9100

Technical Manual

Viscosity and temperature transmitter

Original version

SOFRASER
Pioneering viscometry since 1972

REF.: 423-0

IMPORTANT

THE OFFSET ADJUSTMENT IN THE AIR MUST BE THE FIRST TASK COMPLETED.

Offset adjustment procedure is detailed in § 3.3.

1. CLEAN AND DRY THE SENSOR ROD.
2. BE SURE THE PROCESS IS EMPTY. THE ROD MUST BE VIBRATING IN THE AIR.
3. INSTALL THE SENSOR ON THE PROCESS AND FIX IT WITH ITS 4 SCREWS.
4. POWER ON THE DEVICE, WAIT AT LEAST 30 MINUTES.
5. PRESS THE “HOME” BUTTON UNTIL REACHING THE OFFSET MENU AND PRESS “OK”.
6. FOLLOW THE INSTRUCTIONS DISPLAYED ON THE ELECTRONICS SCREEN.
7. PRESS “OK” TO ADJUST THE OFFSET. IT MEANS THE RAW SIGNAL IS SHIFTED TO THE VOLTAGE REFERENCE DEFINED IN THE FACTORY CALIBRATION STAGE.
   THE NEW OFFSET VALUE IS THEN DISPLAYED.

Table of contents

1. Transmitter principle

The measuring chain is composed of three inseparable elements: the sensor, its cable and the 9100 transducer that controls it. The sensor cannot be used with another transducer or another cable type or length because they are all a part of the resonant loop so they are matched together as one vibrating system.

The active part of the sensor is composed of a vibrating rod held in oscillation at resonance frequency by driving magnets. When the rod is immersed into a viscous material, the amplitude of the vibration is dampened. The vibration amplitude varies according to the product viscosity where the rod is immersed.

The sensor receiving coil detects the response and the signal is converted to a viscosity value through the electronic device. The factory calibration is performed with standard oils.

The transducer acquires the coils' amplitudes and frequency and generates various signals. These signals represent the properties being measured. It is also in charge of powering the whole system. It gives viscosity and temperature information through the serial communication and displays it. The transmitter also allows simple settings as the very important "zero in the air" procedure.

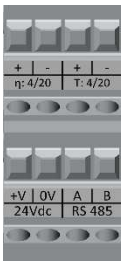
2. Transmitter technical characteristics

2.1 Electronic device size

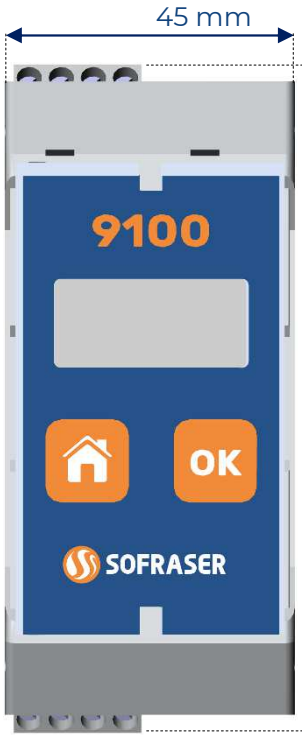
The electronic box has the purpose to be fixed on a DIN rail, close to the process line. Its LCD screen continuously displays the viscosity value and, when connected to a Pt100 probe, the temperature value.

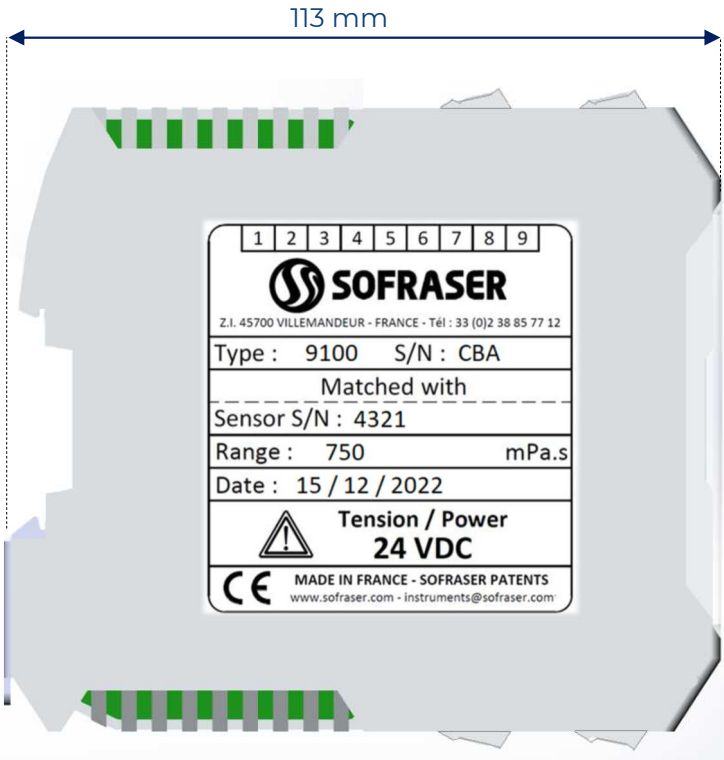
The ID label is stuck on a side of the box. Main information is written down. There are also other stickers on each connector to remind how to connect the sensor, the outputs and the power supply (see §2.3).

