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Fiber Optic Temperature Sensor

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FOH201
User manual

WARNINGS

WARNING: HIGH PRESSURE!

High pressure gases and liquids are potentially hazardous. Energy stored in these gases or liquids can be released suddenly and with extreme force. High pressure systems should be assembled and operated only by personnel who have been trained in proper safety practices.

WARNING : HIGH STRAIN!

Highly strained materials and parts are potentially hazardous. Energy stored in these materials or parts can be released suddenly and with extreme force. Highly strained systems should be assembled and operated only by personnel who have been trained in proper safety practices.

WARNING: NOT EXPLOSION PROOF!

Installation of this instrument in an area requiring devices rated as intrinsically safe is not recommended.

WARNING: VOLTAGE SUPPLY!

Use only the wall plug-in power supply delivered with your instrument and verifies that the input voltage and frequency are compatible with the power outlet.

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1. Quick start

1.1 FOH201 Powering

Connect the plug-in wall or tabletop power supply to a power outlet. Verify that the power supply complies with the voltage and frequency outlet. Connect the power cable to the PicoSens power connector (Figure 1.1).

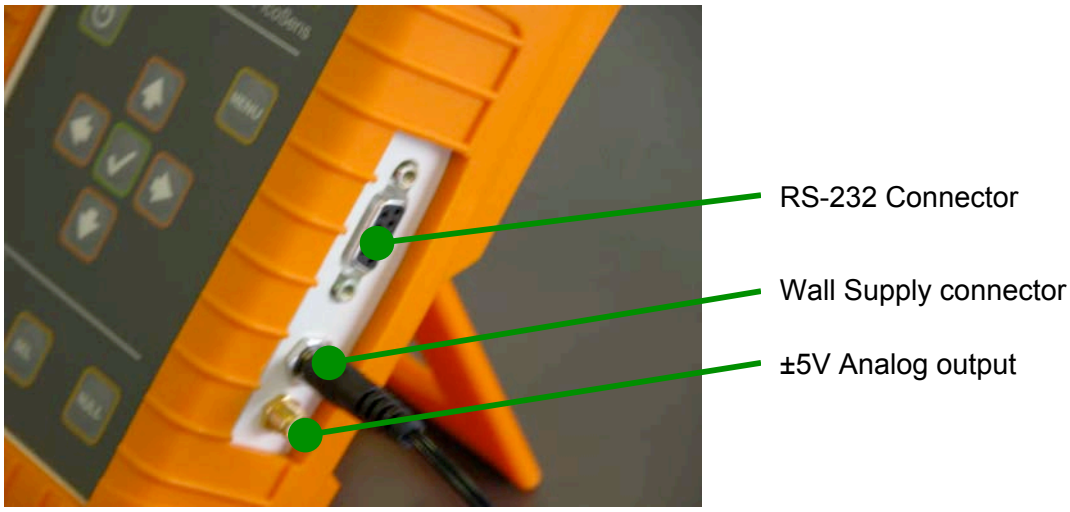


Figure 1.1: Electrical connectors

The FOH201 can also be operated from a 9-Volt battery. 9-Volt battery can be replaced by getting access to the battery compartment as follows: 1) Remove the rubber boot; 2) remove screws holding the battery panel, 3) install a 9-Volt battery with proper orientation of the polarity (Figure 1.2).

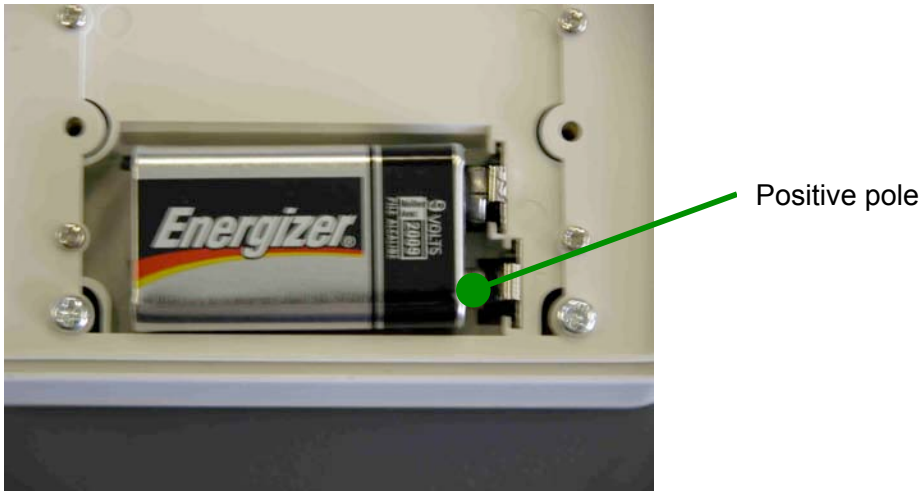


Figure 1.2: Polarity of 9V battery

Note: Battery operation is not provided for performing continuous measurements so it should be used for short term field measurements only.

1.2 Sensor Connection

OMEGA fiber-optic sensors or transducers must me mated to the FOH201 output connector (Figure 2). The optical connector provided with the FOH201 is usually a square push-pull SC-type connector mounted with a SC-SC type mating. Remove the protective cap of the mating and engage the sensor connector with the orientation key properly oriented. It is a good practice to clean the sensor connector prior to connect it to the signal conditioner.

NOTE: always replace the protective dust cap on the mating when there is no sensor connected. Always replace the protective dust cap on the sensor fiber-optic connector when not in used

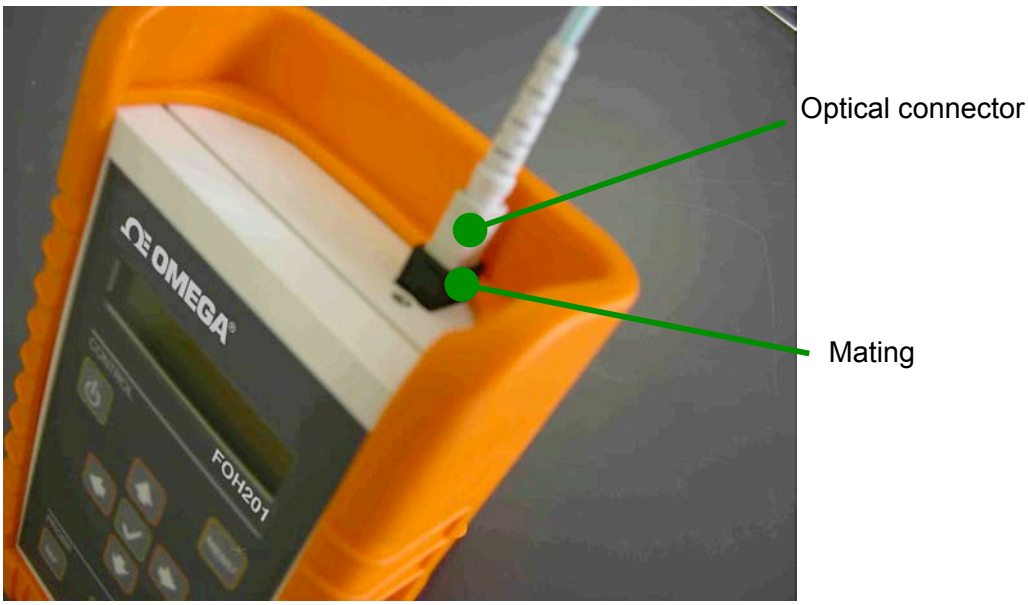
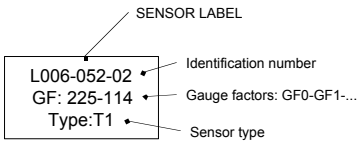


