.

Conductivity calibration:
1st step: Calculate offset
Place the sensor in the open air.
•231

Calibration standard value: 0.00 µS/cm
Measurement: 0.12 µS/cm
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •170 with the calibration standard value for the range chosen for the measurement.
•230 when putting to '1' the coefficient corresponding to the offset in the correct range.

0.00: this corresponds to information supplied by the operator.
0.12: this corresponds to information returned by the Sensor.

If the operator wishes to exit the calibration without considering anything (no matter which of the 3 steps) : •231

Conductivity calibration:
2nd step: Calculate gradient
Place the sensor in a calibration solution.

Calibration standard value: 84.00 µS/cm
Measurement: 86.48 µS/cm
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •170 with the calibration standard value for the range chosen for the measurement. Et •230 (when putting to '1' the coefficient corresponding to the offset in the correct range)

Conductivity calibration:
Validation of entire calibration

Operator's name: J. Doe
Date: 01/10/08

Validation by the operator: •210, •231

At this step, one range is calibrated.
Carry out this operation for each range to be calibrated (a maximum of 4 times).
For the gradient, use a calibration standard suited to the range chosen for the measurement.

REMARK :
The salt content and TDS are not calibrated. Instead, these parameters are deducted from the conductivity measurement.

4.7 Inductive conductivity sensor calibration – CTZN:

Conductivity calibration:
1st step: Calculate offset
Place the sensor in the open air.
•231

Calibration standard value: 0.00 mS/cm
Measurement: 0.12 mS/cm
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •170 with the calibration standard value for the range chosen for the measurement.
•230 when putting to '1' the coefficient corresponding to the offset in the correct range.

0.00: this corresponds to information supplied by the operator.
0.12: this corresponds to information returned by the Sensor.

If the operator wishes to exit the calibration without considering anything (no matter which of the 3 steps) : •231

Conductivity calibration:
2nd step: Calculate gradient
Place the sensor in a calibration solution.

Calibration standard value: 4.00 mS/cm
Measurement: 6.48 mS/cm
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •170 with the calibration standard value for the range chosen for the measurement. Et •230 (when putting to '1' the coefficient corresponding to the offset in the correct range)