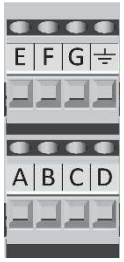
It has an IP20 rating. Its weight is about 200 g. Hereunder are the different views and the associated dimensions (in mm) of the device.



Top connectors







Bottom connectors

2.2 Main features

2.2.1 Best performance conditions

The processor must be connected to a **24 VDC** (± 2.4 V) stabilized and filtered power supply.

It is very important to respect the polarity.

The operating temperature for this transmitter is up to 50 °C.

It is recommended to install this transmitter in a safe place with a stable temperature and non-condensing atmosphere.

To ensure the proper behavior of the two 4-20 mA current outputs, it is highly recommended to connect them to a PLC or a regulator through a galvanic isolated device (one for each current output).

Never connect the 4/20 mA outputs to a power supply, an active PLC input or tester

2.2.2 Display

The 9100 transmitter device has a 2-line alphanumeric backlighting LCD screen. The effective dimensions of this screen are 40 mm * 10 mm. One line can display 8 digits. This screen is showing the different menus with the help of the 2-button face plate.

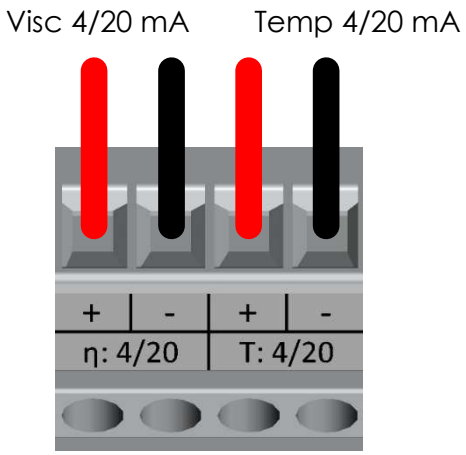
2.3 Connections

All the connections to the electronic device are made through four connectors.

There are two 4-pin connectors on the top for the power supply and outputs and two other 4-pin connectors on the bottom for the sensor. Refer to the sensor's technical manual for wires A to F identification. Connections have to be made **by the user** scrupulously respecting the following indications.

2.3.1 Top connector – current outputs

If the current outputs are used, the plugging scheme of the connector is as follows:



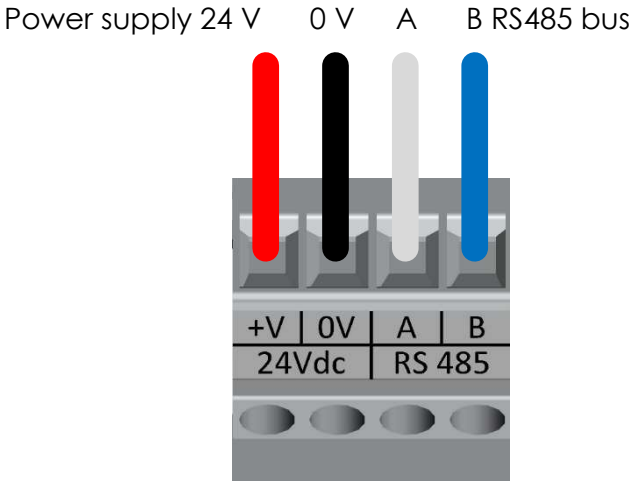
The Pins η: 4/20 and T: 4/20 are used to connect the 4/20 mA outputs for **V**iscosity and **T**emperature. They have been calibrated according to customer's request. They must be connected to installations with an impedance of not more than 400Ω. It is recommended to use shielded cables for these outputs and the shield should be connected to the earth. They are already powered internally.

When the measured value is out of the configured range of the 4/20 output (below minimum value or over maximum value), the output passes in default mode and is forced to 2 mA.