Figure 2: SC mating for connecting the fiber-optic sensor

1.3 FOH201 Setup

The FOH201 is compatible with all OMEGAS' WLPI type sensors or transducers for measuring various parameters such as temperature, pressure, strain and displacement. (To properly use a specific sensor, its corresponding Sensor Type and Gauge Factor(s) must be entered into the FOH201 non-volatile memory as explained next. These numbers contain the parameterization factors of the sensor that is the sensor type and the sensor calibration parameters. These factors are indicated on a label fixed on the optical cable of the sensor, nearby the optical connector as indicated on the left figure. The label shows the identification number of the sensor (used for record purpose only), the Gauge Factors GF0, GF1, …, and the Sensor Type.



1.4 Define a sensor

Before selecting a specific sensor, it must be defined that is its corresponding Sensor Type and Gauge Factor must be stored into the non-volatile memory of the PicoSens. The following example shows how to define a T1 type temperature sensor.

Enter Define Sensor Menu

Confirm Define Sensor Menu

Select Sensor Type; use up or down arrow keys

Use Default Name or select a name for the sensor using up or down arrow keys (00 to 99 numbers only)

Default Gauge Factor GF0

Enter Gauge Factor GF0; use arrow keys and validate the entry with the confirm (√) key

Repeat above procedure if other GFs required

Quit the menu

1.5 Select a sensor among previously defined sensors

Once a sensor is defined, it can be selected from the defined sensor list as indicated below.

Enter Sensor Select Menu

Select a defined sensor in the list

Confirm selection

1.6 Zeroing a sensor (when required)

If required, zeroing a sensor is easily done with the NULL button.

Used with sensors that require zeroing

2. Operating Principle

The FOH201 is a fiber-optic white light interferometric signal conditioner having the capability of accurately measuring the absolute path length difference of various type of sensing interferometers. OMEGA produces a variety of interferometric sensors that are based on either so-called Fabry-Perot interferometer (low-finesse version) configuration or the polarization interferometer configuration. For example, OMEGA temperature sensors are based on a polarization sensing interferometer using the temperature-dependent optical properties of a birefringent crystal while OMEGA pressure, strain and displacement sensors are based on a Fabry-Perot sensing interferometer where the distance between the two mirrors of the interferometer varies as a function of the measured parameter. In all cases, the sensing interferometer is made so its path length difference varies with the physical parameter of interest. The path length difference of the sensing interferometer is accurately measured with a nanometer resolution and this over 30 000 nanometers range.

Physical measurements are possible if the path length difference of the sensing interferometer is a univocal function of the parameter under scrutiny. This being the case, the FOH201 must know the relation between the path length difference and the physical parameter. The Gauge Factors, or equivalently the calibration factors, that comes with each interferometric sensor contain all the information needed by the PicoSens to perform the conversion from the measurement of the path length difference to the physical value being measured.

3. Sensor type

The type of the sensors depends of the physical parameter to be measured. For example, the T-type (T1, T2, etc) are used for defining temperature sensors, the P-type (P1, P2, Pv, etc) are used for defining pressure sensors and the S-type are used for defining strain sensors. There are also special type definitions that are the N-type and the X-type, which are not related to any specific sensor. These are needed for internal calibration purpose only and should be not used unless instructions have been given by OMEGA to do so.

4. Local Operation

4.1 Keyboard

4.1.1 Switch on/off

The FOH201 is switched on/off with this button.

4.1.2 Menu Button

Menu button gives access to the system menus. Once in the menu, this button brings the user one level higher into the menu hierarchy. Once at the root, the system will exit the menu and goes back to measurement display.

4.1.3 Left/Right Arrows

Left/Right arrows allows navigating 1) within the Gauge Factors of a given sensor being defined, selected, modified or deleted, or 2) it allows moving from one digit to the other when a value is being entered.

4.1.4 Up/Down Arrows

Up/Down arrows allows navigating 1) between menu items of a given hierarchical level, or 2) it allows changing a value being entered.

4.1.5 Confirmation button

Confirmation button permits confirming 1) a new value being entered, 2) confirm the selection of a menu item then moving one hierarchical level lower, 3) refreshing displayed value in the case of diagnostic.

4.1.6 Define Button

This button is short cut that brings the user directly to the menu item for defining the Gauge Factor of a new sensor.

4.1.7 Select Button

This button is a short cut that brings the user directly to the menu item for selecting a new sensor being used.

4.1.8 Null Button

This button allows to cancel most operations taking place, and return directly to the measurement display. This button is also used for zeroing a sensor when the system is not within the menu (measurement display mode).

4.2 Sensor-related functions

The functions below are related to the definition of the Sensor type and Gauges Factors to permit the conversion of the optical measurement into a physical quantity. Those functions are then related specifically to a given sensor.

4.2.1 Define sensor

The Sensor Type and Gauge Factors which define a specific sensor must be entered into the FOH201 for getting a meaningful physical measurement. Methods for defining a sensor are described in Figure 3. As shown on the figure, one can access to the Define menu level with the MENU button or uses the shortcut DEF button. The number of defined sensors is limited to eight and trying to define an additional sensor will make the FOH201 to display Mem Full message. The user is first asked to define the type of sensor being defined, for example Type T1 (see the sensor label for the type to enter). Once the type is confirmed with ✓ button, an allocation for this type of sensor is added to the sensor list stored in the FOH201 memory. The system then gives a default name to the sensor, from 01 to 08, e.g. Pr T101. The type of sensor is always part of the name, while the last two digits can be specified by the user (00 up to 99). Two different sensors cannot have the same last two digits. If the user tries adding a sensor number already used, the system will not permit the change and will use the default name. After confirming the sensor type, the used is requested to enter the Gauge Factor value(s). Depending of the sensor type, one, two or more GF values must be entered. These factors are indicated on a label fixed on the optical cable of the sensor, nearby the optical connector.

