1 YEAR WARRANTY

OMEGA™

User's Guide

SP-006

Omega Link Pressure Monitoring and Control Smart Probe

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1 Notes, Warnings, and Cautions

If the equipment is used in a manner not specified in this manual, the protection by the equipment may be impaired.

Do not operate the equipment in flammable or explosive environments.

It is important to read and follow all precautions and instructions in this manual before operating or commissioning this device as it contains important information relating to safety and EMC. Failure to follow all the safety precautions may result in injury and/or damage to your equipment.

The following labels identify information that is especially important to note:

Note: Provides you with information that is important to successfully setup and use the Omega Link device.

Caution or Warning: Tells you about the risk of electrical shock.

Caution, Warning, or Important: Tells you of circumstances that can affect the functionality of the instrument and must refer to accompanying documents.

2 Introduction

The Omega Link SP-006 Pressure Monitoring Smart Probe provides an easy way to integrate Absolute or Gauge pressure readings and ambient temperature readings into the Omega Link Ecosystem. The SP-006 accepts Omega Link Smart Interfaces through its M12 8-pin connector. See Figure 1.

For additional functionality, the Omega Link SP-006 features 2 configurable discrete I/O pins which can be used for a myriad of applications including driving relays, physical alarms, or sensing dry contacts like door switches. The SP-006 can also be utilized as an edge controller with autonomous independent decision-making capabilities to generate local alarms or provide control outputs based on sensor inputs. The optional M12.8-T-SPLIT Sensor Splitter can be used to access the Discrete I/O pins on the M12 8-pin connector. The optional M12.8-S-M-FM mating connector can be utilized to easily connect wire leads to the SP-006 or Sensor Splitter. See Figure 2.

Included with your SP-006

- SP-006 Unit
- Quick Start Guide

Additional Material Needed

- An Omega Link Smart Interface
- A Windows 7, 8, 9, 10, or 11 OS PC or laptop with Omega's free SYNC configuration software
- An Omega Link Cloud account or a qualifying Omega Enterpr Gateway license tier (Pro, Business, or Business Pro)
- A compatible Omega Link Gateway

IF-001 sold separately

Figure 1: SP-006 Unit

Optional Materials

- M12.8-T-SPLIT Sensor Splitter (For DIO access)
- M12.8-S-M-FM Screw Terminal Accessory (For DIO Access)