Never connect the 4/20 mA outputs to a power supply, an active PLC input or tester

2.3.2 Top connector – Power supply and RS485 port

The plugging scheme of the connector is as follows:



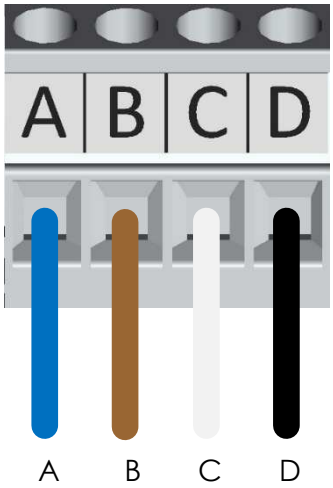
Pins 24Vdc +V and 0V are for the **24 VDC** (± 2.4 V) stabilized and filtered power supply.

Caution: watch out the polarity

Pins A and B are used to connect the RS-485 cable in order to communicate with an external console.

2.3.3 Bottom connector – sensor's coils

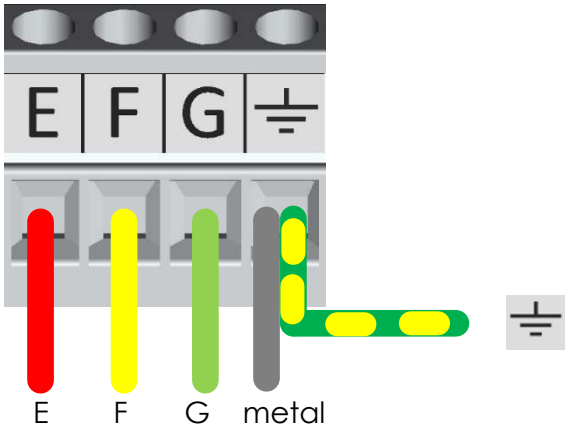
The plugging scheme of the connector is as follows:



Pins A, B, C and D make the connection between the electronic board and the coils wires of the MIVI sensor cable. This is how the driving signal is generated and how the receiving signal is measured.

2.3.4 Bottom connector – Pt100 temperature probe & earth

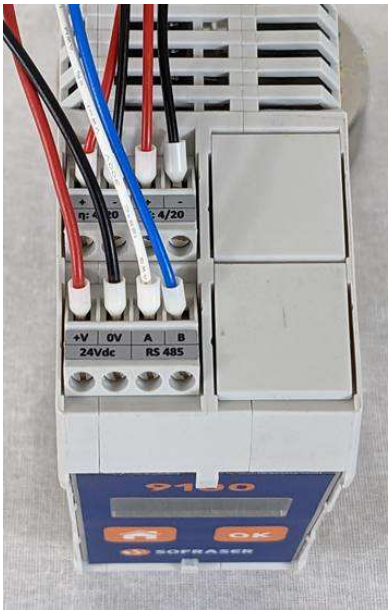
The plugging scheme of the connector is as follows:



Pins E, F and G are used to connect the 3 wires of the optional Pt100 temperature probe.

Last Pin must be connected to

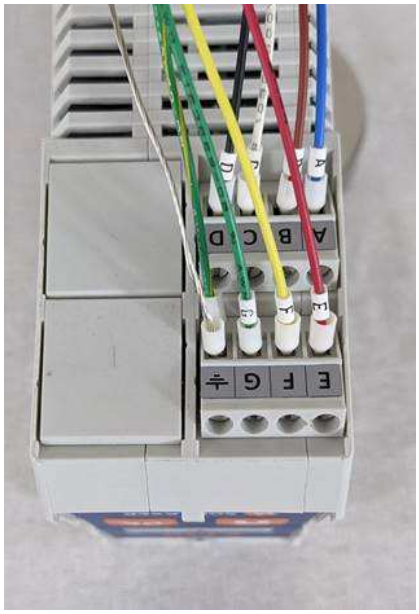
- the "metal" wire of the MIVI sensor cable
- the ground earth of the workshop



Top connectors

Current outputs

24VDC power supply & RS485 output



Bottom connectors

Viscosity sensor

Earth & Pt100 temperature probe

2.4 Backlight setting

In standard, 9100 is delivered with disabled display backlight. The backlight can be enabled thanks to a switch located on the back side of the display. Hereunder the procedure that describes how to access to the switch and how to set it.

Power off the transmitter and remove the cover on the top side of the transmitter with a small flathead screw driver.