4.2.2 Select sensor

The user must select, within the list of defined sensors (maximum of eight), the specific sensor connected to the unit. Failure to do so will make the FOH201 to display meaningless readings. Methods for selecting the Gauge Factors are described in Figure 4. Once the sensor is selected, a confirmation message is displayed for about 1 second before it comes back to measurement display.

4.2.3 *Modify Gauge Factor*

The user can modify a previously entered Gauge Factor. The method for modifying a Gauge Factor is described in Figure 5. It is not possible to modify the type of sensor. The sensor must in this case be deleted, and a new sensor definition must be made.

4.2.4 *Delete Defined Sensor*

A defined sensor can be deleted from the FOH201 memory as described in Figure 6. When a sensor is being deleted, a confirmation message is displayed, for example Del T101. To accept deleting the sensor, press the confirmation button ✓ or use Menu Button MENU or the Null button NULL to cancel the operation.

4.3 System Setting

The functions below are used to setup specific parameters of the FOH201. Some of the settings are not necessary related to a specific sensor.

4.3.1 *Average*

The user can set ON or OFF the averaging mode (ON by default). When on, the measurements either displayed on the front panel display, output on the analog output or on the RS-232 port is the result of the average of twenty sequential measurements based on the running average method. So even when averaging takes place, the output on the analog output is refreshed at a rate given by the sampling rate of the FOH201. Note that the front panel display is refreshed a rate never higher than 3 measurements per second. The method to set the averaging is described in figure 7. This parameter is not saved and is lost when the system is switched off.

4.3.2 *Analog output*

The analog output parameters comprise the scale factor and the offset. The scale factor corresponds to the physical unit per Volt (unit/V) outputted by the system, while the offset corresponds to the physical value at which the user may want the analog output to be at zero volt. For example, one may desire to have 10^{o}C/V, being offset at 5^{o}C. The analog output voltage is thus given by:

$$\text{Temperature} = [\text{Voltage output}] \times 10^{o}\text{C/V} + 5^{o}\text{C}.$$

The method to change the analog output parameters is described in Figure 8. A default value is defined by the FOH201 to give access to the whole available range. Any new scale factor is saved in the non-volatile memory. This value is used whenever the system is switched on and off, and whenever the sensor is de-selected and re-selected. If the sensor is deleted, then its analog scale factor is lost. By default, the offset value is 0. New offset value is not saved and it is lost when the system is switched off, or when the sensor is de-selected.

4.3.3 Auto

(Reserved for future use)

4.3.4 Unit Mod

The FOH201 signal conditioners has two types of units to display and to output the measurement readings: the physical unit mode (°C, bar, etc depending of the Sensor Type) and the nanometer unit mode which provides a measurement of the cavity length of the sensor interferometer. The physical unit mode is the default mode and it is used most of the time. The nanometer unit mode is useful for establishing the calibration curve of the sensor that is the cavity length as a function of the measurand (pressure, temperature, etc.). For practical reasons, OMEGA use the cavity length for calibrating its sensors. The cavity length is defined as half of path length difference of the interferometer. In the case of a Fabry-Perot interferometer, this length corresponds to the distance in between the two mirrors of the interferometer.

4.4 System Diagnostic

The user can look through a variety of FOH201 internal parameter for diagnosing potential problem with the system as described in Figure 10. The available diagnostics parameters are shown below. Diagnostic values can be refreshed by depressing confirmation button ☑.

Parameters		Description
Lg	2.6V(volt)	Light level
Ga	1.3(no unit)	Amplifier gain
Lm	47% (%)	Lamp driving level
Ct	18 %(%)	Signal contrast
SNR	485(no unit)	Signal quality

The following table shows diagnostic values with good signal, poor signal, or with a broken sensor (“fault”). A fault condition results in a “No Signal” being displayed.

Parameter	Good signal	Poor Signal	Fault
Lg	> 2.2	< 2.2	—
Ga	< 2.0	> 2.0	—
Lm	< 90 %	> 90 %	—
Ct	> 15 %	< 15 %	—
SNR	> 200	< 200	< 100

NOTE: Without a sensor connected, the instrument shows the message “NoS” or “No Signal” on its display.

In the unlikely situation that this message appears while a sensor is connected to the unit, take note of the diagnostic parameters and contact OMEGA's technical support.

During a No Signal condition, the analog output and the serial ports output constant values as follow:

Output	No Signal condition output value
Analog	0 Volt
RS-232	65 536.0

4.5 Calib

(Reserved for future use)

4.6 Null button

The Null button is used to cancel an operation that takes place within the menu, and exit the menu. In the display mode the null button is used for zeroing the selected sensor, i.e. referencing the sensor to the actual value. For example, when using a strain gauge, it is always required to zero the sensor at a known zero strain state. Depending on the type of sensor being used, the null button will perform differently.

4.6.1 Type T1, T2 Temperature sensors

A temperature sensor can not be zeroed using the null button. These temperature sensors always give an absolute measurement.

4.6.2 Type P2, P3, Pv, Pm Pressure sensors; Type S1 strain sensors

Zeroing a P2 or P3 type pressure sensor, or a S1 type strain sensor always reference the sensor to the actual value as shown in figure 10. Right after being zeroed, the sensor will output a measured value that is close to zero. It is important to maintain the sensor into a stable measurement condition while making a zero operation. The Pv-type sensor cannot be zeroed using the null button.

4.6.3 Type N and X

These types cannot be zeroed.