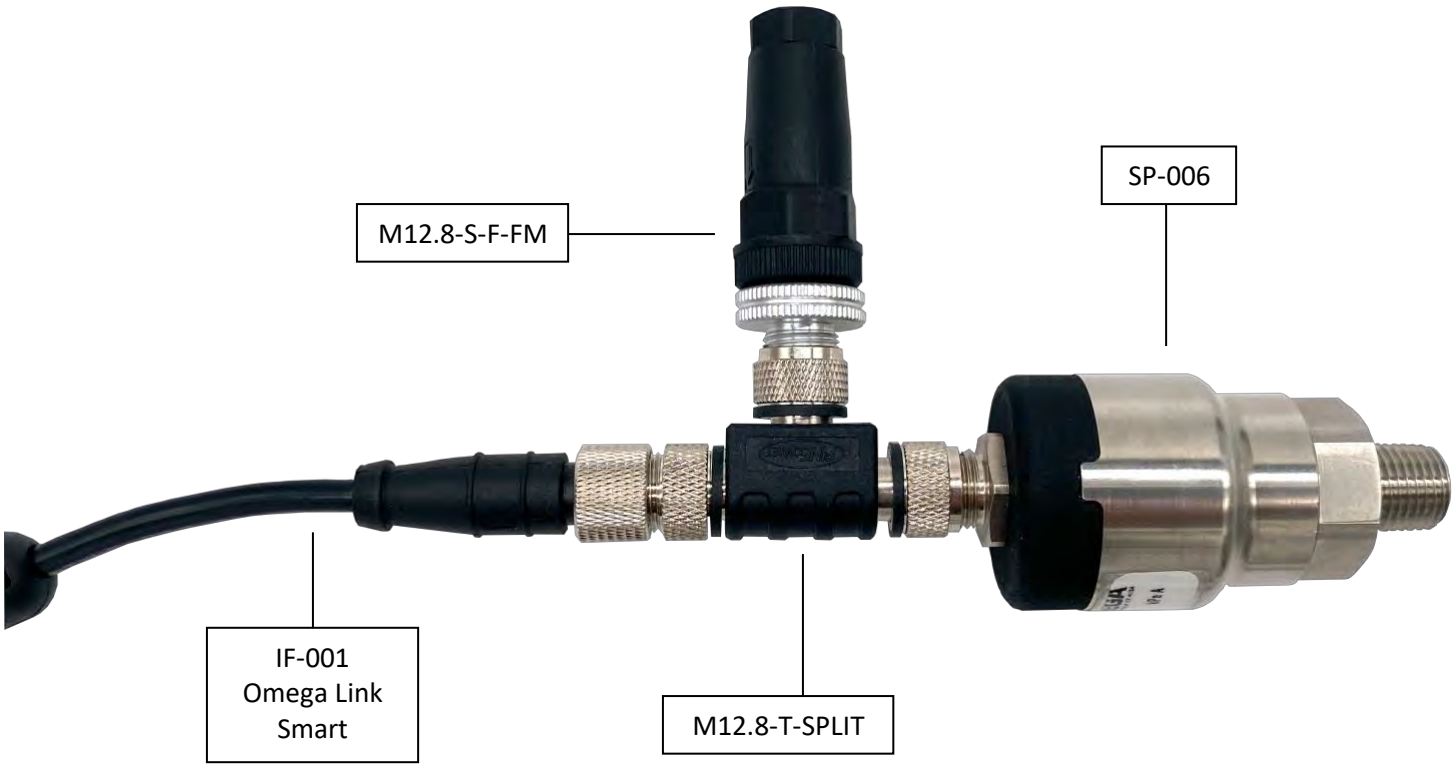

Figure 2: Example SP-006 integrated into an Omega Link ecosystem

3 Specifications

INPUT POWER

Voltage: 2.8 V_{DC} - 3.3 V_{DC}

DIO DISCRETE INPUTS

$V_{inHighThreshold}$ = 2.2 V_{MAX}

$V_{inLowThreshold}$ = 0.3 V_{MIN}

V_{inMAX} = 30 V_{DC}

DIO DISCRETE OUTPUTS

2x Open Drain 100 mA max

V_{MAX} = 30 V_{DC}

PRESSURE

Range: (See Ordering Guide below)

Accuracy: ±0.5% full scale

Resolution: 0.1 kPa

TEMPERATURE

Range: -10 to 80°C (14 to 176°F)

Accuracy: ±1.5°C

Resolution: 0.1°C

ENVIRONMENTAL

Storage Temperature: -40 to 85°C (-40 to 185°F) less than 95% RH, non-condensing

GENERAL

Agency Approvals: CE, UKCA

Configuration: Configurable via Omega Link Smart Interface and SYNC configuration software