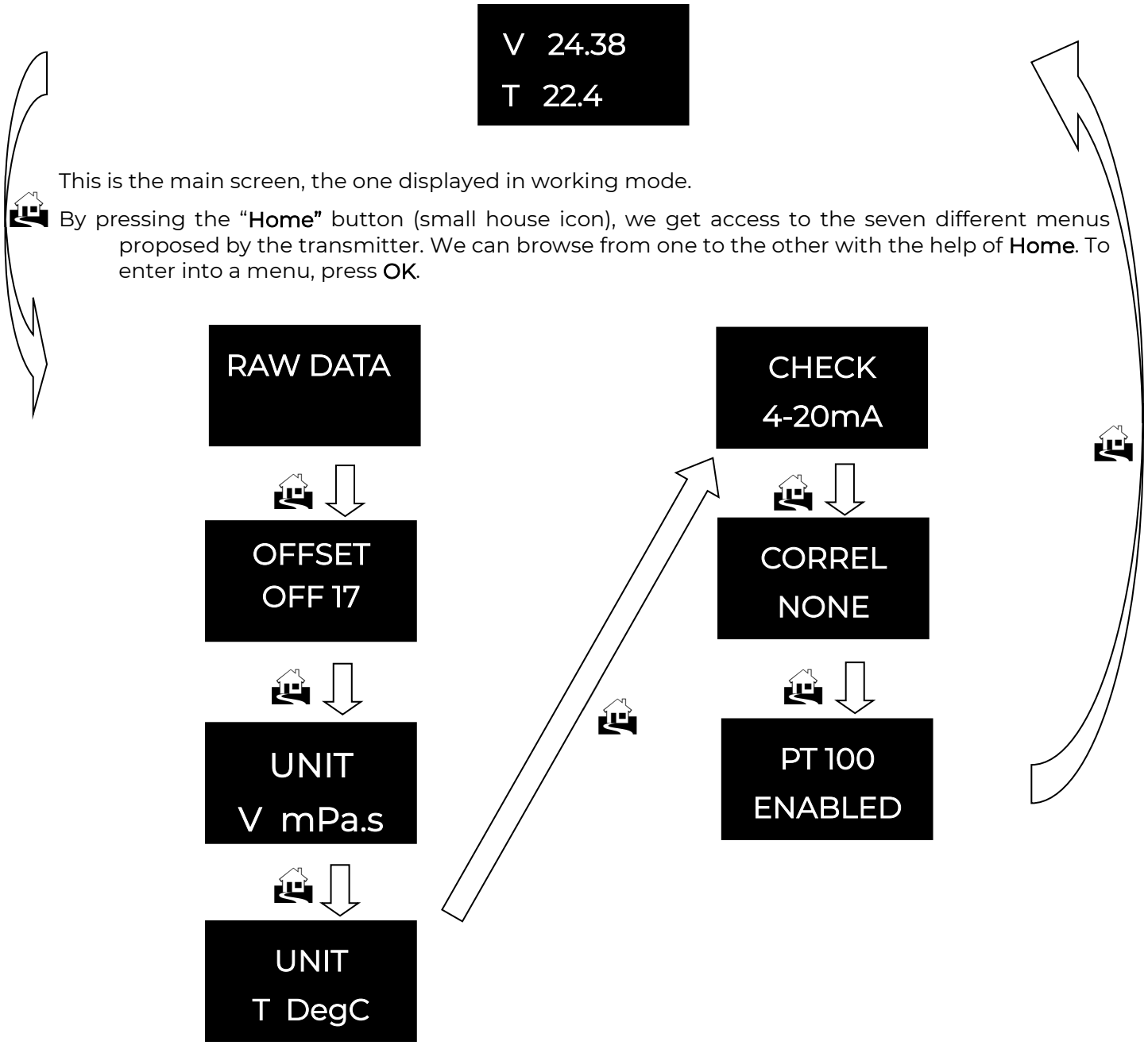
Change the position of the switch to active and deactivate the backlight.

Put the cover back on.

3. The 9100 operating functions

3.1 Start and menus

After turning on the device, the LCD screen switches on and it will take a few seconds to display the measured viscosity and temperature values.



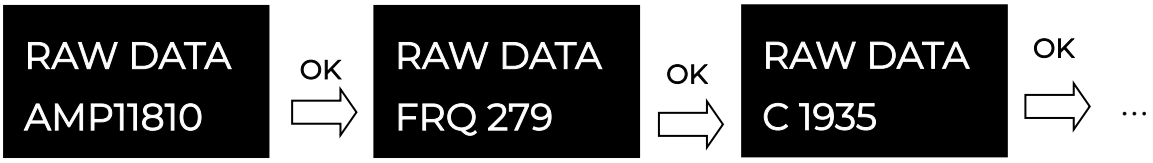
This is the main screen, the one displayed in working mode.

By pressing the "**Home**" button (small house icon), we get access to the seven different menus proposed by the transmitter. We can browse from one to the other with the help of **Home**. To enter into a menu, press **OK**.