Conductivity calibration:
Validation of entire calibration

Operator's name: J. Doe
Date: 01/10/08

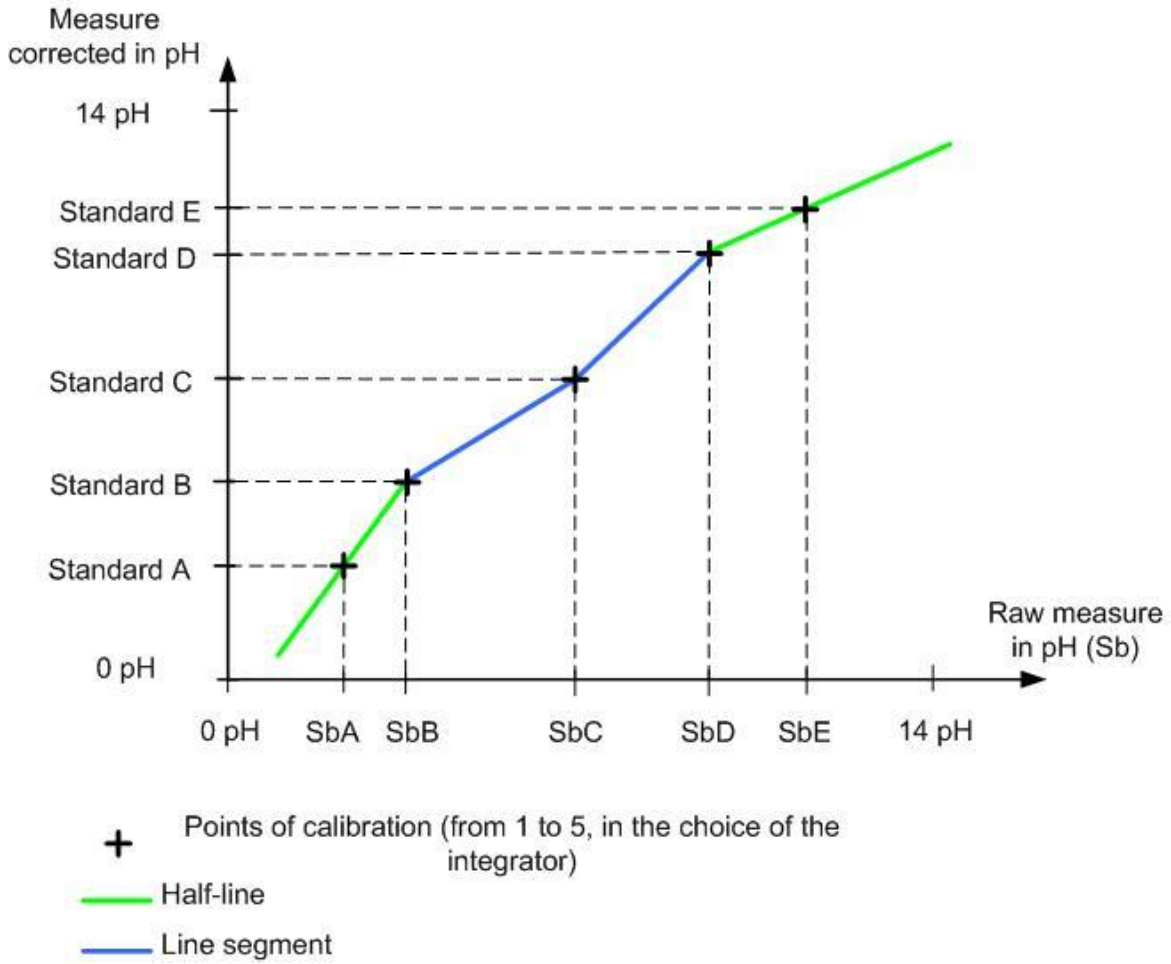
Validation by the operator: •210, •231

REMARK :
The salt content is not calibrated. Instead, this parameter is deducted from the conductivity measurement.

4.8 pH/ORP sensor calibration: PHEHT sensor

pH calibration sequence

This calibration is particular; we can calibrate this parameter on 1, 2, 3, 4 or 5 points of calibration.
The algorithm of calibration detects the order of the points of calibration and uses the principle of right segment between every point of calibration.



REMARK :

In the Modbus memory plane, we number the standards " standard 1 ", " standard 2 ", " standard 5 ", " standard 6 ", " standard 7 ". The digital sensor gets back all the data (standard solutions values and raw measures) and stores automatically the data in the increasing order by obtaining " standard A ", " standard B ", " standard C ", " standard D " and " standard E ".

This allows the integrator to inform any value of standard (of 0 in 14pH) in whatever of the 5 compartments memory of the standards.

pH calibration:
1st step: Calculate offset
Place the sensor in a calibration standard with a pH between (0 and 14).
•231

Calibration standard value: 7.00 pH
Measurement: 7.12 pH
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •170. et •230 (when putting to '1' the 5 standards ; 0x000001CC => coeff. 1, 2, 5, 6 and 7)

pH calibration:
2nd step: Calculate gradient
Place the sensor in another calibration standard

Calibration standard value: 4.00 pH
Measurement: 4.48 pH
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •170

pH calibration:
3rd step: Calculate gradient
Place the sensor in another calibration standard

Calibration standard value: 2.00 pH
Measurement: 2.04 pH
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •170

pH calibration:
4th step: Calculate gradient
Place the sensor in another calibration standard

Calibration standard value: 6.00 pH
Measurement: 6.08 pH
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •170

7.00: this corresponds to information supplied by the operator.
0.12: this corresponds to information returned by the Sensor.

If the operator wishes to exit the calibration without considering anything (no matter which of the 3 steps) : •231

REMARK :
The values of the standard solutions could be passed in any order.

pH calibration:

5th step: Calculate gradient

Place the sensor in another calibration standard

Calibration standard value: 10.00 pH

Measurement: 9.91 pH

Looped measurement command, to refresh the value on the display.

When the operator validates this step: •170

pH calibration:

Validation of entire calibration

Operator's name: J. Doe

Date: 01/10/08

Validation by the operator: •210, •231.

ORP calibration sequence

ORP calibration:
1st step: Calculate offset
AUTOMATIC ZEROING
•230 with the value set to '0'
•180 (activation of automatic zeroing).

Measurement: 2.12 mV
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •190. et •230 (when putting to '1' the coefficient corresponding to the offset)
If the operator wishes to exit the calibration without considering anything : → •200 (deactivation of the electronic Zero).

ORP calibration:
2nd step: Calculate gradient
Place the sensor in a 240 mV calibration standard (for example).
•230, setting the coefficient for the Redox offset to '1'.

Calibration standard value: 240 mV
Measurement: 246 mV
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •170 et •230 (when putting to '1' the coefficient corresponding to the offset and to the slope)

ORP calibration:
Validation of entire calibration

Operator's name: J. Doe
Date: 01/10/08

Validation by the operator: •210, •231

0.00: this corresponds to information supplied by the operator.
0.12: this corresponds to information returned by the Sensor.

The sensor can be placed in the open air since the Redox offset is conducted electronically.

If the operator wishes to exit the calibration without considering anything (no matter which of the 3 steps) : •231

4.9 Annular ORP sensor calibration: EHAN sensor

ORP calibration:
1st step: Calculate offset
AUTOMATIC ZEROING
•230 with the value set to '0'
•180 (activation of automatic zeroing).

Measurement: 2.12 mV
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •190. et •230 (when putting to '1' the coefficient corresponding to the offset)
If the operator wishes to exit the calibration without considering anything : → •200 (deactivation of the electronic Zero).