4.7 Defining a sensor (Menu levels)

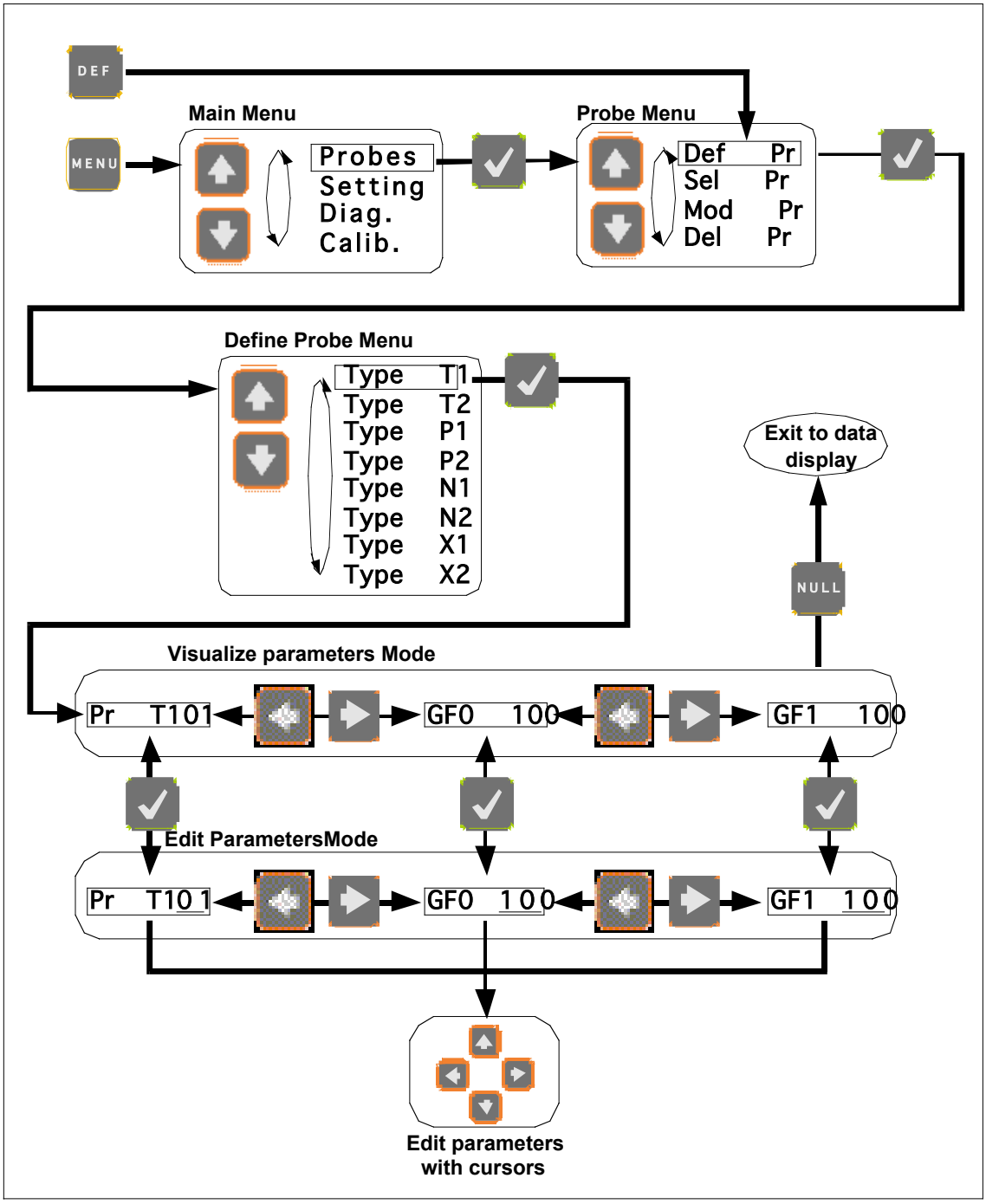


Figure 3: Defining a sensor

Sensor Type and Gauge Factor(s) must first be entered into the FOH201 memory to permit the conversion of the sensing interferometer path length difference into physical measurements.

