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Modbus specifications for Digital Pods

CIRCULATION


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SIGNATURES

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| NAME: FREDERIC RENAUD | NAME: |
| SIGNATURE: | SIGNATURE: |


CHANGE MANAGEMENT

| REVISIONS | DATE | ACTION | CHANGE IDENTIFICATION |
|-----------|------------|--------|---------------------------------------------------------------------------|
| 001 | 15/11/2007 | Issue | |
| 002 | 17/01/07 | | Calibration validation, addition on pod detection |
| 003 | 26/03/08 | | Addition concerning error messages and dialogues between masters and pods |
| 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 |
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1 Link protocol frame: MODBUS RTU

The link protocol must correspond to MODBUS RTU.


See document:

- Modbus_over_serial_line_V1_02.pdf
- Modbus_Application_Protocol_V1_1a.pdf
- modbus.pdf

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

The Modbus protocol for the Pods allows you to measure the parameter (+ temperature) of the Pod and to calibrate the parameter (+ temperature). Furthermore, there are certain numbers of functions such as:

- Select the averaging value
- Read the Pod description
- Return to default coefficients
- Modify the Pod address
- Information on measures conducted (Out Of Specification measures, measures in progress, etc.).
- Date and name of the operator who performed the calibration
- etc.

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1.1 Hardware configuration:

- Transmission medium: RS485
- 9600 bauds
- 8 bits
- 2 stop bits
- No parity
- No flow control

1.2 Addresses:

The pods have an address with a value between **1 and 230**.

The Modbus protocol requires that the address 0 is not used, as well as the addresses 248 to 255 !





All the pods process information when the master calls the 0 address.

IMPORTANT: The pods never respond when the master sends a frame to the 0 address.


In the default parameters, each parameter of the pods has a different address (which is allocated by the Modbus memory plane file).

1.3 Modbus functions used:

The pods 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 Pod returns its description, software version and hardware version.

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.

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1.4 Pod – PC communication:

Before integrating the Pods into a system (controller, inboard system, etc.), Ponsel recommends initially that Modbus communication via a PC is set up.

Ponsel recommends using the following USB/RS485 converter : (because this product has been validated by our engineering department)

- Manufacturer : MEILHAUS.
- Manufacturer's reference: USB-COMi.
- Farnell reference: 124-8370

Note: En RS485, a regularly occurring malfunction is incorrect management of the RTS signal by the converter. The RTS signal allows the line to be de-assigned (switched to high Immittance to liberate the slave).

For the recommended converter, there are bridging connectors that require modification (to avoid the problem of incorrectly configured RTS signals). Their final positions should correspond with those in figure 1.

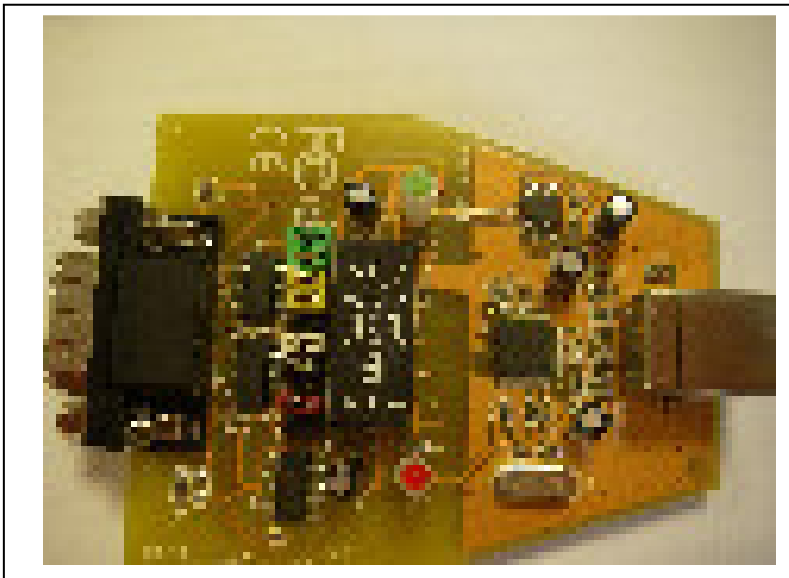


Fig 1. Position of bridging connectors.

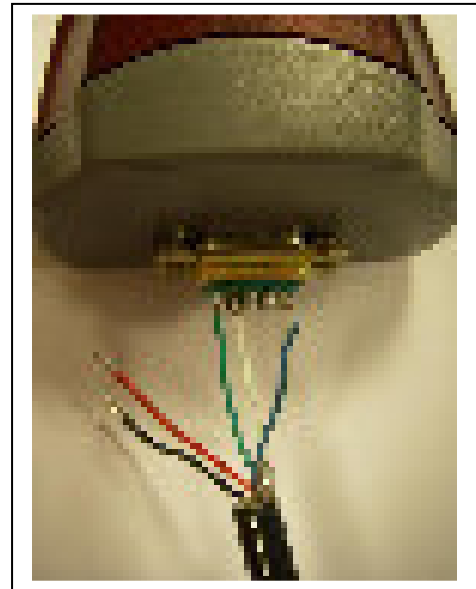


Fig 1 bis

Note: Be careful when consulting the datasheet: there is an error in the wiring diagram – pin 1 and 2 are inversed:

- Pin 1 of the DB9 on the converter corresponds to the green wire of the Pod --> B, data+.
- Pin 2 of the DB9 on the converter corresponds to the white wire of the Pod --> A, data-.

To view the response of the Pod to the master (the PC), you can use the “scanpod.exe” software.


Ask for this software from NEOTEK-PONSEL.

This software scans the Modbus network and reviews all the addresses from 1 to 240. But as soon as it detects a pod, the program stops at the address in question.

To use it, you must force the USB/RS485 converter on the COM 8 of the PC.

For the wiring of the Pod, see the product datasheet.

The energy use of the Pods on stand-by varies between 10 and 40 μ A depending on the Pod's settings.

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PONSEL provide you a PC software in order to help you in the communication between the sensor and your system.
 You can download this software from our website www.ponsel-web.com
 During the installation, an internet connection could be needed.