ORP calibration:
2nd step: Calculate gradient
Place the sensor in a 240 mV calibration standard (for example).
•230, setting the coefficient for the Redox offset to '1'.

Calibration standard value: 240 mV
Measurement: 246 mV
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •170 et •230 (when putting to '1' the coefficient corresponding to the offset and to the slope)

ORP calibration:
Validation of entire calibration

Operator's name: J. Doe
Date: 01/10/08

Validation by the operator: •210, •231

0.00: this corresponds to information supplied by the operator.
0.12: this corresponds to information returned by the Sensor.

The sensor can be placed in the open air since the Redox offset is conducted electronically.

If the operator wishes to exit the calibration without considering anything (no matter which of the 3 steps) : •231

4.10 TSS sensor calibration : MES5 sensor

TSS calibration in g/L (Calibration by dry weight) – Step 1 - :

The sensor does not record the last 10 calibrations for this parameter but the sensor can save 10 different sites chosen by the operator.

TSS calibration :
1st step : Calculating of the offset,
Put the sensor in clear water
•231

Value of the measure : 0.00 g/l
Maesurement : 0.12 g/l
Looped measurement command, to refresh the value on the display.

When the operator confirms this step : •170 with the value of measure and •230 when putting to '1' the coeff icient corresponding to the offset of turbidity.

0.00 : This corresponds to an information given by the operator
0.12 : This corresponds to an information returned by the Sensor.

If the operator wishes to exit the calibration without considering anything (no matter which of the 3 steps) : •231

TSS calibration :
2nd Step : Recording of the value of the material
Put the sensor in the material.

Maesurement : 2.48 g/l
Looped measurement command, to refresh the value on the display.

When the operator confirms this step : •320 (CgDif of param 3 to 0b01), •170 with any standard value.

The slope calibration coefficient is calculated in a delayed manner.
This step can only know the extent obtained by the sensor of the material. The real concentration value of the material is obtained by Dry Weight and then returned to the sensor.

TSS calibration :
Complete calibration validation

11- Site 1
12- Tank 1
13-
14- Tank 2
15-
16- Site 2
17-
18-
19- Tank 5
20-

Operator's name : J. Doe
Date : 01/10/08

Validation by the operator : •300, •210, •321

The operator must select the location of the site to be calibrated between 1 and 10.
The operator must appoint or reappoint the site.

REMARK :
The site names contains up to 8 characters.

TSS calibration in g/L– Step 2 -slope calculation with dry weight value :

This step enables to achieve the parameter calibration in mg /l. The operator will enter the value of the Dry Weight to allow the Sensor to calculate the real slope of the turbidity based on the sample of material.

TSS calibration:
3rd Step : Value of dry weight

•231

10- Site 1
11- Tank 1
12-
13-
14- Tank 2
15-
16- Site 2
17-
18- Tank 5

Value of dry weight : 1 g/l

When the operator confirms this step : •310 call back the site, •321 (CgDif of param 3 to 0b10), •170 with the dry weight as standard value for the slope. •230 when putting to '1' the coefficient corresponding to the turbidity slope.

The operator must choose the site to get back.

If this site has an outstanding dry weight, we can then confirm this step (information given by the calibration status of the slope coefficient). Otherwise you have to prevent the operator to validate the step.

If the operator wishes to exit the calibration without considering anything (no matter which of the 2 steps):
•231

Turbidity calibration in mg/l :
Validation of entire calibration

Operator's name : J. Doe
Date : 01/10/08

Validation by the operator : •300, •210, •231

Turbidity calibration in FAU :

Calibration of the Turbidity in FAU :
1st step : Calculating of the offset,
Put the sensor in clear water.

•231

Value of the standard : 0.00 FAU
Measure : 0.12 FAU
Looped measurement command, to refresh the value on the display.

When the operator confirms this step : •170 with the value of measure and •230 when putting to '1' the coeff icient corresponding to the offset of the FAU.

0.00 FAU : This corresponds to an information given by the operator
0.12 FAU : This corresponds to an information returned by the Sensor.

If the operator wishes to exit the calibration without considering anything (no matter which of the 3 steps) : •231

Calibration of the Turbidity in FAU :
2nde step : Calculate gradient

Value of the standard : 2000 FAU
Measure : 2048 FAU
Looped measurement command, to refresh the value on the display.

When the operator validates this step: •170 et •230 (when putting to '1' the coefficient corresponding to the offset and to the slope)

We recommends to put the sensor in a solution in 2000 FAU (middle of the range).

Calibration of the Turbidity in FAU :
Validation of entire calibration

Operator's name : J. Dupont
Date : 01/10/08

Validation by the operator : •210, •231

Sludge blanket calibration

Sludge blanket parameter needs only one step of calibration in clear water.

SB calibration :
1st step : Calculating of the offset,
Put the sensor in clear water.

•231

Value of the standard :100.00 %
Measure : 102.48 %
Looped measurement command, to refresh the value on the display.

When the operator confirms this step : •170 with the value of measure and •230 when putting to '1' the coefficient corresponding to the offset of the SB parameter.