If both **Home** and **OK** buttons are pressed simultaneously, the 9100 display will move back to the main screen showing the viscosity and the temperature.

3.2 Raw data

This menu has eight screens. It allows the user to read the raw data of the main measured signals and other information specific of the unit.



Mainly, these data are used to diagnose when something wrong happens with the sensor.

Passing from one screen to the next is done thanks to **OK** button and the order is as follow:

- AMP: The amplitude value, image of the amplitude of the oscillating rod with no correction and no calculation.
- FRQ: The frequency of the vibration.
- C: The coil value, image of the inner temperature.
- TC: The inner temperature.
- PROG: The program version is displayed for after-sale purposes.
- The serial number of the sensor (4 digits) and the electronics (3 letters).
- D: The date of manufacturing.
- FSR: The viscosity range of the sensor.

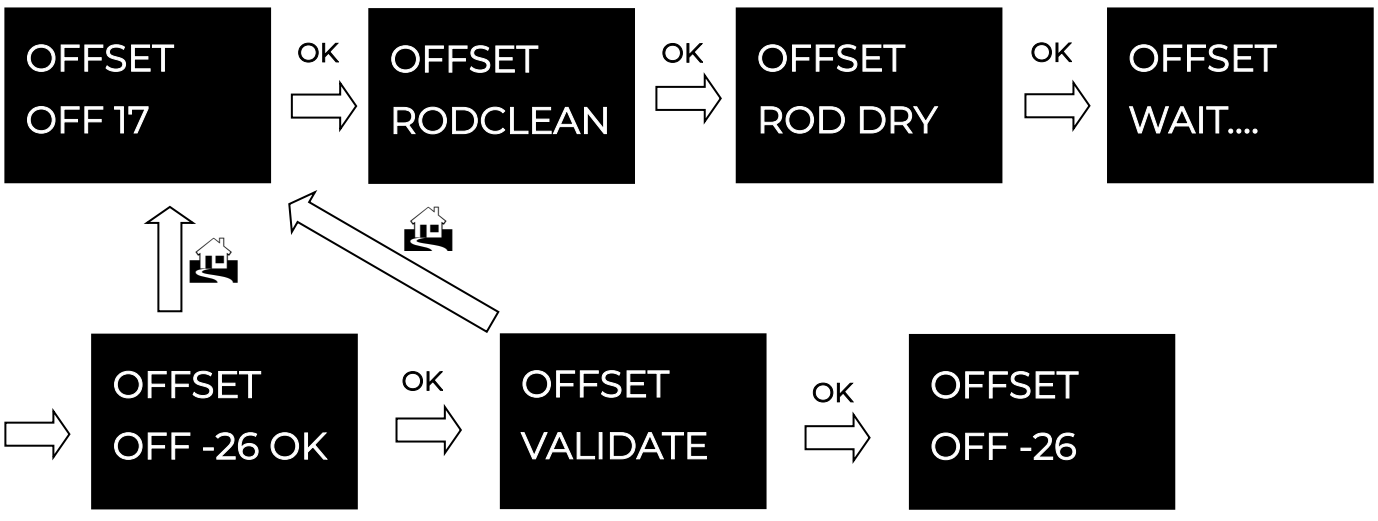
Exit this menu by pressing **Home**.

3.3 Offset

In this menu, we set the zero in the air. This is a very important step in the installation procedure of the equipment and it must be done each time the sensor is installed again after being removed for cleaning, calibration or maintenance.

Before proceeding to the zero setting, the rod must be clean and dry. Be sure the process is empty and that the rod is vibrating in the air at a stabilized temperature. The sensor must be fixed on its final position and will have to remain so. If not, the offset calibration will have to be done again.

Press **OK** to enter the **Offset** menu. Two warning messages will appear when pressing **OK** confirming that the rod must be clean and dry. If **OK** is pressed, the transmitter calculates and then displays after a couple of seconds the new adjusted value (here -26). The user can validate the new offset pressing **OK** or he can get out of the menu by pressing **Home**.



The viscosity signal delivered to the outputs of the electronic device is calculated by using the adjusted amplitude of the rod. If the offset is done in a wrong way or has been forgotten, the viscosity value will be wrong.