Software: Compatible with OEG, SYNC, and OMEGA Cloud

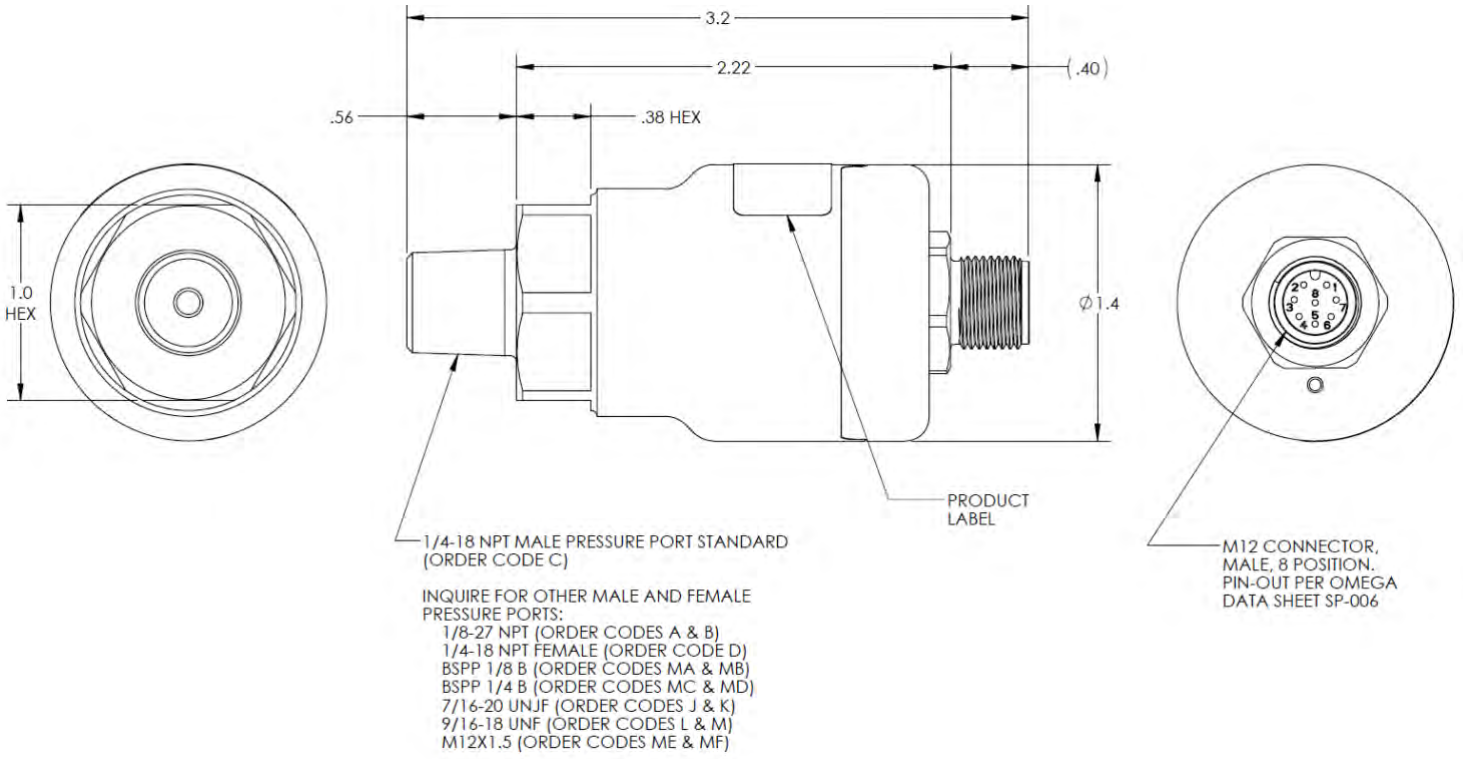

Figure 3: SP-006 Dimensions and Pressure Ports. Units shown in INCHES

Ordering Guide

Model Number	
SP-006-1-C-050G	Omega Link pressure monitoring and control smart probe with discrete I/O - **50 psi 350 kPa Gauge**
SP-006-1-C-050A	Omega Link pressure monitoring and control smart probe with discrete I/O - **50 psi 350 kPa Absolute**
SP-006-1-C-100G	Omega Link pressure monitoring and control smart probe with discrete I/O -**100 psi 700 kPa Gauge**
SP-006-1-C-250G	Omega Link pressure monitoring and control smart probe with discrete I/O -**250 psi 1700 kPa Gauge**

Notes:

- Model Numbers above have a ¼ - 18 NPT male pressure port (i.e. ordering code C)
- Inquire with Omega Engineering for other pressure port options. Refer to Figure 3.