102.48 : This corresponds to an information returned by the Sensor.

Value of standard is 100% of light transmission in clear water.

If the operator wishes to exit the calibration without considering anything (no matter which of the 2 steps) : •231

SB calibration :
Validation of entire calibration

Operator's name : J. Dupont
Date : 01/10/08

Validation by the operator : •210, •231

5 Annex N°1 : PONSEL Modbus frames

Frame for calculation of a given calibration point: ***•170, •180, •190, •200***

This communication is used by the master when it needs to validate a calibration point. The Sensor conducts calculation of the calibration coefficient. This calculation is performed when the master writes “calibration standard X” in the memory box for the value of the solution in which the Sensor is placed. For the calculation, the Sensor retrieves the last measurement point.

•170 :

In the file “Digital sensor Frame_xxx.xls” , the memory plane describes all the standard as a generic methodology.

@ 0x0200 to 0x0222

0x0200	Flash	r / w	write calibration standard 1 for temperature	float
0x0202	Flash	r / w	write calibration standard 2 for temperature	float
0x0204	Flash	r / w	write calibration standard 1	float
0x0206	Flash	r / w	write calibration standard 2	float
0x0208	Flash	r / w	write calibration standard 3	float
0x020A	Flash	r / w	write calibration standard 4	float
0x020C	Flash	r / w	write calibration standard 5	float
0x020E	Flash	r / w	write calibration standard 6	float
0x0210	Flash	r / w	write calibration standard 7	float
0x0212	Flash	r / w	write calibration standard 8	float
0x0214	Flash	r / w	write calibration standard 9	float
0x0216	Flash	r / w	write calibration standard 10	float
0x0218	Flash	r / w	write calibration standard 11	float
0x021A	Flash	r / w	write calibration standard 12	float
0x021C	Flash	r / w	write calibration standard 13	float
0x021E	Flash	r / w	write calibration standard 14	float
0x0220	Flash	r / w	write calibration standard 15	Float
0x0222	Flash	r / w	write calibration standard 16	Float

In the file, each sensor has a standard description as following:

Description of calibration standards :

	Master returns:	Unit:	Calibration standard used for parameter:	Comments:
calibration standard 1 for temperature	Calibration standard value (offset):	°C	Temperature	value recommended by Ponsel: near 0°C
calibration standard 2 for temperature	Calibration standard value (slope)	°C	Temperature	value recommended by Ponsel: near 25°C
standard 1	Calibration standard value (offset):	in NTUs	Parameters 1 and 2	value recommended by Ponsel: demineralised water 0 NTU
standard 2	Calibration standard value (slope)	in NTUs	Parameters 1 and 2	value recommended by Ponsel: 25 NTU (middle of range)
standard 3	Calibration standard value (offset):	in NTUs	Parameters 1 and 2	value recommended by Ponsel: demineralised water 0 NTU
standard 4	Calibration standard value (slope)	in NTUs	Parameters 1 and 2	value recommended by Ponsel: 100 NTU (middle of range)

standard 5	Calibration standard value (offset):	in NTUs	Parameters 1 and 2	value recommended by Ponsel: demineralised water 0 NTU
standard 6	Calibration standard value (slope)	in NTUs	Parameters 1 and 2	value recommended by Ponsel: 500 NTU (middle of range)
standard 7	Calibration standard value (offset):	in NTUs	Parameters 1 and 2	value recommended by Ponsel: demineralised water 0 NTU
standard 8	Calibration standard value (slope)	in NTUs	Parameters 1 and 2	value recommended by Ponsel: 2000 NTU (middle of range)

Example :
In this example, the master sends to the sensor the reference value **24.3°C** (0x41C26666) for calculation of the slope (0x0202). Then the sensor calculates the coefficient using this value and the last measurement. The coefficient is stored in the suitable space of temporary calibration area.
The sensor updates the status of temporary calibration.
The sensor confirms to master that the task has been done.

14:06:35:180 – frame sent : (13 octets) : 0x04-0x10-**0x02-0x02**-0x00-0x02-0x04-**0x41-0xC2-0x66-0x66**-0x64-0x90
14:06:35:290 – received frame : (8 octets) : 0x04-0x10-0x02-0x02-0x00-0x02-0xE1-0xE5

Special case of the ORP offset:

For the Redox offset "calibration standard 3", the master must send com •180. The sensor can be placed in the open air since the offset is conducted electronically.

In the file "Digital sensor Frame_xxx.xls" , the memory plane describes all the standard as a generic methodology.
@ 0x0208

standard 3	Offset		Parameter 2	0 mV is measured electronically, so sensor may remain exposed to air.
	0x01			- '0' activated electronically
	0x02			- Offset calculation and '0' disabled electronically
	0x03			- Disablement of '0' only

•180 :

The master writes the value 0x01 in "calibration standard 3" (0x3F800000).
The sensor electronically zeroes the Redox.

exemple :

17:07:02:960 - Frame Sent : (13 octets) : 0x04-0x10-**0x02-0x08**-0x00-0x02-0x04-**0x3F-0x80-0x00-0x00**-0xF7-0x59
17:07:03:050 - Received Frame : (8 octets) : 0x04-0x10-0x02-0x08-0x00-0x02-0xC1-0xE7

•190 :

Communication •190 is used by the master to validate the ORP offset, then the sensor starts calculation of the offset. For the calculation, the Sensor retrieves the last measurement point.