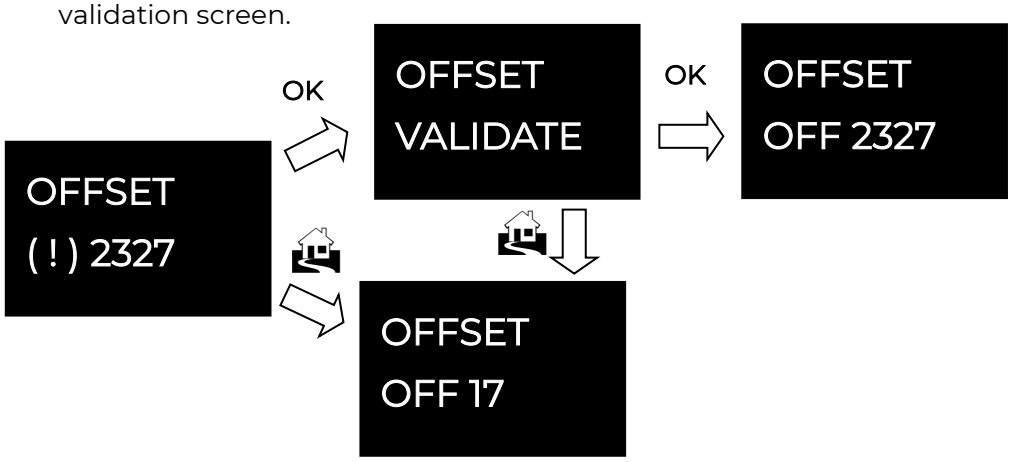
It is THE essential setting during installation and has to be performed with the most extended attention in order to set the MIVI in its best conditions for optimal measurements.

Note: *The user should wait at least one minute between two zero adjustments, in order to get accurate signals and calculations.*

If the offset is not done correctly, a warning message will appear:

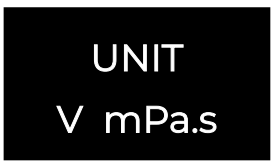
This message appears automatically when the offset value is too high (or too low in the negative). If so, check that the sensor is correctly installed on the process, with the vibrating rod clean and dry and let the unit stabilize. Then redo the zero in the air procedure.

If this message remains even after carrying all the precaution recommended by Sofraser, the end-user can anyway validate the Offset value by pressing **OK** and then **OK** again after a last validation screen.



3.4 Viscosity and temperature units

It is possible to select the viscosity and the temperature units for the main display on the LCD screen.



Press **OK** to enter the menu, choose between the different units by pressing **OK** and validate the choice with **Home**.

The choices are mPa.s and Pa.s for the viscosity and degree Celsius (°C) or degree Fahrenheit (°F) for the temperature.

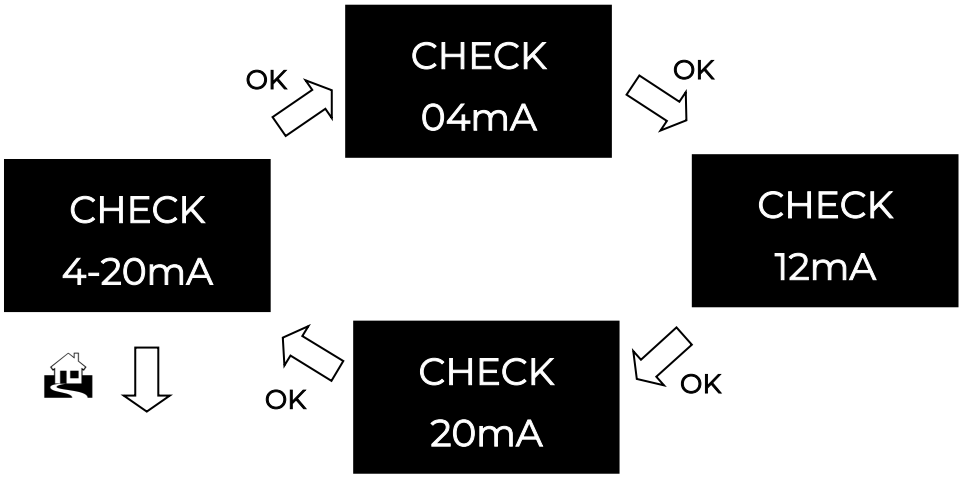
3.5 Check 4-20 mA

In the same checking approach, this menu lets the user check the good calibration of the 4-20 mA outputs. In this function, we ask the processor to send three different known current values to the outputs and the user has to check with the help of an ammeter the value which is delivered on the dedicated top connector (see chapter 2.3.1).

Do not use an active tester (write mode), only use a passive tester like an ammeter (read mode).