4.8 Selecting a sensor (Menus levels)

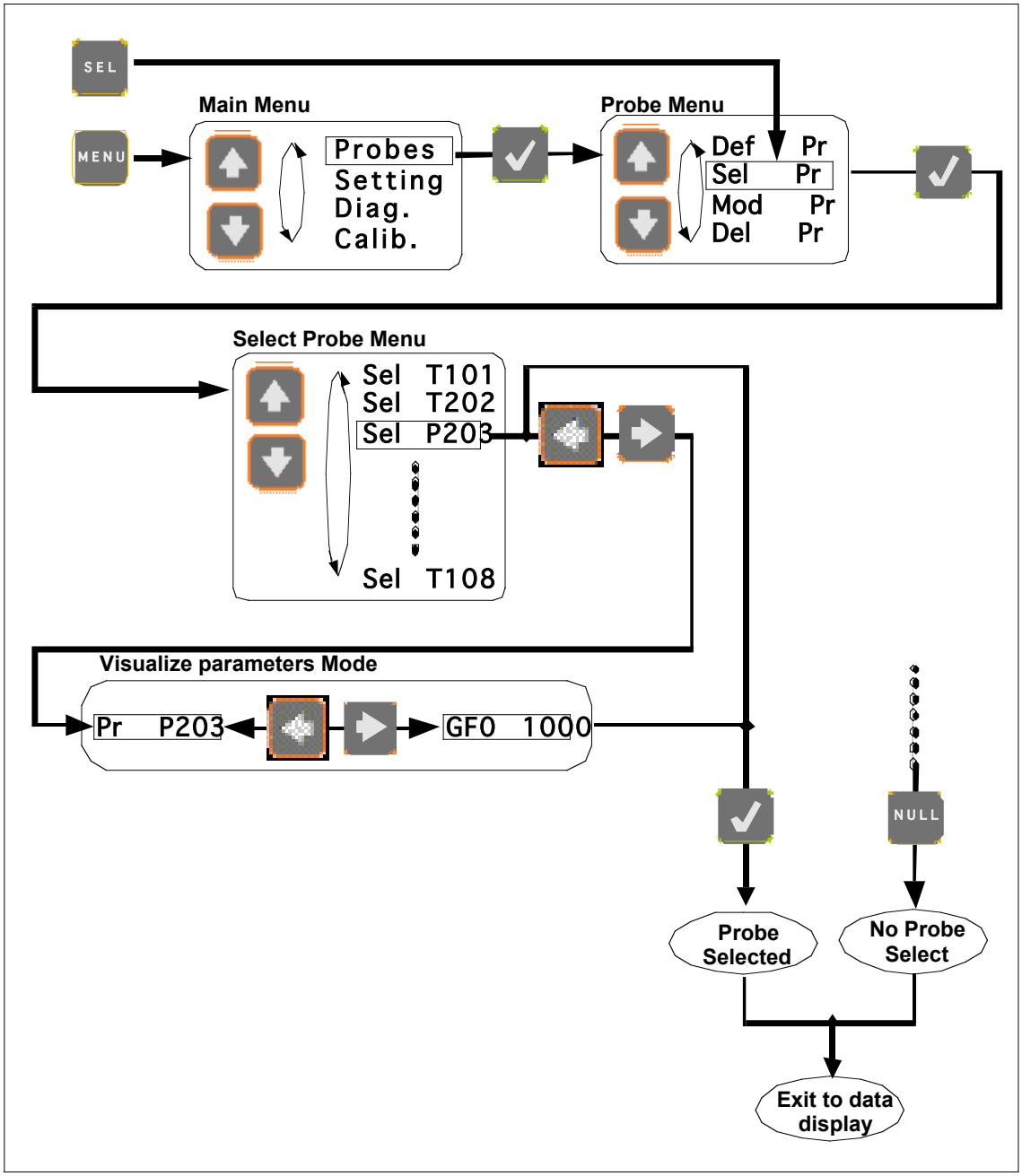
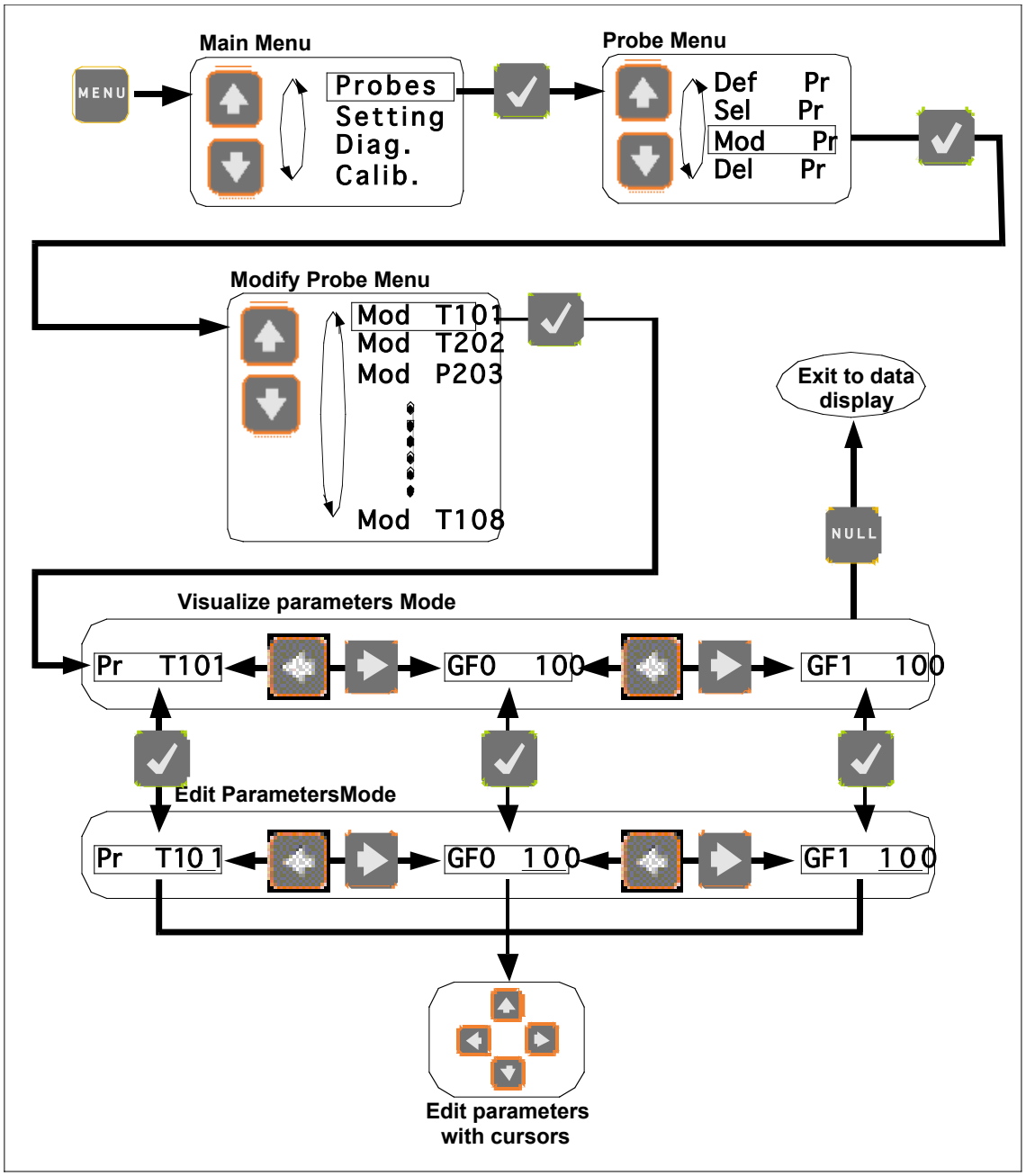


Figure 4: Selecting a sensor

Sensor must be selected among those defined into the FOH201 internal memory.

4.9 Modifying Gauge Factor(s) (Menus levels)



+

Figure 5: Modifying Gauge Factor(s)

Gauge Factors saved into the internal memory can be modified.