The master writes the value 0x02 in "calibration standard 3" (0x40000000).
The Sensor calculates the calibration coefficient using the last measurement made, the calibration standard value (‘= 0mV’) and files the result in the appropriate coefficient.
The SENSOR removes electronic zeroing of the Redox.

exemple :

17:17:03:610 - Frame Sent : (13 octets) : 0x04-0x10-**0x02-0x08**-0x00-0x02-0x04-**0x40-0x00-0x00-0x00**-0xEF-0x65
17:17:03:700 - Received Frame : (8 octets) : 0x04-0x10-0x02-0x08-0x00-0x02-0xC1-0xE7

•200

Communication •200 is used by the master to escape from the ORP calibration sequence. Consequently, this frame deactivates electronic zero.

The master writes the value 0x03 in "calibration standard 3" (0x40400000).
The sensor removes the electronic ZERO from the redox without any calculation.

exemple :

17:08:26:250 - Frame Sent : (13 octets) : 0x04-0x10-**0x02-0x08**-0x00-0x02-0x04-**0x40-0x40-0x00-0x00**-0xEE-0xB1
17:08:26:350 - Received Frame : (8 octets) : 0x04-0x10-0x02-0x08-0x00-0x02-0xC1-0xE7

Frame for validating a calibration •210

Calibration of one or more coefficients is validated by the Sensor when the master sends operator name and the date.
IMPORTANT NOTE :
If the master does not send this frame (and •231), then the calibration will not be taken into account when the master requests a measurement.

Sensors take less than 500ms to treat the calibration validation information.

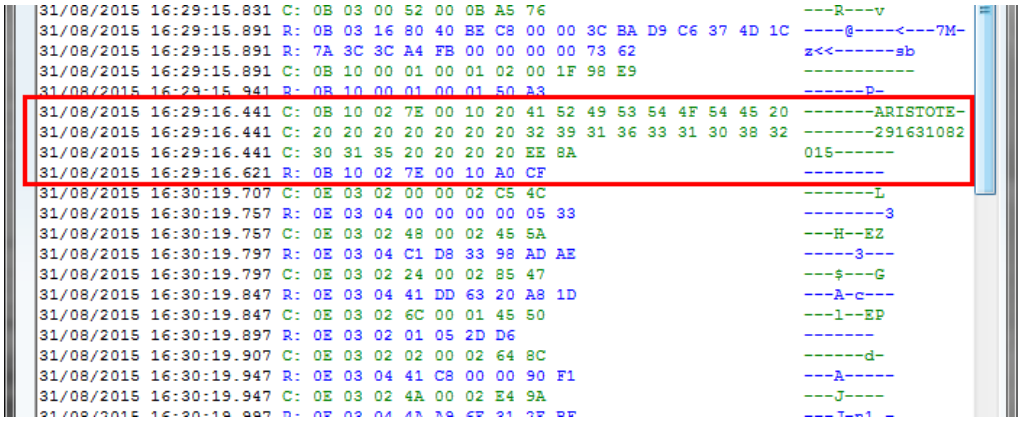
You must send 16 octets for operator name and also 16 octets for the date.

In the file "Digital sensor Frame_xxx.xls", the memory plane describes **@ 0x027E to 0x02C6**

Writing operator's name and date in temporary calibration.
The sensor validates the calibration sequence by transferring data from temporary coefficients to current coefficients.

0x027E	Flash	w	Name of operator who calibrated temporary calibration standard	ascii	8
0x0286	Flash	w	Date of temperature calibration (temporary calibration)	ascii	8
0x028E	Flash	w	Name of operator who calibrated parameter 1 (temporary calibration standard)	ascii	8
0x0296	Flash	w	Date of calibration for parameter 1 (temporary calibration standard)	ascii	8
0x029E	Flash	w	Name of operator who calibrated parameter 2 (temporary calibration standard)	ascii	8
0x02A6	Flash	w	Date of calibration for parameter 2 (temporary calibration standard)	ascii	8
0x02AE	Flash	w	Name of operator who calibrated parameter 3 (temporary calibration standard)	ascii	8
0x02B6	Flash	w	Date of calibration for parameter 3 (temporary calibration standard)	ascii	8
0x02BE	Flash	w	Name of operator who calibrated parameter 4 (temporary calibration standard)	ascii	8
0x02C6	Flash	w	Date of calibration for parameter 4 (temporary calibration standard)	ascii	8

Example of frame :



In the red square :
Operator's name : ARISTOTE
Calibration date : 2015, 31th of august, 16:29

Frame for filling out the list of "temporary coefficients to be used for the measurement". ***•230***

Activating a given coefficient in this list enables the SENSOR to return the measurement not with the correction coefficient from the current calibration, but the one from the temporary calibration coefficient.