4 Hardware Setup

4.1 Connecting to your Omega Link Smart Interface

The SP-006 requires an Omega Link Smart Interface to connect to a computer. Omega offers a variety of Omega Link Smart Interfaces such as the wired IF-001 (USB) and IF-002 (Modbus) or the wireless IF-006. Use the M12 8-Pin Connector diagram below to connect the SP-006 to an Omega Link Smart Interface.

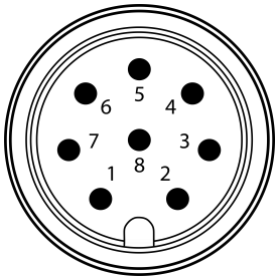

Figure 4: M12 8-Pin Connector front view

Pin	Name	Function
Pin 1	DIO 0	Discrete I/O Signal 0
Pin 2	INTR	Interrupt Signal
Pin 3	SCL	I2C Clock Signal
Pin 4	SDA	I2C Data Signal
Pin 5	Shield	Shield Ground
Pin 6	DIO 1	Discrete I/O Signal 1
Pin 7	GND	Power Ground
Pin 8	3.3VDD	Power Supply

5 SYNC Configuration

Omega Link Smart Probe products are easily configurable through Omega's SYNC configuration software. Ensure SYNC is running on a Windows OS computer before continuing. Connect the SP-006 to a computer running SYNC through your Omega Link Smart Interface to begin.

Note: SYNC is available to download for free on the Omega website.

5.1 Connecting to SYNC – Automatic Detect

Once the SP-006 and Omega Link Smart Interface are connected to a computer, SYNC will automatically detect the device and display readings.

Note: If live readings from the SP-006 are displayed on SYNC, skip ahead to the section titled **Input Configuration**.

5.2 Connecting to SYNC – Manual

If SYNC does not automatically detect the device, follow these instructions to manually connect it.

Step 1: Click on the ➕ icon located on the top left of the SYNC interface.

Step 2: Proceed through the **Add Device Wizard** and click **End Device/Probe**.

5.2.1 Communication Interface

Set the communication parameters for the Omega Link Smart Interface that you are connecting to.

Note: The connection type and parameters must be accurate for a proper connection to be established. Failure to accurately set up communication parameters may result in communication errors.