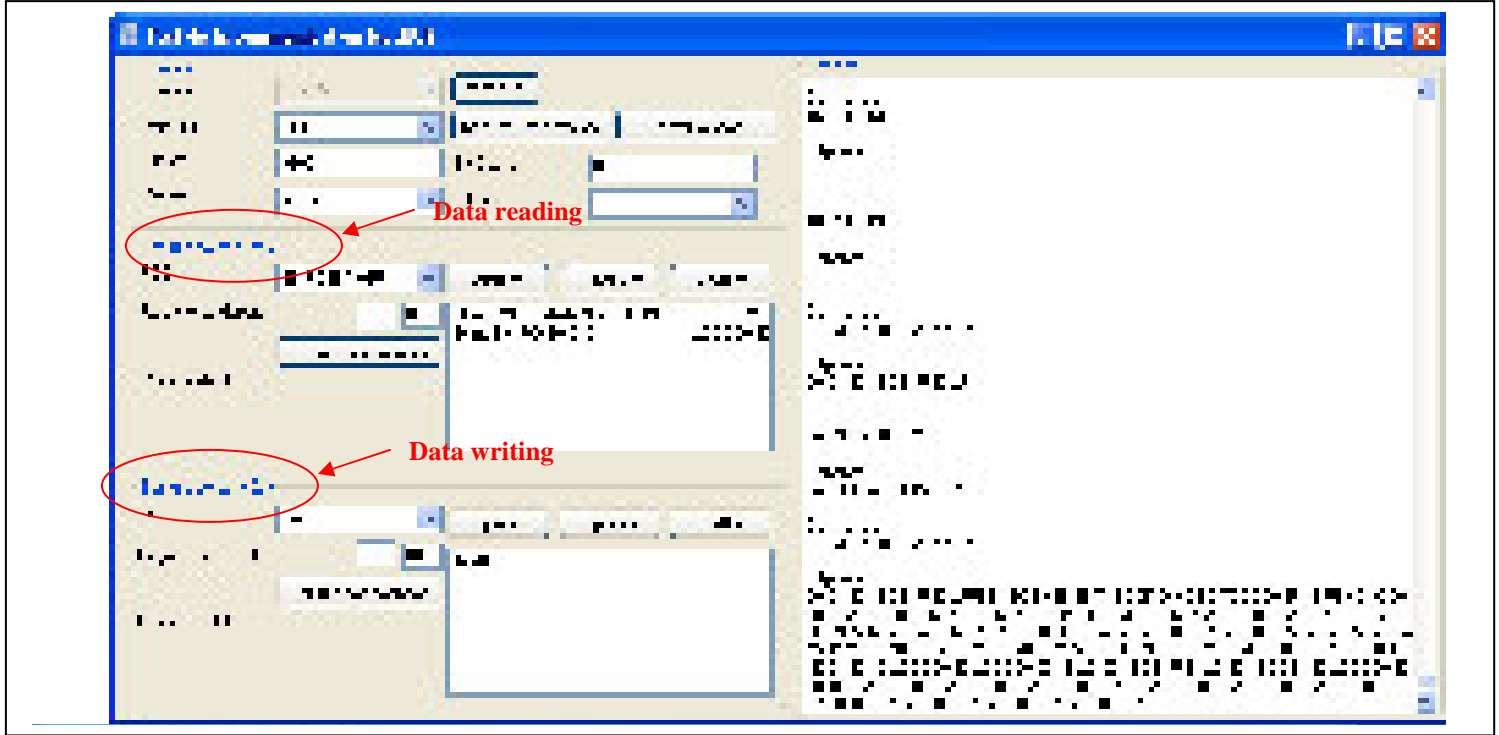



Fig 2. Software to test the communication with the digital sensors.

Remarque 1 : You must install the driver of the CD

Remarque 2 : You have to enter the COM where is connected the RS485 / USB converter. You can find the COM in your computer Configuration\System\material\Com Management\Com.

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Hereunder an example of configuration to obtain a measure of 4 parameters from a Optical DO sensor (1:temp, 2: DO %sat; 3 : DO mg/L; 4 : DO ppm).

- 1- first at all, order to write a measure to the address 0x0001 (press “Ecriture de Départ”)
- 2- read the value (press “Lecture des données”)