IMPORTANT NOTE:
When the operator exits the calibration menu by cancelling the previous actions, each coefficient in the list is zeroed.

In the file "Digital sensor Frame_xxx.xls", the memory plane describes **@ 0x014C**

Write all data in the list of temporary coefficients to be used for measurement.

0x014C	Flash	r / w	List of temporary coefficients to be used in measurement calculation	long	2	Coef14	Coef13	Coef12
						CoefX:		1: Pod will use temporary coefficient value for measurement calculation instead of current coefficient; this function only used during calibration. Example: offset already calculated used to display measurement during second calibration (slope)

Example of frame :

The master asks to sensor a measurement obtained with temporary offset and gain.

16:28:00:140 – frame sent : (13 octets) : 0x04-0x10-**0x01-0x4C**-0x00-0x02-0x04-**0x00-0x00-0x00-0x03**-0xAB-0x97
16:28:00:190 – received frame : (8 octets) : 0x04-0x10-0x01-0x4C-0x00-0x02-0x81-0xB6

Resets all "Temporary" calibration data. And the measurements use only current coefficients : ***231***

With these frames, the sensor sends the measurement with coefficients from current calibration and also resets data written in temporary calibration.

Write '0x00000000 ' at 0x014C address and also 0x0001 at 0x004C address.

In the file "Digital sensor Frame_xxx.xls", the memory plane describes two registers from **@ 0x014C and 0x004C.**

0x014C	Flash	r / w	List of temporary coefficients to be used in measurement calculation	long	2	Coef14	Coef13	Coef12
						CoefX:		1: Pod will use temporary coefficient value for measurement calculation instead of current coefficient; this function only used during calibration. Example: offset already calculated used to display measurement during second calibration (slope)

0x004C		w	Reset standard + Operator + Date of temporary calibration	int	1	actif with value 0x01

Example of frame :

14:20:51:740 - frame sent : (13 octets) : 0x04-0x10-0x01-0x4C-0x00-0x02-0x04-**0x00-0x00-0x00-0x00**-0xEB-0x96
14:20:51:790 - Received frame : (8 octets) : 0x04-0x10-0x01-0x4C-0x00-0x02-0x81-0xB6
14:20:52:020 - frame sent : (11 octets) : 0x04-0x10-0x00-0x4C-0x00-0x01-0x02-**0x00-0x01**-0x56-0xCC
14:20:52:090 - Received frame : (8 octets) : 0x04-0x10-0x00-0x4C-0x00-0x01-0xC0-0x4B

Frame to inform the site name to calibrate : ***300***

In the file "Digital sensor Frame_xxx.xls", the memory plane describes **@ 0x02CE**
The master must write the site name in temporary calibration (8 characters max).

0x02CE	Flash	w	Site Name (temporary calibration standard)	ascii	4	used only for Nephelo in mg/L and for MES

The master must write the site number, between 1 and 10, related to the calibration coefficients.

@ 0x014E

0x014E	Flash	r / w	Site number	int	1	Identifies site to be used for temporary calibration transfer (value from 1 to 10)

Example of frame :

The master must write the site name : "STEP BAS3
The site number used is #4 (0x0004).

15:36:18:540 – Frame sent : (17 octets) : 0x04-0x10-**0x02-0xCE**-0x00-0x04-0x08-**0x53-0x54-0x45-0x50-0x20-0x42-0x41-0x53**-0xDB-0x61
15:36:18:540 – Frame sent, ASCII format : (17 octets) : '---Î---**STEP BAS**Ûa'
15:36:18:580 - Received frame : (8 octets) : 0x04-0x10-0x02-0xCE-0x00-0x04-0xA1-0xD8

15:36:18:610 - Frame sent : (11 octets) : 0x04-0x10-**0x01-0x4E**-0x00-0x01-0x02-**0x00-0x04**-0x87-0xED
15:36:18:640 - Received frame : (8 octets) : 0x04-0x10-0x01-0x4E-0x00-0x01-0x60-0x77

Frame to call back a site or a history : ***310***

The master asks the switch of current calibration coefficients by others linked to a site or calibration history.