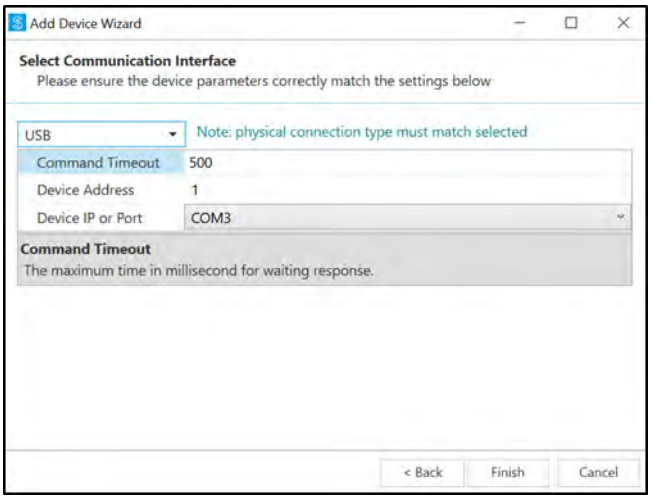

Figure 5: USB Communication Interface

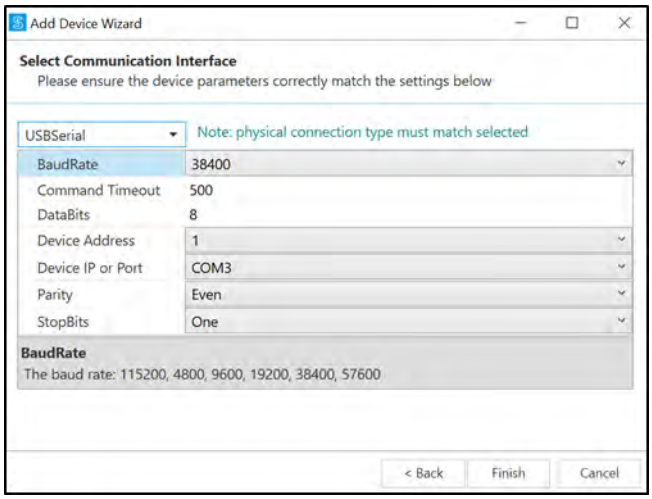

Figure 6: USB Serial Communication Interface

- **Connection Type:** Select the type of connection you have between your SP-006 and your computer.
- **Command Timeout:** The maximum time (in milliseconds) for a command to be completed before the command is aborted.

Note: The default command timeout is 500 milliseconds. It is recommended that this section be left unchanged to avoid communication errors.

- **Device Address:** The default device address is 1. The numerical value will automatically increase to the next available device address for every new device added to prevent duplicate addresses.
- **Device IP or Port:** The COM port number that your device is connected to on your computer.

- **BaudRate:** Controls bits per second
- **DataBits:** The number of bits in each character sent.
- **Parity:** A means of checking the correctness of a character by adding an extra bit to the character and setting the value based on all the other bits in the character.
- **StopBits:** The number of bits used to indicate the end of the character.

Once you have completed setting the communication parameters for your device, click **Finish**.

5.3 Input Configuration

The SP-006 provides readings for pressure, temperature, and discrete I/O (DIO). To use these features, click the ***Inputs*** configuration tab on SYNC and choose your preferred input mix from the ***Type*** dropdown. The SP-006 allows selecting pressure and discrete I/O only or pressure, temperature, and discrete I/O.

5.3.1 Pressure

The SP-006 Pressure readings are fixed based on the specific model. The user may calibrate the Pressure sensor using Single or Dual-Point calibration by clicking the ***Calibration*** button.

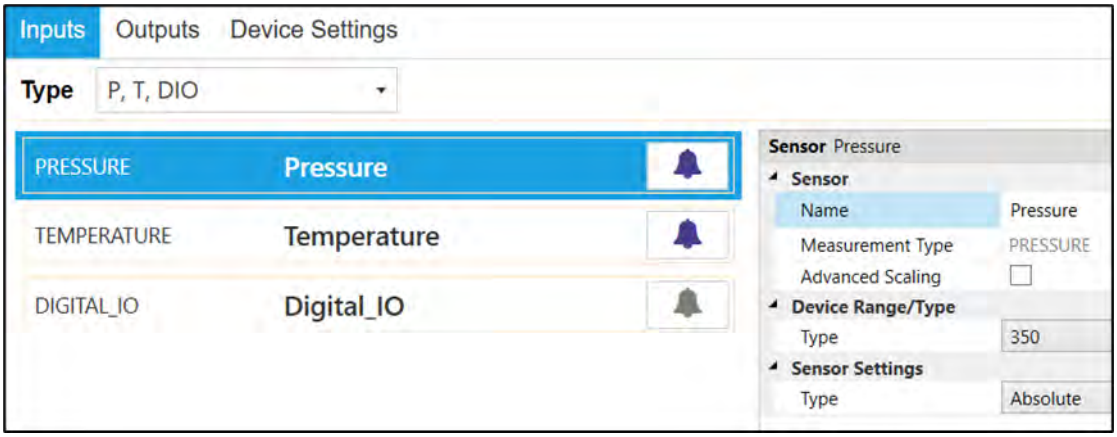

Figure 7: SYNC interface pressure input

5.3.1.1 *Pressure User Calibration*

After clicking the ***Calibration*** button, the user must follow the onscreen directions to calibrate the device.