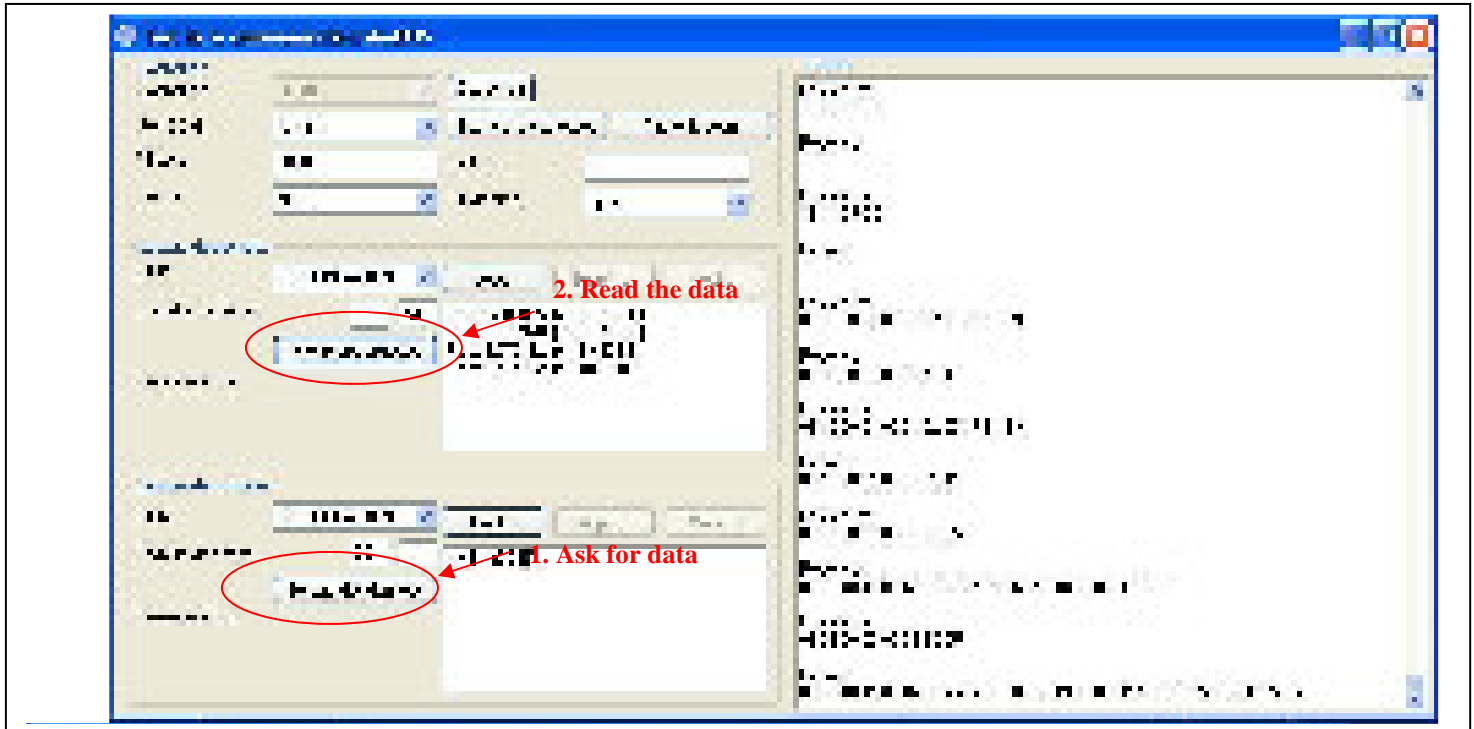
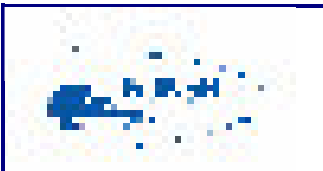


Fig 3. Example of configuration


Very important remark : The system is able to manage 230 sensors and it could take time. So it is very important to wait for 500 ms between a writing and a reading in order to have all data.

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1.5 Modbus error messages:


Note: The time between the end of the master frames and the start of slave frame is supplied by the Modbus protocol. It is 3.5 times the transmission time for 1 bit (i.e. 364 μ s for 9600 bauds).

- For the error codes, use:
 - o When the pod returns the error code “FF”. There is a communication problem.
 - o When the pod returns the error code “01”. The function code is not recognized by the Pod.
 - o When the pod returns the error code “02”. The address is not valid.
 - o When the pod returns the error code “03”. The data format is incorrect.

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2 Modbus communication sequence and frame:

- 15: Configuration the measurement type.
- 60: Compensate by one or more external parameters (if required, depending on the measurement configuration).
- 70: Order for launching a given measurement.
- 80: Read measurement(s) status(es) (measurement ready or in progress) and request for one or more measurements.
- 100: Read of calibration statuses for the current calibration or calibration 1 to 10 or the temporary calibration for given parameters or coefficients.
- 110: Write the averaging value for the measurements.
- 120: Return to default parameters for given coefficients.
- 160: Write an external compensation.
- 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.
- 210: Validate calibration coefficients.
- 230: Fill out the list of “temporary coefficients to be used for the measurement”.

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2.1 Sequence and frame for measurement requests: ●15, ●60, ●70, ●80, ●100

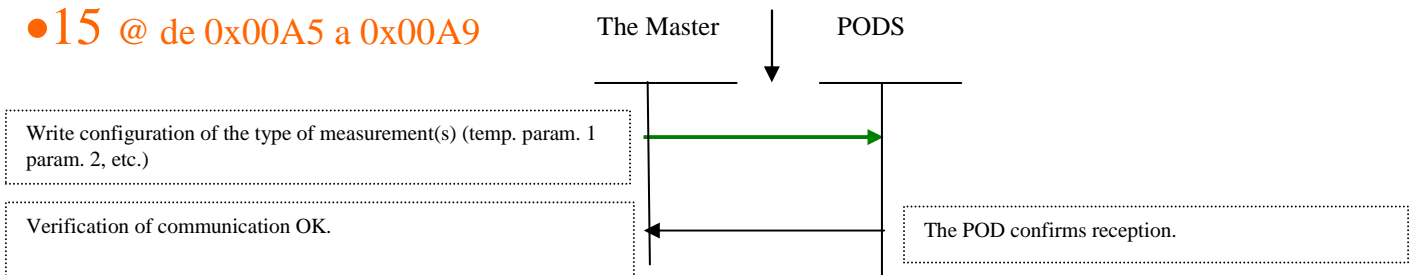
IMPORTANT: Never communicate with a Pod between the start measurement order (com ●70) and the read measurement request (com ●80) to avoid disrupting measurement.

To request a measurement the master must perform, at the most, the following communication sequence: ●15, ●60, ●70, ●80, ●100.

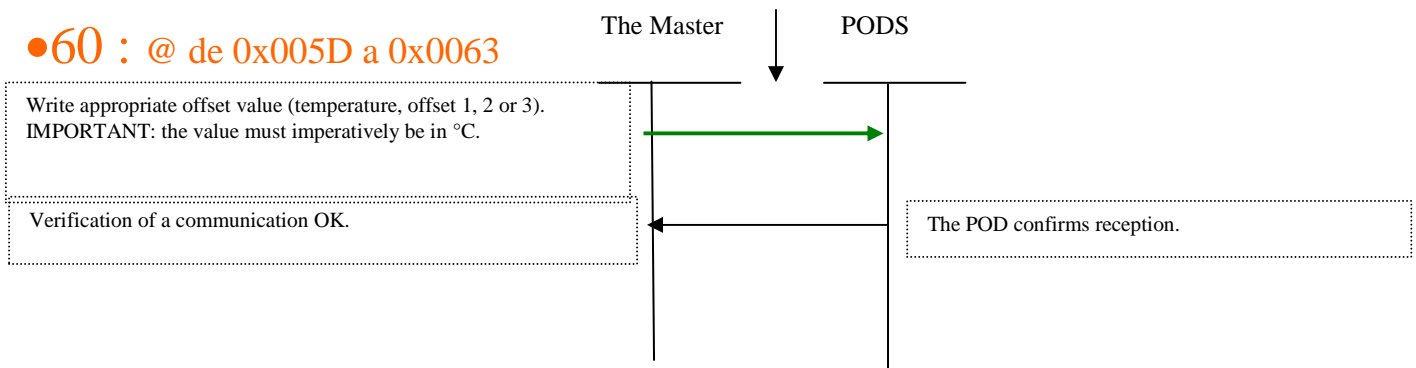
The master returns com ●60 only if the measurement must be compensated by an external parameter for the Pod.