In the file "Digital sensor Frame_xxx.xls", the memory plane describes **@ 0x0003**

0x0003		w	Returns one of 10 latest calibrations or one of 10 sites	int	1	
						PARA X:
						HIST:

Example of frame :

The master calls back the calibration coefficients of parameter #~2 from site #4. (0x0404)

15:42:33:210 – Frame sent : (11 octets) : 0x04-0x10-**0x00**-**0x03**-0x00-0x01-0x02-**0x04**-**0x04**-0x9A-0x30
15:42:33:250 – Received frame : (8 octets) : 0x04-0x10-0x00-0x03-0x00-0x01-0xF1-0x9C

Frame for delayed calibration – configuration for measurement recording **320**

With this step, the sensor knows that it must store the measurement value when it will receive the standard value. (measurement in the sample of material)

The master sends the configuration of the measurement in g/L in order to indicate a delayed calibration : CgDif = 0b01

In the file "Digital sensor Frame_xxx.xls", the memory plane describes : **@ from 0x00A5 to 0x00A9**

0x00A5	Flash	r / w	Temperature measurement type configuration.	int	1			CgDif	CgGamme
0x00A6	Flash	r / w	Param 1 measurement type configuration	int	1	CgMes:			00: corrected measurement, default value
0x00A7	Flash	r / w	Param 2 measurement type configuration	int	1				01: uncorrected measurement 1
0x00A8	Flash	r / w	Param 3 measurement type configuration	int	1				10: uncorrected measurement 2
0x00A9	Flash	r / w	Param 4 measurement type configuration	int	1				11: gross measurement
						CgTEX:			1: Uses temperature returned by Master for compensation calculation. If not, Pod carries out temperature measurement and uses value for compensation.
						Cg1EX:			1: Pod uses Compensates 1 returned by Master for compensation calculation. If not, Pod uses default value
						Cg2EX:			1: Pod uses Compensates 2 returned by Master for compensation calculation. If not, Pod uses default value
						Cg3EX:			1: Pod uses Compensates 3 returned by Master for compensation calculation. If not, Pod uses default value
						CgGamme:			000: range definition is automatic, or if no range
									001: use of measurement range 1
									010: use of measurement range 2
									011: use of measurement range 3
									100: use of measurement range 4
						CgDif: Differed calibration		00: Default Val	
									01: gross measurement configuration saved for future use (activation during calibration standard write process)
									10: warns that gross value saved will be used to calculate parameter with calibration standard (when calibration standard next required)

Example of frame :

The master sends the configuration 0x1000 to parameter #2 (0x00A7) : cgDif = 0b01.

14:54:46:110 – Frame sent : (11 octets) : 0x04-0x10-**0x00-0xA7**-0x00-0x01-0x02-**0x10-0x00**-0x8D-0xD7
14:54:46:150 – Received frame: (8 octets) : 0x04-0x10-0x00-0xA7-0x00-0x01-0xB0-0x7F

5.1.8 Frame for delayed calibration – configuration for dry weight collecting •321

With this step, the sensor must collect the dry weight when it will receive the standard value.
It could calculate the calibration coefficient.
The master sends the configuration of measurement in g/l in order to indicate a delayed calibration.

In the file "Digital sensor Frame_xxx.xls", the memory plane describes : **@ from 0x00A5 to 0x00A9**

Example of frame :

The master sends the configuration 0x2000 to parameter #2 (0x00A7) : cgDif = 0b10.

15:21:43:940 – Frame sent : (11 octets) : 0x04-0x10-**0x00-0xA7**-0x00-0x01-0x02-**0x20-0x00**-0x99-0xD7
15:21:43:980 – Received frame : (8 octets) : 0x04-0x10-0x00-0xA7-0x00-0x01-0xB0-0x7F

6 Annex 2 – FAQ

- **No frame receipt:**
  - **Default in the cable or with power supply.**

    - solution : Measure power consumption of the sensor, in stand-by mode, current value below 50µA,

      Check the cable,

      Check the power supply near the sensor.
  - **Hardware flow control (RTS signal) :**

    - solution : Change the RS485 converter. The converter must compatible with RTU Modbus.

      Check RTS signal timing,

      Try with 4200 DIGITAL MODULE and CALSENS software then come back to your own software.

- **Unknown frames received from the sensor :**
  - **Echo problem with the sent frame :**

    - solution : Adapt the software to put or remove echo,
      Change the converter configuration, if it is possible,
      Try another RS 485 converter.
  - **Cable problem :**

    - solution : Invert A/B wires.

- **Could we modify the parity bit ?**

  The sensor could be configure at 0x00BC address.
  - 2 stop bit and no parity (default factory settings)
  - 1 stop bit and even parity,
  - 1 stop bit and odd parity,