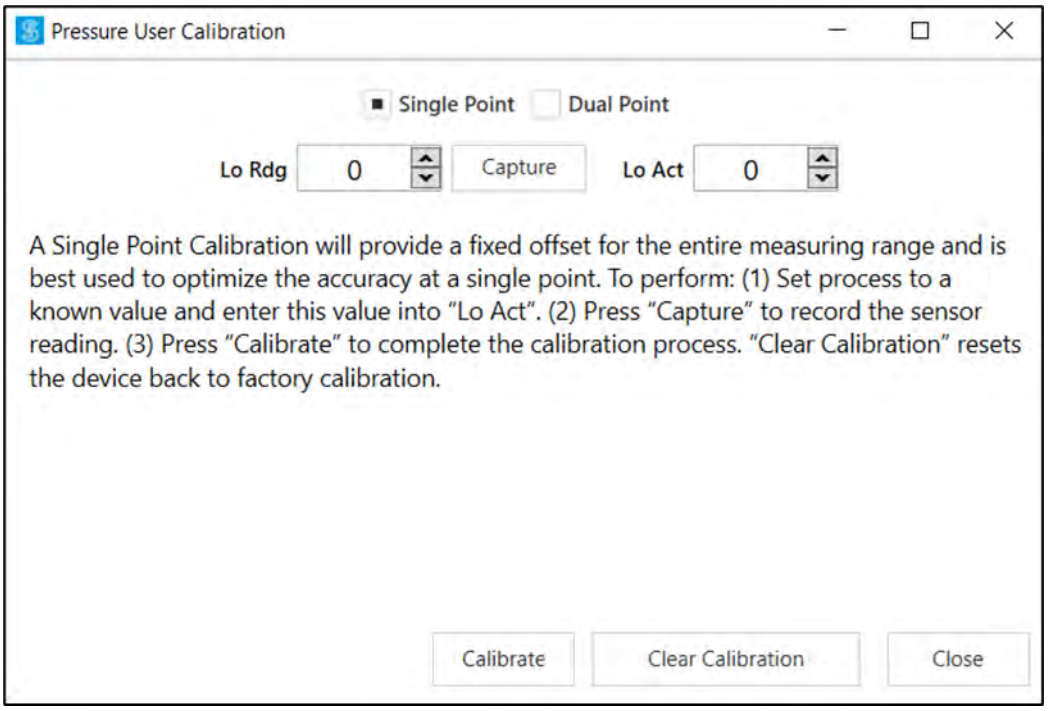

Figure 8: SYNC pressure user calibration

5.3.2 Temperature

The SP-006 Temperature readings may be configured under the advanced scaling options which include Gain and Offset.