The master returns com ●15 only if the configuration of the measurement must be modified, otherwise the Pod retains the old set-up.

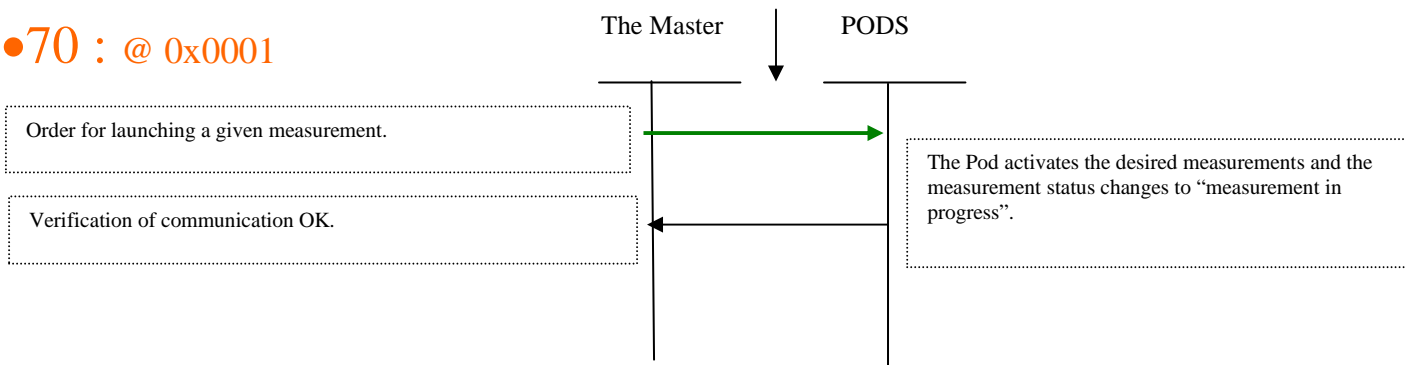
●15 @ de 0x00A5 a 0x00A9




●60 : @ de 0x005D a 0x0063



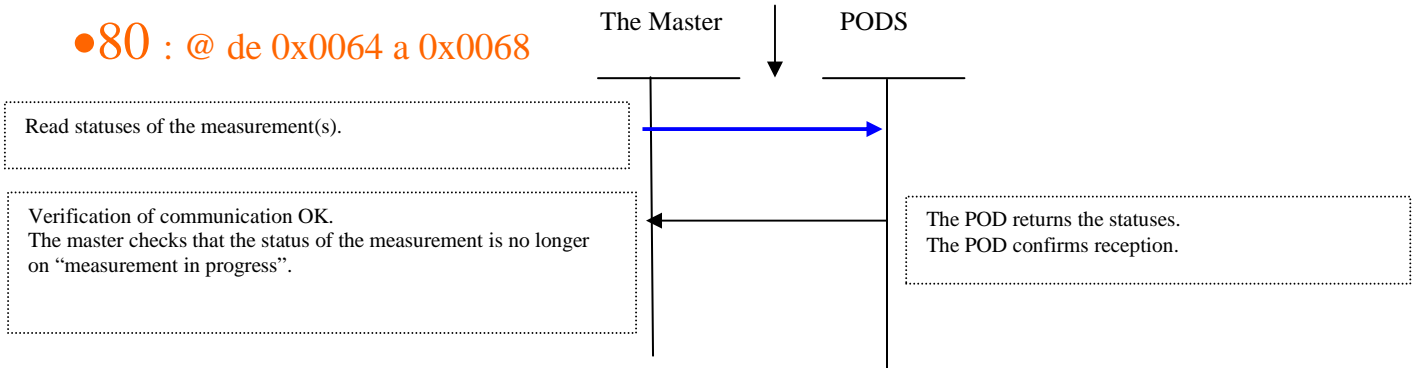
●70 : @ 0x0001



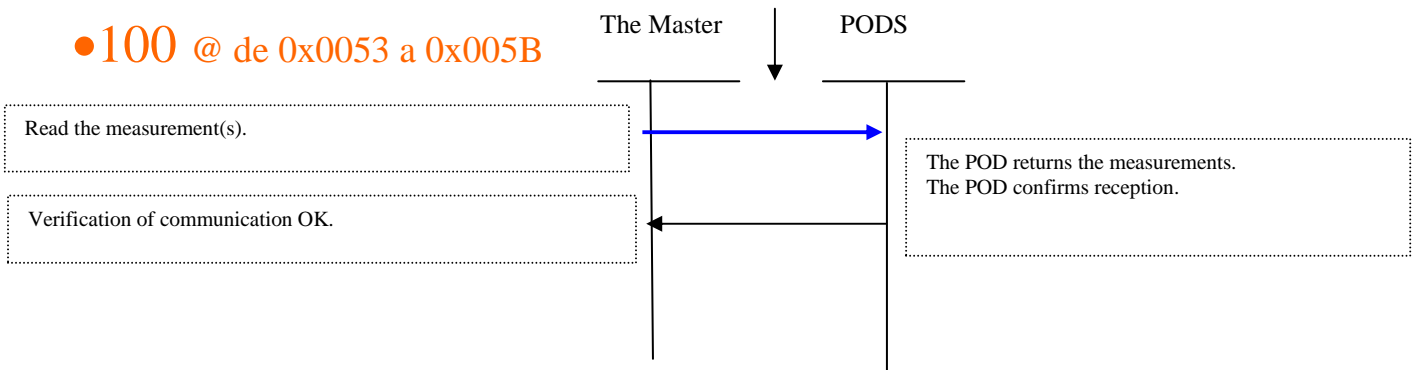
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The master waits for the minimum time set for obtaining the measurements (value entered by the Pod, see Modbus memory plane). It then passes to step ●80.