4.10 Delete Gauge Factor (Menus levels)

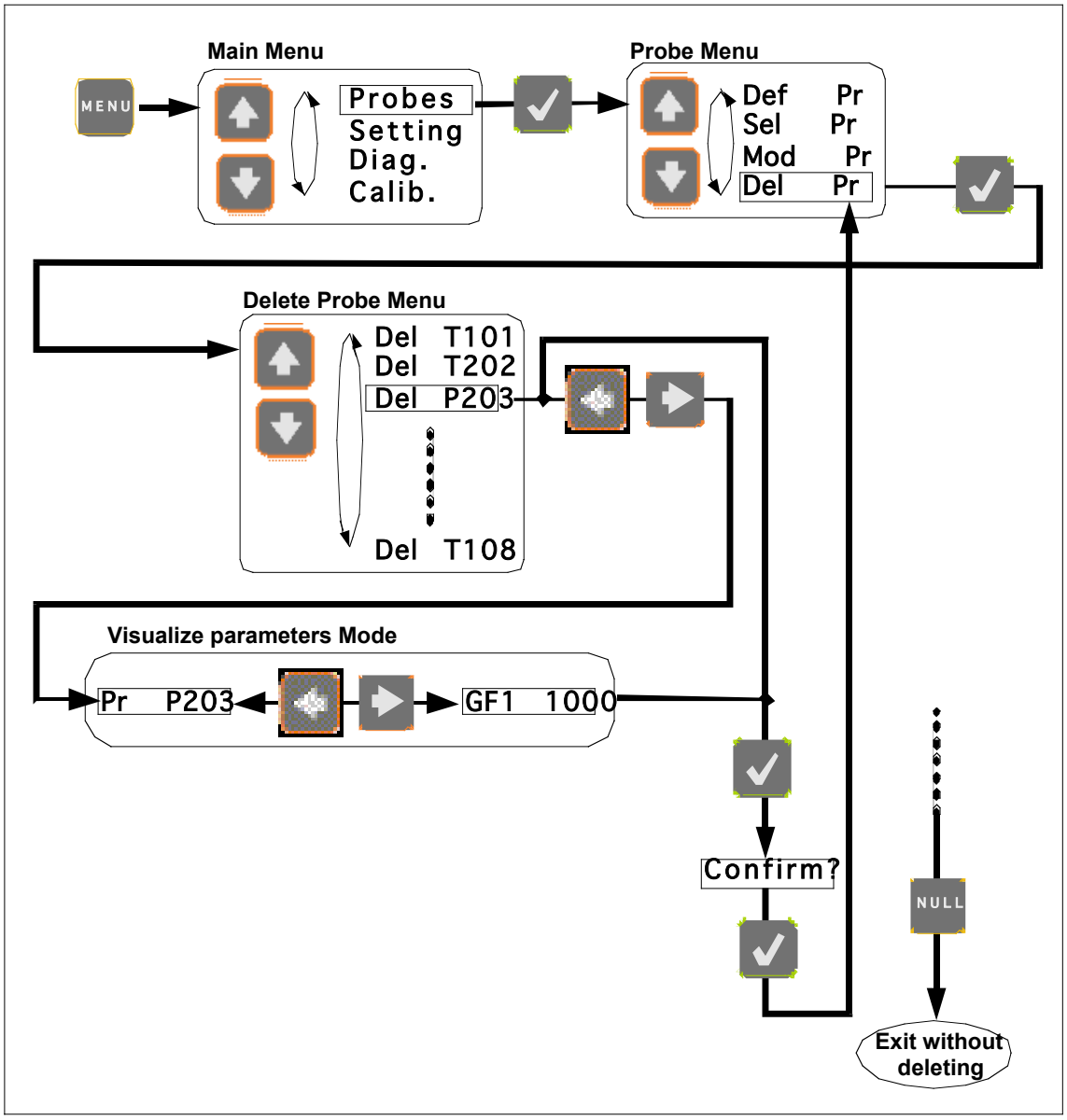


Figure 6: Delete Gauge Factor

Gauge Factors can be deleted from the internal FOH201 memory.

4.11 Averaging measurements (Menus levels)

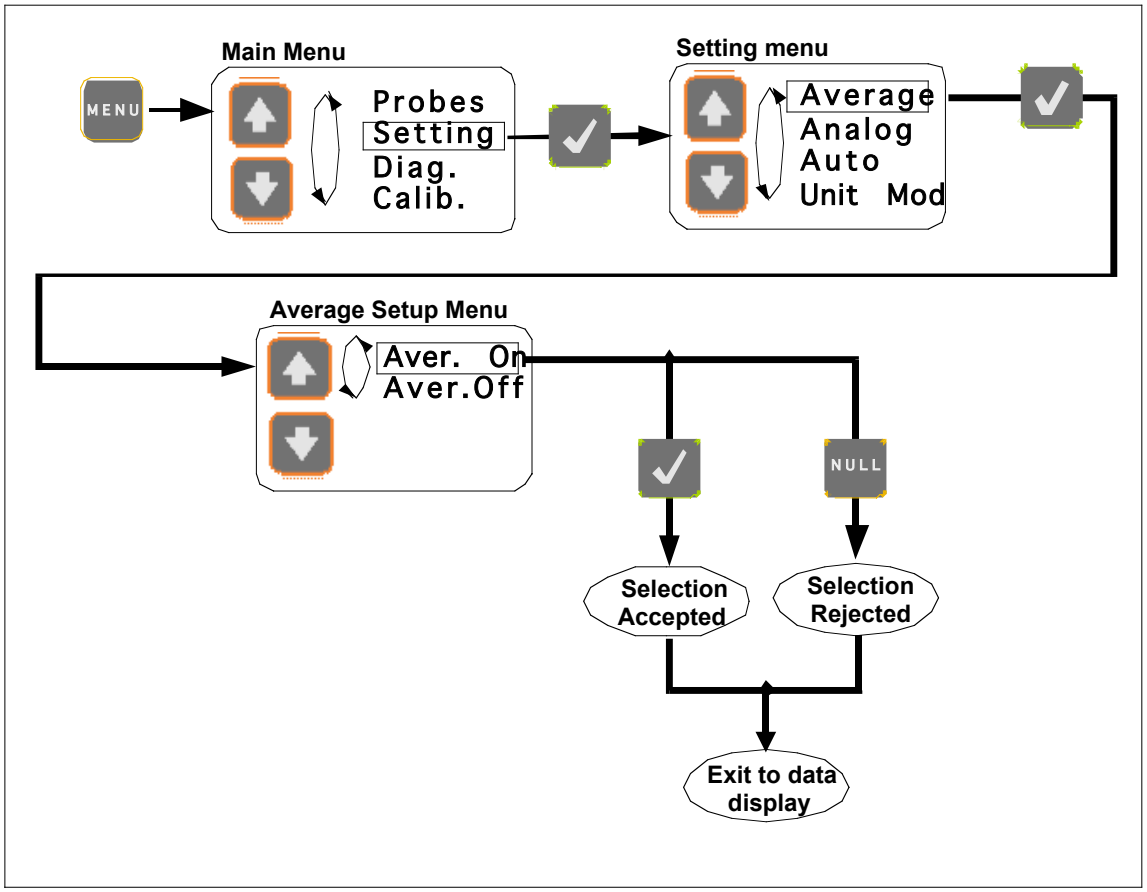


Figure 7: Averaging measurements

Averaging: twenty sequential measurements are averaged (running average method) for obtaining even smoother signal.