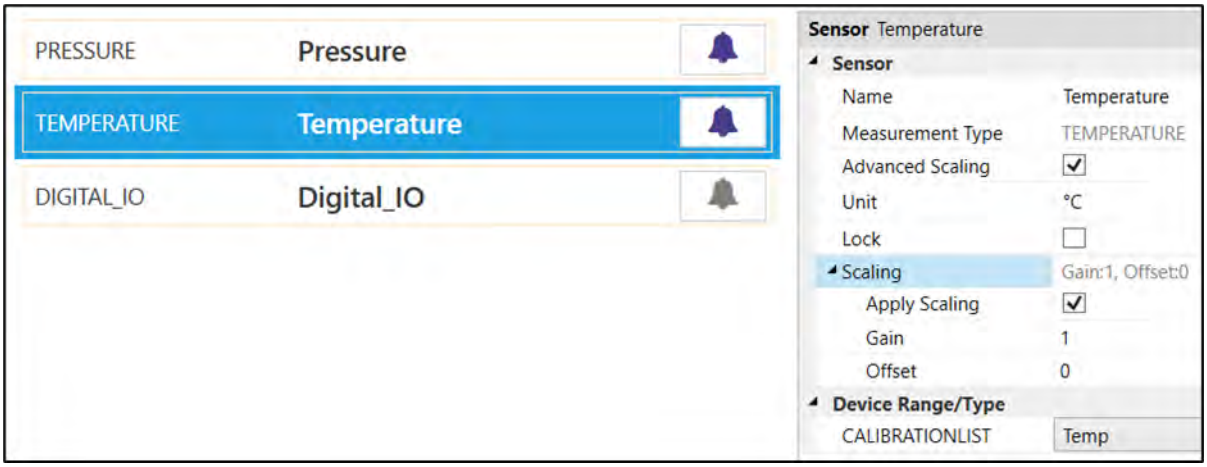

Figure 9: SYNC interface temperature input

5.3.3 Discrete Input/Output (DIO)

The Omega Link SP-006 features 2 configurable discrete I/O pins DIO_0 and DIO_1. These DIO pins can be used for a myriad of applications including driving relays, physical alarms, or sensing dry contacts like door switches. The user may configure the polarity of the inputs (active **HIGH** or active **LOW**) or **Disable** the DIO to utilize the outputs (ON/OFF, PWM, SERVO). The Advanced Scaling option does not apply to the DIO input reading.

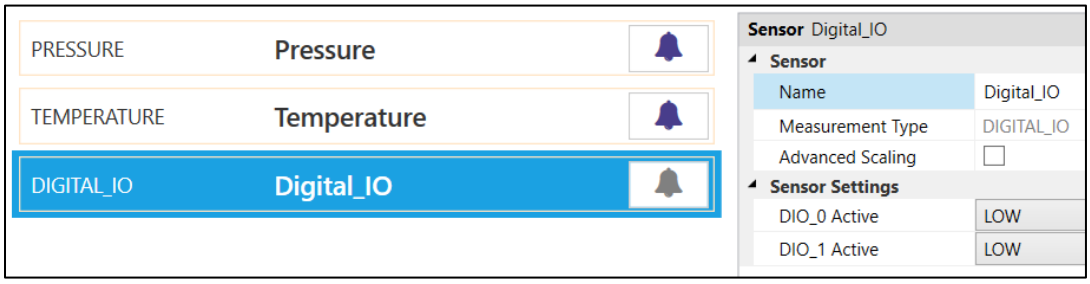

Figure 10: SYNC interface discrete I/O input configuration

The Discrete I/O input shares the same circuitry as the output. The internal process drives the output control signal to turn on the output driver which will force the output low. When the state of the DIO input signal is to be read the processor applies 3.3 V_{DC} to the Input Bias signal and reads the level detected at the Input Sense. If the output is inactive an external signal may be used to force the input level low. A diode protects external positive voltages, allowing the output driver to activate loads greater than the internal 3.3 V_{DC}.