●80 : @ de 0x0064 a 0x0068



●100 @ de 0x0053 a 0x005B



Note: The master must not switch off the PODS after having given the order to start a measurement.

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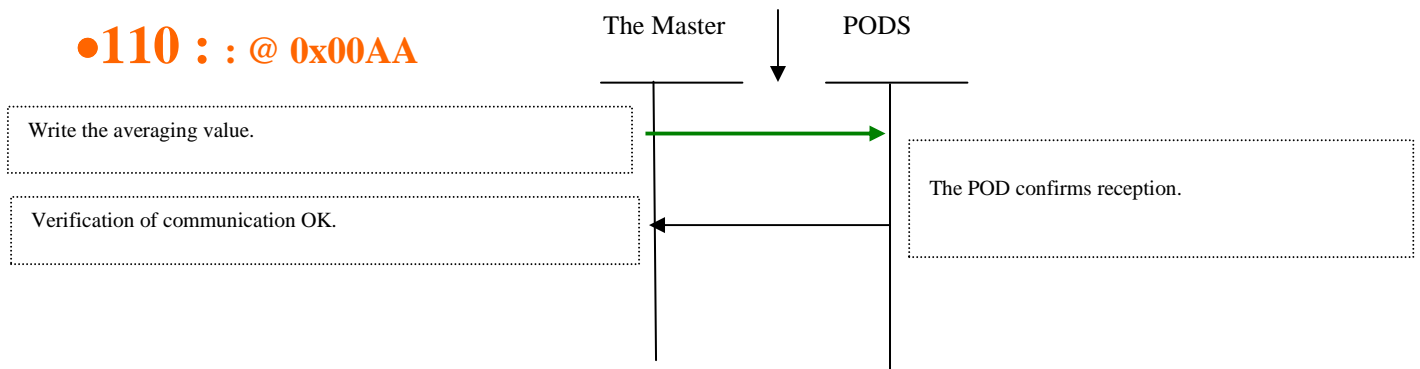
2.2 Frame for configuring measurement averaging: ●110


The temperature is NEVER averaged. The averaging value is incorporated for parameters 1, 2, 3 and 4.

Information:

When the master returns an order to write the averaging value, the Pod reinitializes the averaging. However, when the power supply is cut, the Pod saves the values to calculate the averaging.

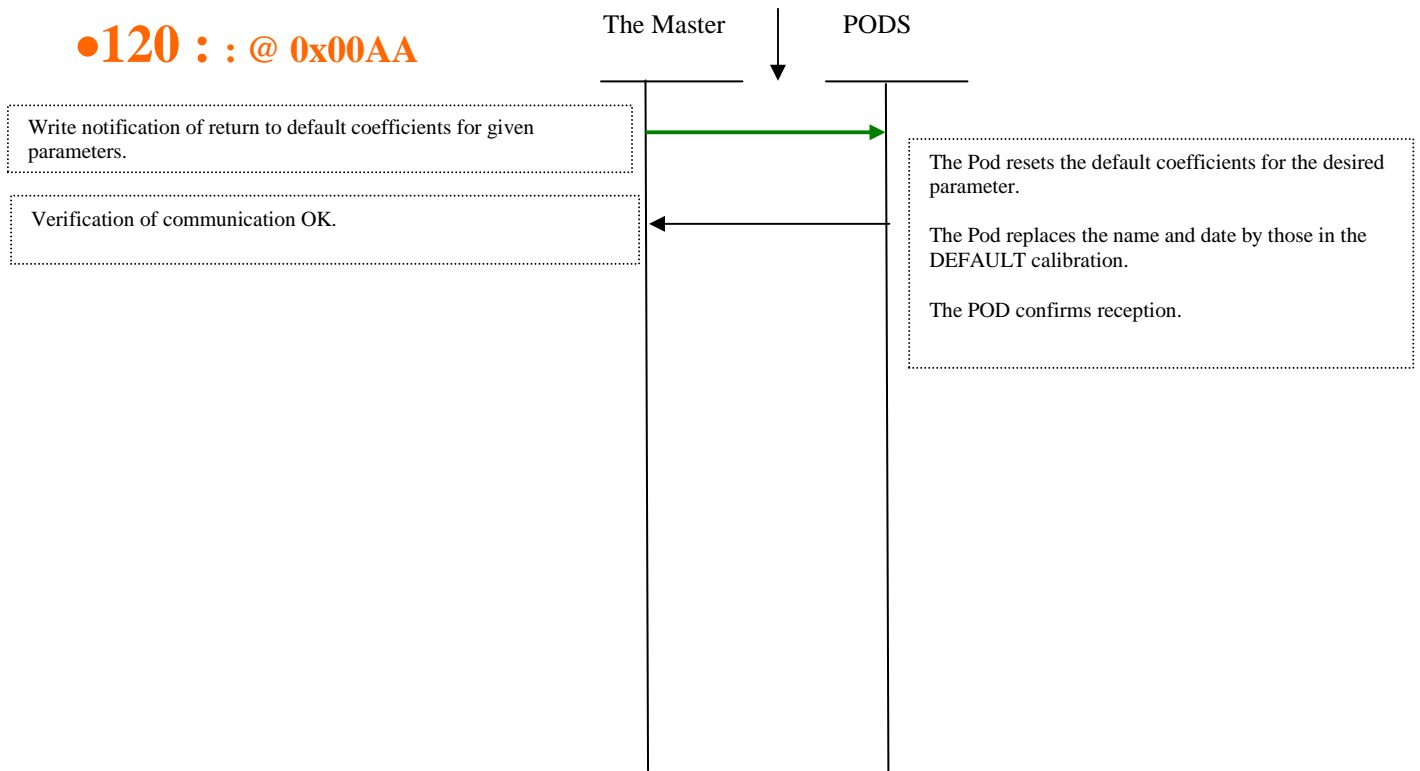
●110 :: @ 0x00AA




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2.3 Frame for returning to the default coefficient: ●120

●120 :: @ 0x00AA



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2.4 Calibration request:

General:

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

Advice: when the master wants to conduct a calibration, force averaging via com •110.