4.12 Setting the analog output (Menus levels)

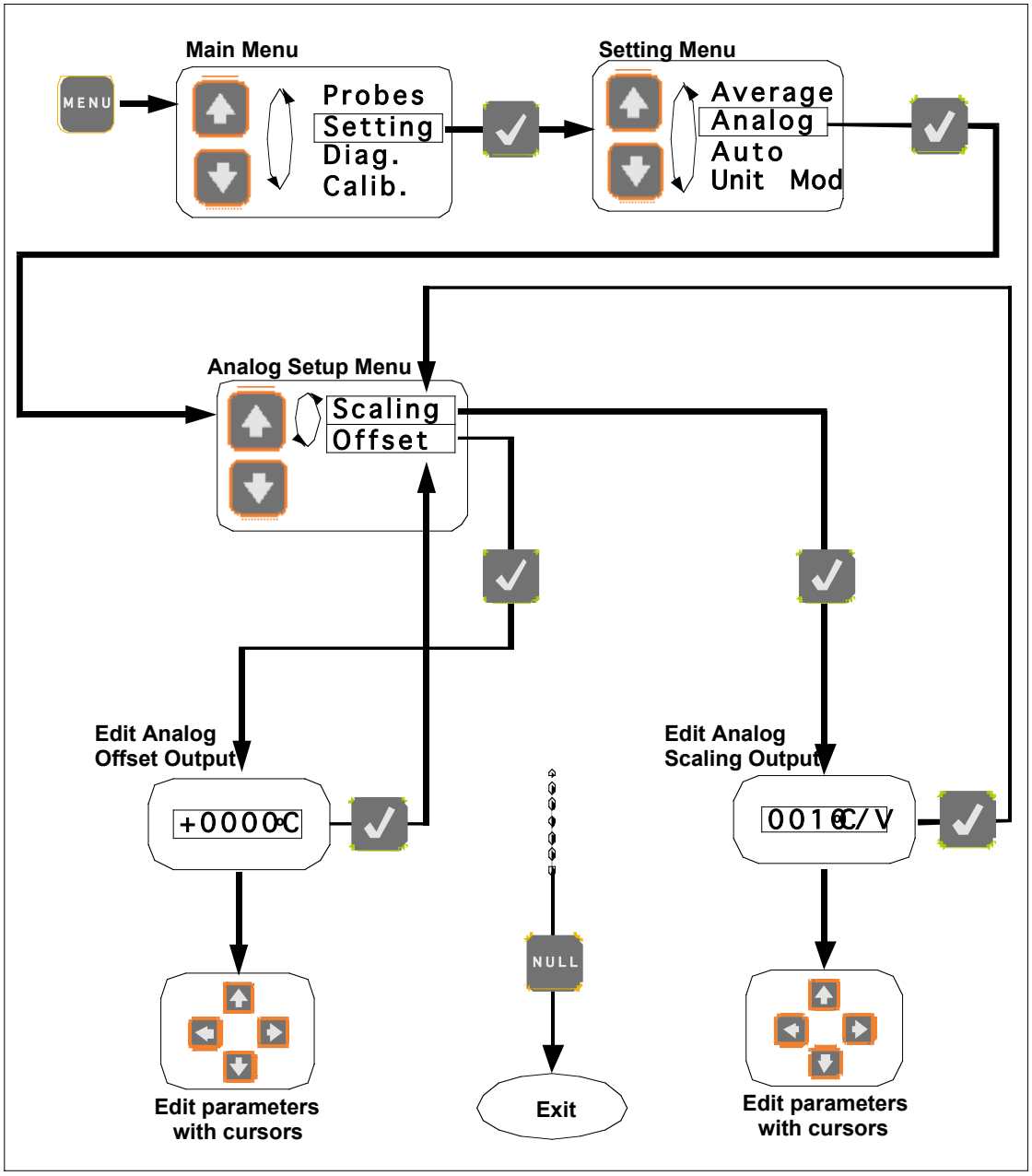


Figure 8: Setting up Analog output

Both the scale factor and offset can be setup according to user requirements.

4.13 Unit mode (Menus levels)

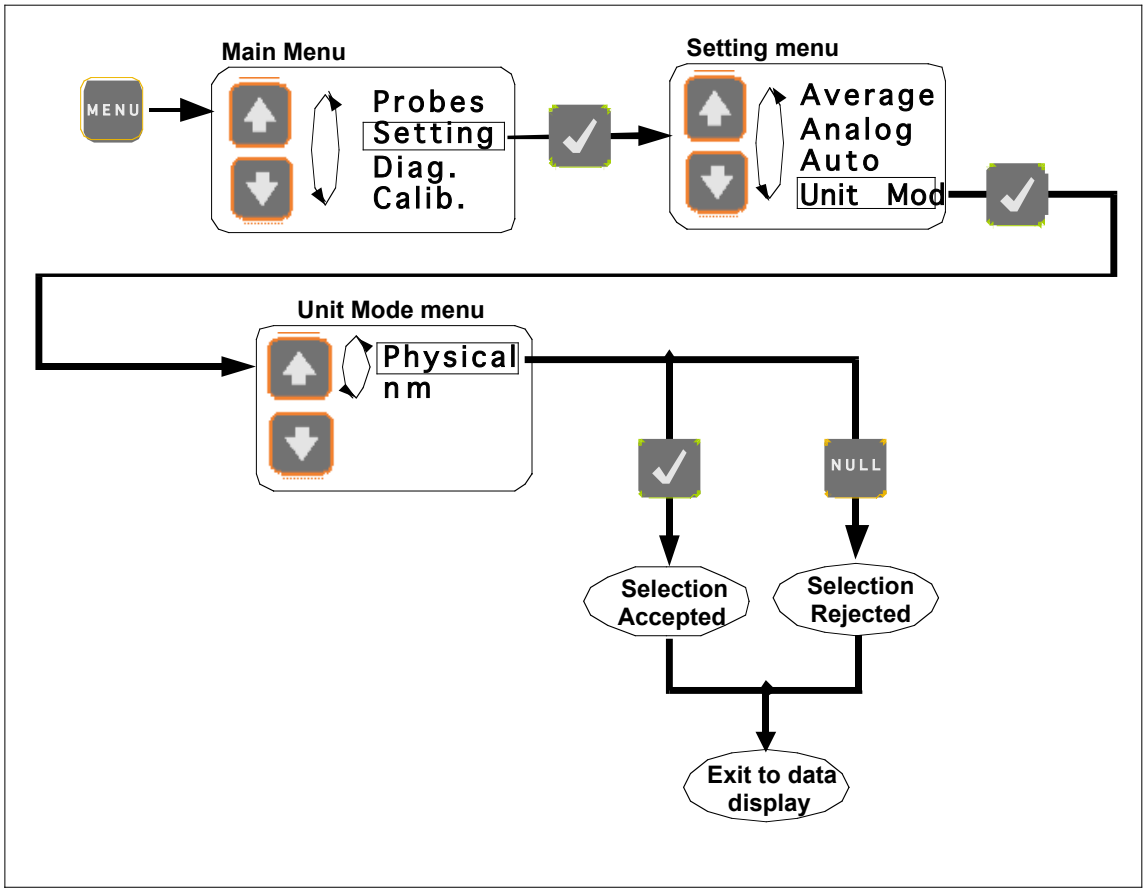


Figure 9: Unit Mode

The user can select the signal conditioner to display and output the measurement reading in physical units or in nanometer units.