- **Could we modify the baud rate ?**

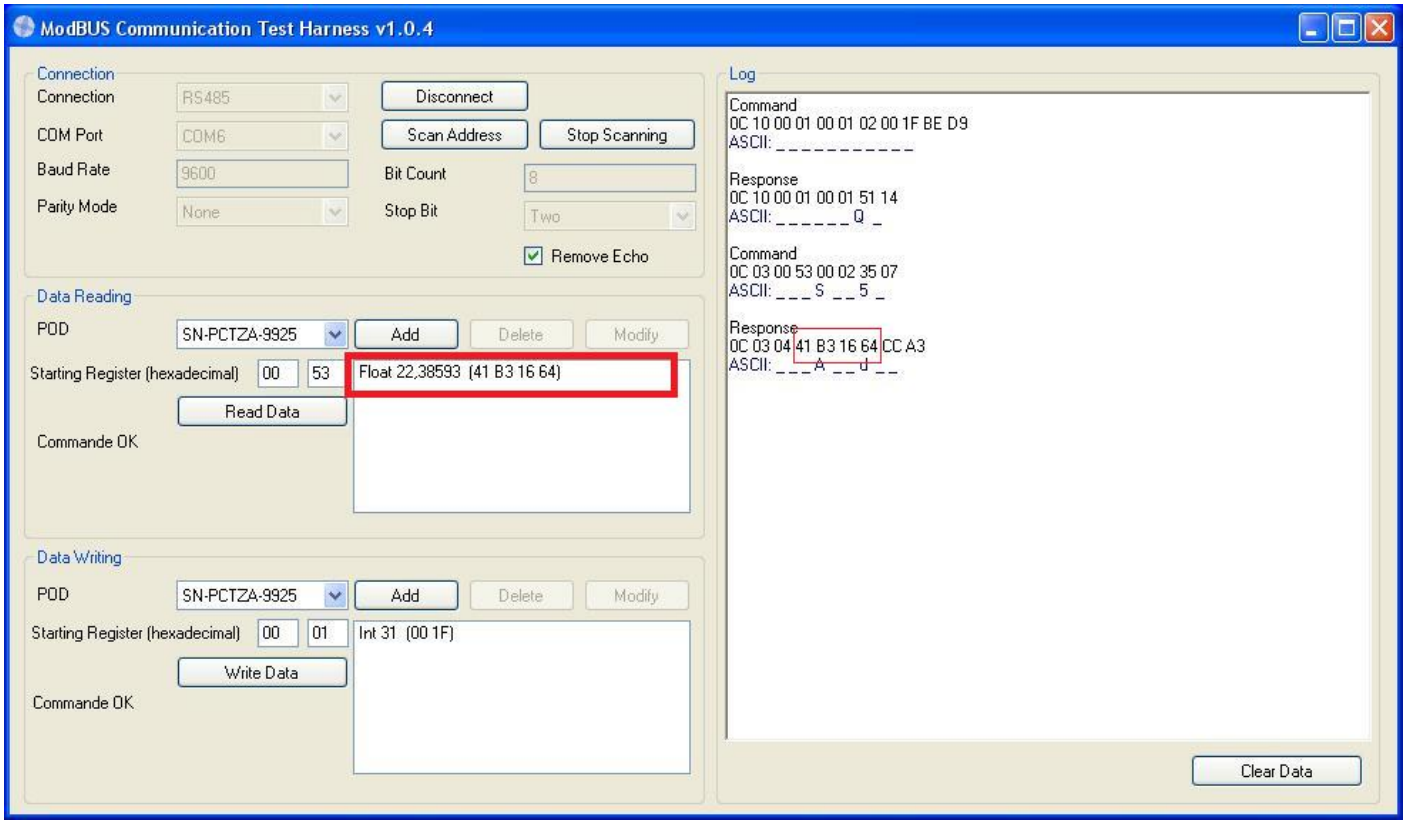
  No, the sensors works with 9600 bauds.

- **How could we calculate and check CRC16?**

  The Modbus normative document explains the CRC16 algorithm CRC16.
  Examples of CRC could be obtained using CALSENS software.
  See "***Modbus_over_serial_line_V1_02.pdf***"document**,** 6.2.2. Chapter "CRC Generation"
  Web : http://www.modbus.org/specs.php

- **Float number format for measurement :**

Float number format is in accordance with normative document ANSI/IEEE Std 754-1985 - simple precision (32 bits), 'big-Endian'.



- **How we manage a calibration process?**

Use this document and also CALSENS software to see the frames in real time in commands log window (access in the Menu / Tool).

- **What is the default address of the sensor?**

See factory certificate.
Default addresses are the following:

10, OPTOD sensor,
20, pH/ORP/Temperature sensor
21, ORP/Redox/Temperature
30, C4E conductivity sensor
40, Nephelometric turbidity sensor
50, Inductive conductivity sensor
60, TSS sensor.

- **What is the warm-up time of the sensor ?**

Warm-up time:100 mS max for all the digital sensors.

- **Is there a galvanic insulation with RS485 communication line?**

There is no galvanic insulation with the RS485 line. However, the physico-chemistry sensors (pH, C4E conductivity) have galvanic insulation at the measurement conditioning level. In this way, there is no perturbation when several sensors are used.

- **How could we activate the stand-by mode of the sensor?**

In stand-by mode, power consumption of sensors is very low (below 50µA). This is an automatic mode after the end of measurement and communication.
In the other way, the sensor wake-up with communication frame.

- **Could we obtain consecutive measurements without measurement command?**

No. In order to optimize power consumption, the master needs to send a frame to obtain a new measure.

- **What happens when a 12V voltage is applied to RS485 wires?**

10V voltage is the limit value for RS 485 driver component.