Note: Ponsel can supply certain calibration solutions.

2.4.1 Example sequence for temperature calibration:

Temperature calibration:
 1st step: Calculate offset
 Sensor fully immersed in an ice/water bath.
 •230 with the value set to '0'

Calibration standard value: 0.00 °C
 Measurement: 0.12 °C
 •60, •70, •80, •100 looped, to refresh the measurement.

When the operator validates this step: •170

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

0.12°C: this corresponds to information returned by the Pod.

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

•230, setting the coefficient for the temperature offset to '1'.


Calibration standard value: 25.00 °C
 Measurement: 22.48 °C
 •60, •70, •80, •100 looped, to refresh the measurement.

When the operator validates this step: •170

Temperature calibration:
 Validation of entire calibration

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

Validation by the operator: •210, •230 with the value set to '0'.
 Or Cancellation of the entire calibration by the operator:
 •230 with the value set to '0'.

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2.4.2 Example sequence for ODO calibration:

ODO calibration:
1st step: Calculate offset
Place the sensor in an aqueous solution of 2% sodium sulfite at ambient temperature.
•230 with the value set to '0'

Calibration standard value: 0.00%
Measurement: 0.12%
•60, •70, •80, •100 looped, to refresh the measurement.

When the operator validates this step: •170

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

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

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

•230, setting the coefficient for the ODO offset to '1'.

Calibration standard value: 100.00%
Measurement: 102.48%
•60, •70, •80, •100 looped, to refresh the measurement.


When the operator validates this step: •170

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

ODO calibration:
Validation of entire calibration

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

Validation by the operator: •210, •230 with the value set to '0'.
Or Cancellation of the entire calibration by the operator:
•230 with the value set to '0'.

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2.4.3 Example sequence for turbidity calibration:

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.
●230 with the value set to '0'

Calibration standard value: 0.00 NTU
Measurement: 0.12 NTU
●60, ●70, ●80, ●100 looped, to refresh the measurement.

When the operator validates this step: ●170 with the calibration standard value for the range chosen for the measurement.

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

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

●230, setting the coefficient for the turbidity offset to '1' in the appropriate range.

Calibration standard value: 100.00 NTU
Measurement: 102.48 NTU
●60, ●70, ●80, ●100 looped, to refresh the measurement.


When the operator validates this step: ●170 with the calibration standard value for the range chosen for the measurement.

Turbidity calibration:
Validation of entire calibration

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

Validation by the operator: ●210, ●230 with the value set to '0'.
Or Cancellation of the entire calibration by the operator:
●230 with the value set to '0'.

For this step, 1 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.

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2.4.4 Example sequence for conductivity calibration:

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.
 ●230 with the value set to '0'

Calibration standard value: 0.00 µS/cm
 Measurement: 0.12 µS/cm
 ●60, ●70, ●80, ●100 looped, to refresh the measurement.

When the operator validates this step: ●170 with the calibration standard value for the range chosen for the measurement.

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

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

●230, setting the coefficient for the conductivity offset to '1' in the appropriate range.

Calibration standard value: 84.00 µS/cm
 Measurement: 86.48 µS/cm
 ●60, ●70, ●80, ●100 looped, to refresh the measurement.

When the operator validates this step: ●170 with the calibration standard value for the range chosen for the measurement.


Conductivity calibration:
 Validation of entire calibration

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

Validation by the operator: ●210, ●230 with the value set to '0'.
 Or Cancellation of the entire calibration by the operator:
 ●230 with the value set to '0'.

For this step, 1 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.

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

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2.4.5 Example sequence for pH calibration:

pH calibration:
 1st step: Calculate offset
 Place the sensor in a calibration standard with a pH of 7.
 ●230 with the value set to '0'

Calibration standard value: 7.00 pH
 Measurement: 7.12 pH
 ●60, ●70, ●80, ●100 looped, to refresh the measurement.

When the operator validates this step: ●170.

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

pH calibration:
 2nd step: Calculate gradient
 Place the sensor in a calibration standard with a pH of 4
 (for example).
 ●230, setting the coefficient for the pH offset to '1'.

Calibration standard value: 4.00 pH
 Measurement: 4.48 pH
 ●60, ●70, ●80, ●100 looped, to refresh the measurement.


When the operator validates this step: ●170

Note: The calibration standards pH4, pH9 and pH10 can be used.

pH calibration:
 Validation of entire calibration

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

Validation by the operator: ●210, ●230 with the value set to '0'.
 Or Cancellation of the entire calibration by the operator:
 ●230 with the value set to '0'.

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2.4.6 Example sequence for ORP calibration:

ORP calibration:
 1st step: Calculate offset
 AUTOMATIC ZEROING

- 230 with the value set to '0'
- 180 (activation of automatic zeroing).

Measurement: 2.12 mV

- 60, •70, •80, •100 looped, to refresh the measurement.

When the operator validates this step: •190.

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

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

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


- 60, •70, •80, •100 looped, to refresh the measurement.