4.14 Diagnostic (Menus levels)

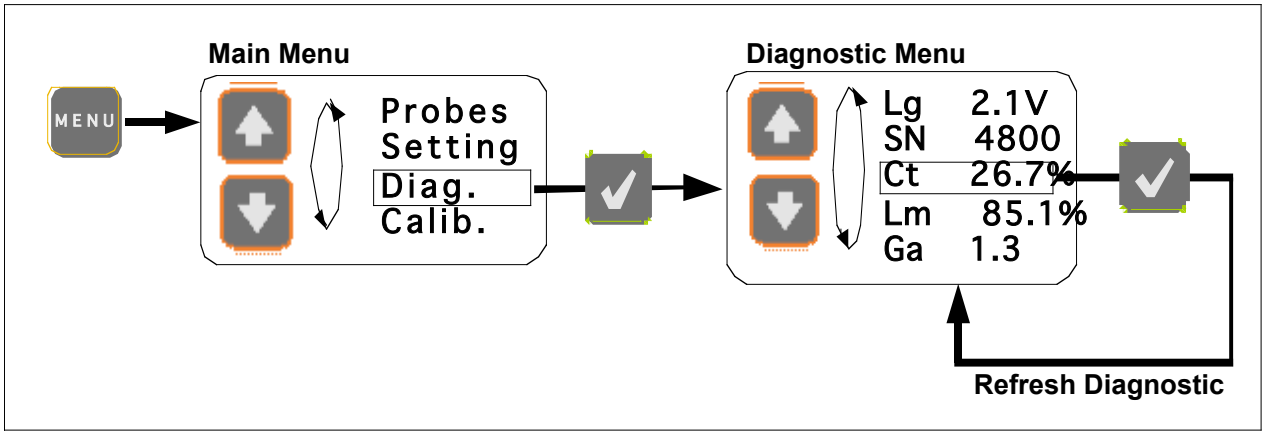


Figure 10: Diagnostic

- The user can look through a variety of diagnostic parameters for diagnosing potential problem with the FOH201 or the fiber-optic sensor. The available diagnostic parameters are as follows.

Diagnostic parameters:	**Unit**
Light level (Lg)	Volts
Signal-to-noise ratio (SN)	(no unit)
Signal contrast (Ct)	%
Lamp driving level	%
Amplifier gain (Ga)	(no unit)

4.15 Zeroing pressure sensor of P2, P3 type; Strain sensor of S1 Type (Menus levels)

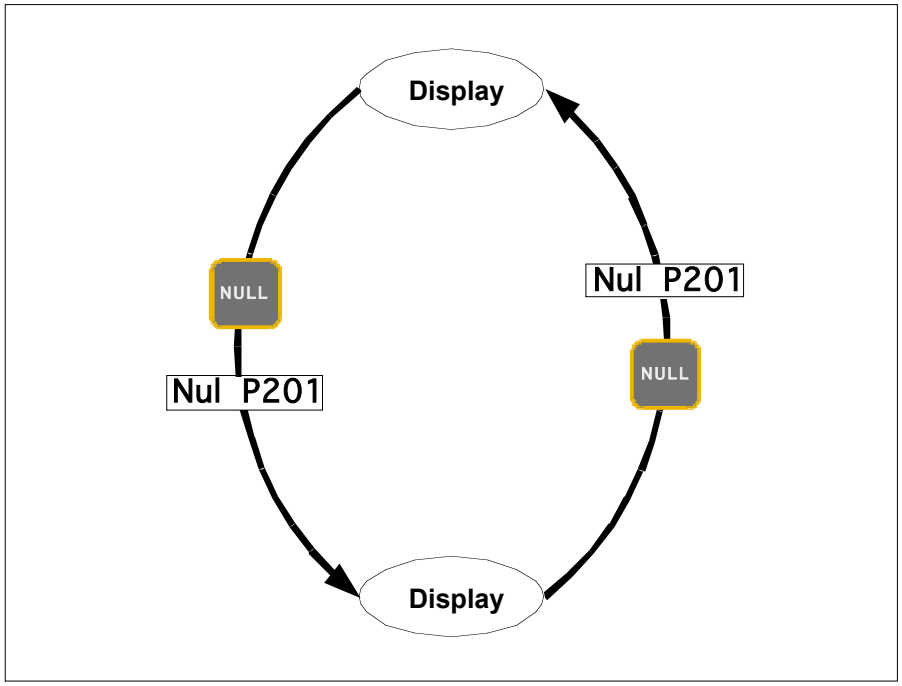


Figure 11: Zeroing Pressure sensor Type P2, P3, Pm; Strain sensor Type S1

Zeroing a pressure or strain sensor always reference the sensor to the actual value, so that the output value becomes zero right after the zeroing operation.

5. Remote operation

OMEGA's FOH201 signal conditioner comes with a RS-232 serial communication interfaces to allow control with a remote computer. The RS-232 interface settings are indicated on the following figure.

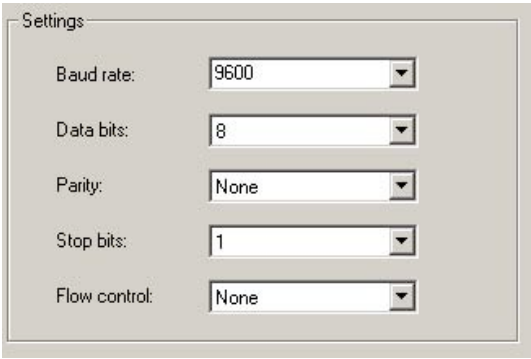


Figure 12: RS-232 interface setting

The FOH201 serial interface remote control commands are based on the standard SCPI syntax (**S**tandard **C**ommands for **P**rogrammable **I**nstrumentation). The user can create its own remote control software using the various SCPI commands available for the FOH201. But for ease of operation, OMEGA provides its own control software, called SoftSens, which gives access to all the functionalities of the FOH201 conditioner. See SoftSens user manual for how to remotely control the FOH201 conditioner.

For those who which to develop their own remote control software, ask for OMEGA Serial communication user manual to get all the information about serial interfacing with OMEGA's signal conditioners.

6. Specifications

Number of channels	One
Compatibility	All Opsens WLPI transducers
Full scale	30 000 nm (path length difference)
Resolution	±0.003 % of F.S. (no averaging)
Precision	±0.01 % of F.S. @ ±3.3 sigma limit (99.9 % confidence level)
Sampling rate	20 Hz standard
Output interface	±5 Volts and RS-232 standard
Input power	9 to 24 VDC (AC/DC wall-transformer adapter included)
Consumption	1.8 Watts typical
Battery	9V
Enclosure	Plastic casing with a removable rubber boot protection
Dimensions (without rubber boot protection)	45 mm (H) x 105 mm (W) x 165 mm (L)
Storage temperature	-40 °C to 65 °C
Operating temperature	0 °C to 45 °C
Humidity	95 % non condensing
Light source life span	40 000 hours MTBF

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by the company will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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