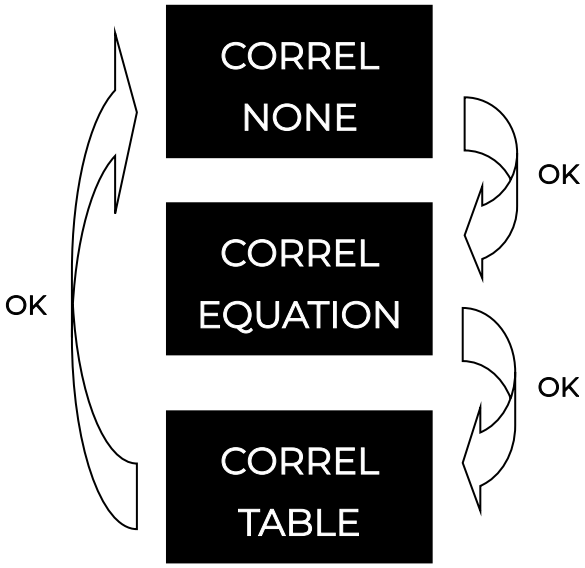
By pressing **OK**, it sends the first current value (04 mA). Then by browsing with **OK**, it goes to the next two values (12 mA and 20 mA).

Exit the menu by pressing **Home**.



3.6 Correlation

This menu allows the user to enable or disable the correlation function. After positioning on the Correlation menu change the status by pressing **OK** and exit by pressing **Home** when the desired status is reached.

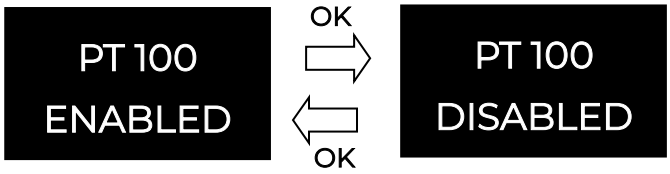


It is necessary to use the Sofraser Interface Software (SIS, see chapter 5) to choose the type of correlation (Linear with ax + b formula or Table) and to change the values of correlation.

When the correlation is activated, an asterisk ***** appears on the bottom right corner of the main screen (see chapter 2.2.2).

3.7 Enable or disable temperature

This menu allows the user to enable or disable the display of temperature on the main screen. After positioning on the Temperature menu, change the status by pressing **OK** and exit by pressing **Home** when the desired status is reached.



Pressing Home one more time leaves the Menu and goes back to the main screen (see chapter 2.1).

4. RS485 frame protocol

Goal: read viscosity and Pt100 values using RS-485 communication

S: send from the console to the board
R: response from the board to the console
Viscosity: viscosity in the unit displayed on the 9100 screen (mPa.s or Pa.s)
Pt100: value in the unit displayed on the 9100 screen (°C or °F) of the temperature read by the probe when there is one

COM port characteristics:

Speed: 9600 bits/s Number of bits: 8 Parity: none Stop bit: 1

Generic frame format (all the data in the frames are in Hexadecimal)

S = SN 04 XX XX YY YY <CRC-16>
R = SN 04 AA {DATA} <CRC-16>

SN: slave number
04: reading function
XX XX: starting point for the addresses to be read
YY YY: number of words to be read
AA: read bytes number
DATA: content of all the asked addresses
<CRC-16>: checksum Modbus RTU on 16 bits (can be automatic if PLC or software is compatible)

NB: 1 word = 2 bytes

List of addresses:

Data to read	Address in Hexadecimal	Number of words	Multiplied factor of the data received	Frame to send with a unit at slave address 01
Viscosity *(in cP, P mPa.s or Pa.s)*	0x 00 14	2 words 4 bytes (UINT_32)	1,000 or 10,000 or 1,000,000 (see table below)	01 04 00 14 00 02 31 CF
Temperature *(in °C or °F)*	0x 00 12	2 words 4 bytes (INT_32)	100,000	01 04 00 12 00 02 D1 CE

The viscosity value read through the RS-485 is the viscosity displayed on the 9100 main screen multiplied by a factor which depends of the viscosity range of the unit.

Therefore, the viscosity read through the RS-485 has to be divided by a factor in function of its full-scale range and which is indicated in the table below:

Full scale range	Multiplied factor
0 to 4,000 mPa.s	1,000,000
4,001 to 40,000 mPa.s	10,000
Above 40,001 mPa.s	1,000

Example 1: to read the viscosity of a unit which has a slave address 01 (01 in Hexadecimal), with a full-scale range of 100 mPa.s and which measures a viscosity of 67.65 mPa.s

S = 01 04 00 14 00 02 31 CF
R = 01 04 04 04 08 4F 18 4F 4C

01: slave number of the viscometer in Hexadecimal
04: reading function
00 14: viscosity address
00 02: number of words
31 CF: checksum of sending frame
04: number of bytes read
04 08 4F 18: viscosity value in Hexadecimal which is converted to 67,653,400 in Decimal and this value has to be divided by 1,000,000 (because range is below 4,001 mPa.s) so the viscosity is 67.65 mPa.s
4F 4C: checksum of receiving frame