When the operator validates this step: •170

ORP calibration:
 Validation of entire calibration

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

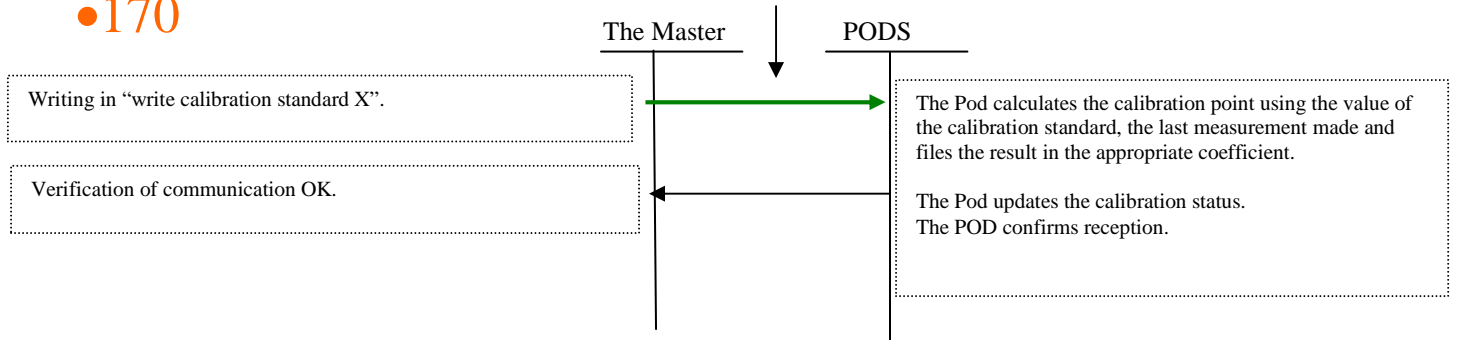
Validation by the operator: •210, •230 with the value set to '0'.
 Or Cancellation of the entire calibration by the operator:
 •230 with the value set to '0'.

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2.4.7 Frame for calculation of a given calibration point: ●170, ●180, ●190


This communication is used by the master when it needs to validate a calibration point. The Pod 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 Pod is placed. For the calculation, the Pod retrieves the last measurement point.

●170



“Calibration standard X” depends on the calibration point performed by the operator (either calibration 1 of the temperature, calibration 2 for the temperature, or calibration 1, or calibration 2, etc. up to calibration 16).

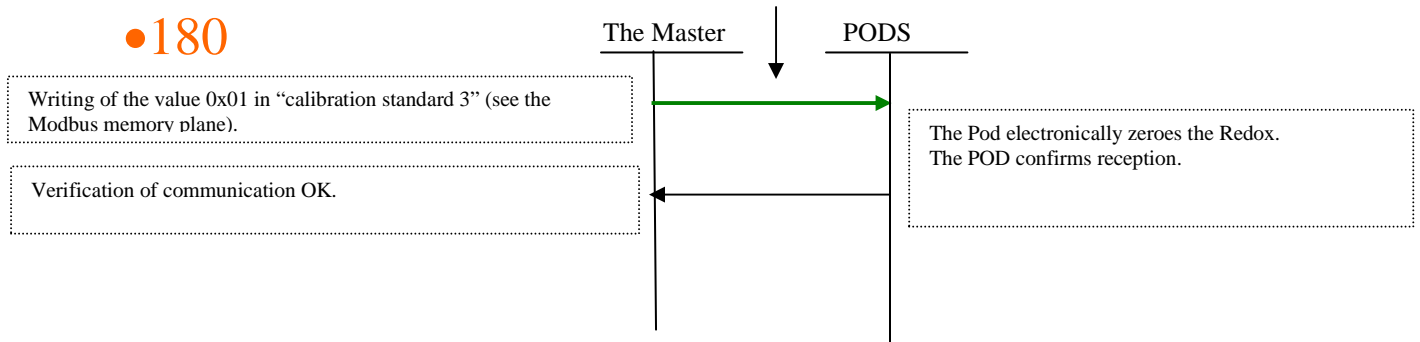
The description of each calibration standard is designated in the Modbus memory plane.

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| | MODBUS RTU specifications | Modbus_Specifications v010-EN.doc | 30/01/2009 | 010 | 21/24 |

Special case of the ORP offset:

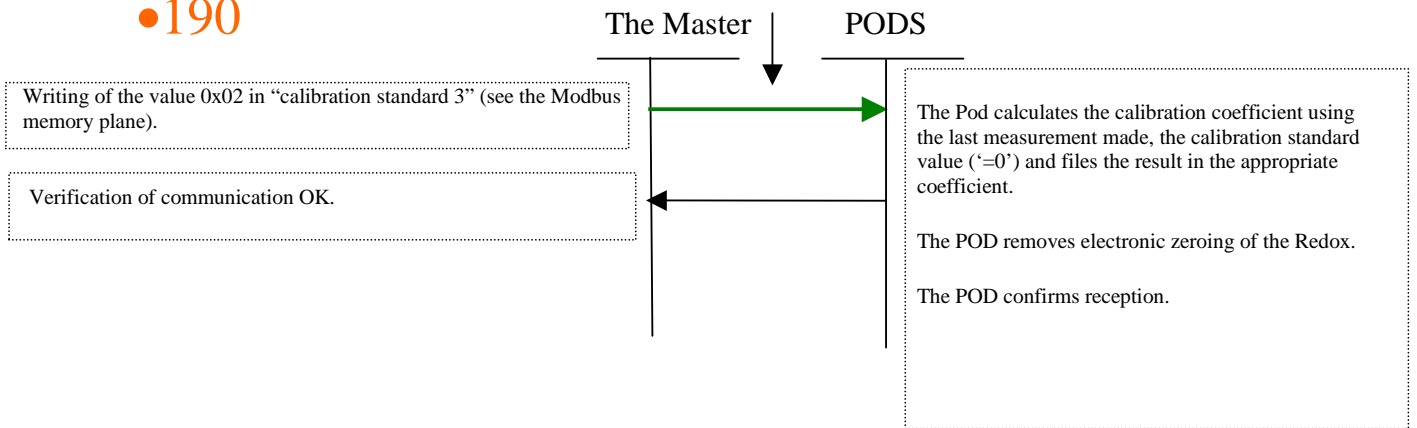
For the Redox offset “calibration standard 3”, the master must send com •180. The sensor can be placed in the open air since the offset is conducted electronically.


•180



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

•190



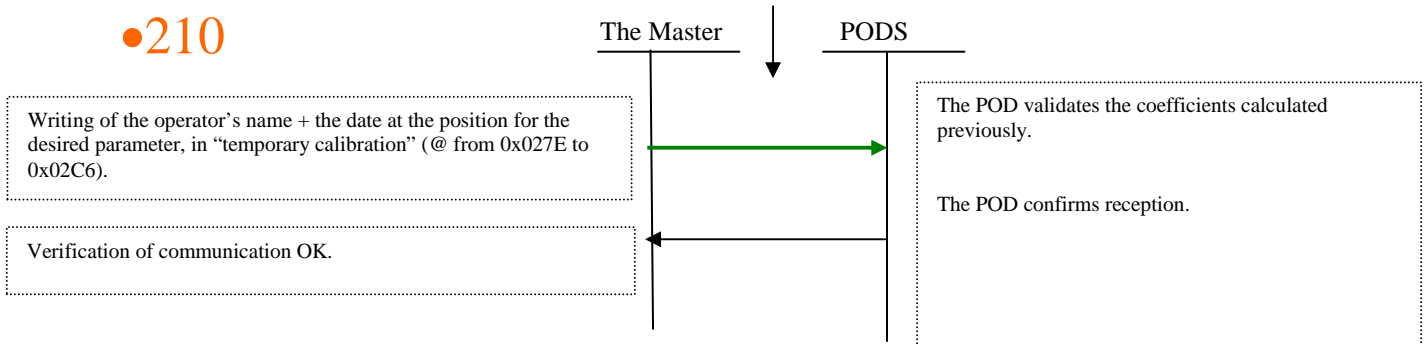
|  | General specifications | Reference | Date | Revision | Page |
|---------------------------------------------------------------------------------|------------------------|---------------------------|-----------------------------------|------------|------|
| | | MODBUS RTU specifications | Modbus_Specifications v010-EN.doc | 30/01/2009 | 010 |

2.4.8 Frame for validating a calibration ●210

Calibration of one or more coefficients is validated by the Pod when the master sends this communication signal (●210).

Important: If the master does not send this frame (and ●230 is set to the value 0x0000), then the calibration will not be taken into account when the master requests a measurement.

●210

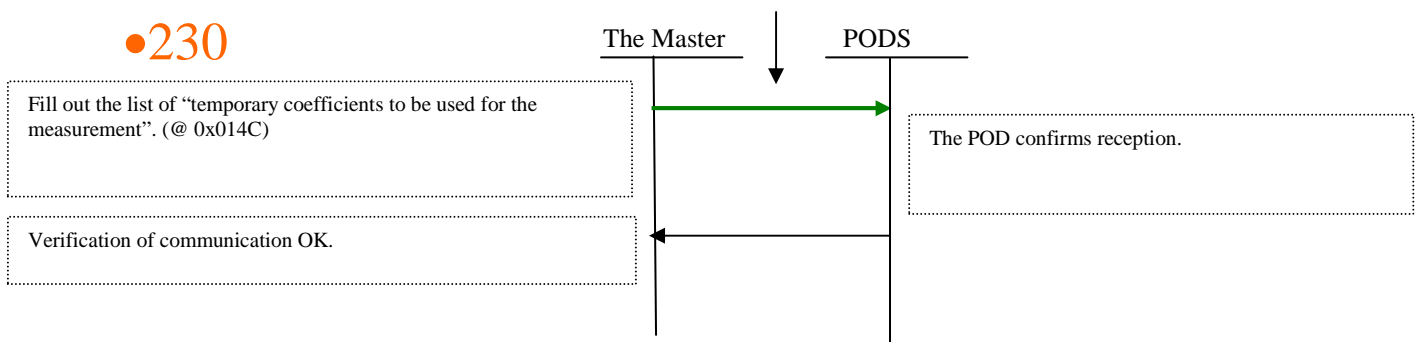



2.4.9 Frame for filling out the list of "temporary coefficients to be used for the measurement" ●230

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

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

●230



| | | | | | | |
|---------------------------------------------------------------------------------|-------------------------------|--|--------------------------------------|-------------|-----------------|-------------|
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3 Modbus communication frame example:

3.1 Apply the 11 address (0x0B) to all the PODS connected:

Emission frame:

| POD address | Function code | Register address (see Modbus memory plane) | | Registry value | | CRC 16 | |
|-------------|---------------|--------------------------------------------|------|----------------|------|--------|------|
| 0x00 | 0x06 | 0x00 | 0xA3 | 0x00 | 0x0B | 0x39 | 0xFE |

Reception frame: none (with the 0 address, no Pod replies).

3.2 Start a measurement order for all parameters on all PODS with the 11 address:

Emission frame:

```

45 00 00 00 00 06 00 00 00 A3 00 0B 39 FE
|-----|-----|-----|-----|-----|
|  POD  |  FC  |  RA  |  RA  |  RV  |  RV  |  CRC |  CRC |
|-----|-----|-----|-----|-----|

```

Reception frame:

```

45 00 00 00 00 06 00 00 00 A3 00 0B 39 FE
|-----|-----|-----|-----|-----|
|  POD  |  FC  |  RA  |  RA  |  RV  |  RV  |  CRC |  CRC |
|-----|-----|-----|-----|-----|

```

3.3 Read the status of the measurement from PODS with the 11 address:

Emission frame:

```

45 00 00 00 00 06 00 00 00 A3 00 0B 39 FE
|-----|-----|-----|-----|-----|
|  POD  |  FC  |  RA  |  RA  |  RV  |  RV  |  CRC |  CRC |
|-----|-----|-----|-----|-----|

```

Reception frame:

```

45 00 00 00 00 06 00 00 00 A3 00 0B 39 FE
|-----|-----|-----|-----|-----|
|  POD  |  FC  |  RA  |  RA  |  RV  |  RV  |  CRC |  CRC |
|-----|-----|-----|-----|-----|

```

Registry value: StmT: 0 (measurement OK)
 Stm1: 4 (measurement impossible, out of specifications)
 Stm2: 4 (measurement impossible, out of specifications)
 Stm3: 4 (measurement impossible, out of specifications)
 Stm4: 4 (measurement impossible, out of specifications)