Example 2: to read the viscosity of a unit which has a slave address 01 (01 in Hexadecimal), with a full-scale range of 10,000 mPa.s and which measures a viscosity of 3,495.2 mPa.s

S = 01 04 00 14 00 02 31 CF
R = 01 04 04 02 15 54 DC D4 A1

01: slave number of the viscometer in Hexadecimal
04: reading function
00 14: viscosity address
00 02: number of words
31 CF: checksum of sending frame
04: number of bytes read
02 15 54 DC: viscosity value in Hexadecimal which is converted to 34,952,412 in Decimal and this value has to be divided by 10,000 (because range is between 4,001 and 40,000 mPa.s) so the viscosity is 3,495.2 mPa.s
D4 A1: checksum of receiving frame

Example 3: to read the temperature of a unit which has a slave address 01 (01 in Hexadecimal), which measures a temperature of 25.92 °C

S = 01 04 00 12 00 02 D1 CE
R = 01 04 04 00 27 8C FE AE CF

01: slave number of the viscometer in Hexadecimal
04: reading function
00 12: temperature address
00 02: number of words
D1 CE: checksum of sending frame
04: number of bytes read
00 27 8C FE: temperature value in Hexadecimal which is converted to 2,591,998 in Decimal and this value has to be divided by 100,000 (always the same factor) so the temperature is 25.92 °C
AE CF: checksum of receiving frame

5. Sofraser Interface Software

The Sofraser Interface Software (SIS) has been designed for working with the 9100 transmitter. It allows the communication between the electronic board of the 9100 and a computer in order to make some data logging or to set some parameters.

This software has been designed to work on Windows XP, Windows Vista, Windows 7 and Windows 10 systems. The communication is established through the RS485 port, MODBUS (code RTU) protocol.

This is optional and is not included in standard with 9100 device.

5.1 The main features

The main features of the SIS are as following:

- display and refresh the dynamic values from the sensor: viscosity, temperature (when there is a Pt100 probe), amplitude, coil and frequency signals
- make the zero adjustment in the air
- data log of the dynamic values in an Excel file
- adjust some correlations for the viscosity

5.2 The user-friendly interface

When connecting the 9100 to a computer, choose the COM port on which is connected the viscometer. Then click on the double arrow button; the SIS will automatically detect the board, display the serial number of the device and open a new window. The user is ready to start working with the equipment.

Each equipment is protected with a registration. At first use, you will have to activate the software by entering the registration key given by Sofraser (go to menu “File\Add Sensor” or “F6”). From then on, the SIS installed on this computer will always be able to communicate with the 9100.

Different levels of security have been set up in the SIS, so that different users can have different possibilities on the equipment through menu “Options\Connect As” or “F9”.

User	Password
Technician	1111
Manager	1111

6. Troubleshooting

The hereunder table lists all the reasonable malfunctioning and some advices in order to analyze them and to fix them:

Observed malfunctioning	Checking advice
The screen does not light on when we turn on the power supply.	Check the wiring connections and the power supply of the equipment (see § 2.2.1 and 2.3.2). Take care to the polarity of the 24 VDC power supply. Inversion may damage the electronics board. If it does not solve the problem, please contact Sofraser or your distributor.
The sensor is not vibrating but the screen lights on.	Check the resistor value between wires A and B and between wires C and D on the sensor cable.
The screen displays Out Of Range instead of the viscosity.	The viscosity measured is over the calibrated range of the unit. Contact Sofraser or your distributor for a new calibration.
The screen displays Sensor BREAK.	Check the connections of the wires A to D of the MIVI sensor on PIN 11 to 14 on the bottom connector (see § 2.3.4).
The screen displays Pt100 BREAK.	Check the connections of the wires E to G of the MIVI sensor on PIN 15 to 17 on the bottom connector (see § 2.3.3). If the MIVI sensor is not equipped with a Pt100, just disable temperature measurement (see § 3.7)
The screen displays an asterisk * on the bottom right corner.	It indicates that a correlation is activated (see § 3.6).
The temperature is not displayed on the main screen.	The temperature feature is deactivated (see § 3.7 to activate it).
The value of the current 4-20 mA output is not consistent with the measured value displayed on the main screen.	Check the range of the current output in the specific notes. Contact Sofraser or your distributor if the 4-20 mA output range must be modified.
There is no signal on the current output.	Contact Sofraser or your distributor.
Current output delivers 2 mA	The physical value is out of the thresholds set for the current output. See specific notes. Contact Sofraser or your distributor for changing the setting.