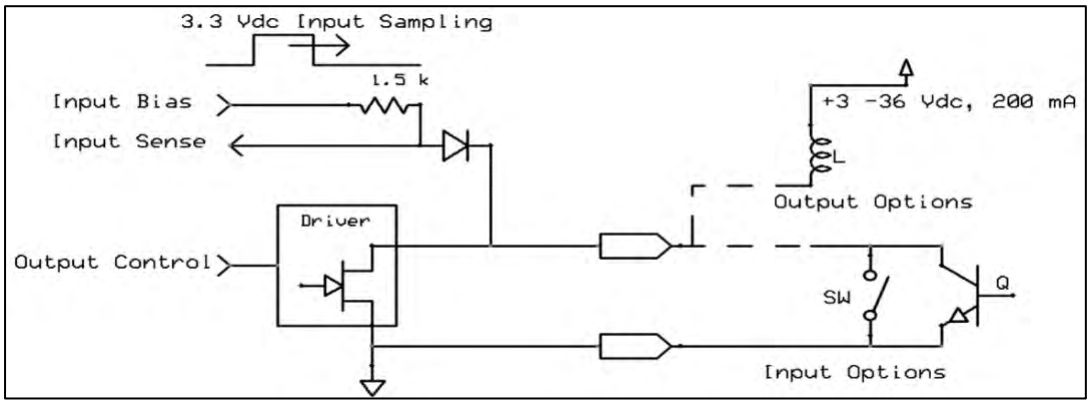

Figure 11: Discrete I/O circuitry

5.3.3.1 Setting DIO as an Input

To use a DIO pin as an input, make sure it is set to **Active Low** (default) in the **Output Tab** in SYNC.

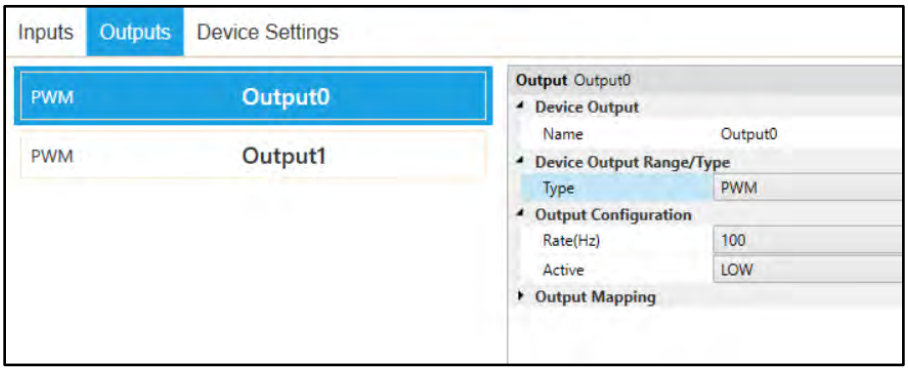

Figure 12: SYNC interface outputs tab

Then, in the **Input Tab**, select a **Type** from the drop-down which includes DIO. Each DIO pin has an internal pull-up, but to save power, the internal pull-up is only active when the unit takes a reading.

5.3.4 Advanced Scaling Options

The Omega Link SP-006 allows for advanced scaling options on the pressure and temperature inputs. The **Advanced Scaling** checkbox can be selected to expand additional configuration options. A gain and/or offset can be applied to the input reading and the displayed unit can be changed.

To apply a gain or offset to the input, expand the **Advanced Scaling** menu and ensure that both **Apply Scaling** and **Lock** are checked. Under Scaling, the gain and offset values can be adjusted. Both positive and negative values may be entered as well as decimal numbers. The equation for the scaled input value is given below.

$$\boldsymbol{Input_{Scaled} = (Input_{Raw} \times Gain) + Offset}$$

The displayed units can be changed by entering a new value in the **Unit** field and clicking **Apply Settings**. This field is limited to a maximum of 4 characters. Note that changing the Unit field does not change the base unit type, only the display name. The **Lock** checkbox must be selected to use the user-defined Unit field. Unchecking the Lock checkbox and clicking Apply Settings will revert the unit display back to the default setting.

5.4 Output Configuration

The SP-006 offers two discrete outputs that share circuitry with the discrete inputs. If an output is to be used then the corresponding input pin must be set to **Disable**. See section ***5.3.3 Discrete Input/Output (DIO)*** for more information.

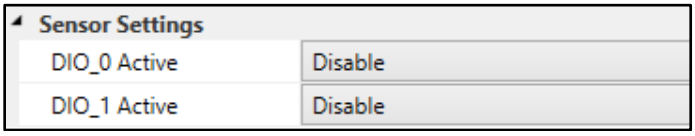

Figure 13: SYNC interface SP-006 DIO_0 and DIO_1 set to Disable

There are three types of output options – On/Off, Pulse-Width Modulation (PWM), or Servo. See section **5.4.1** for more information on each type.

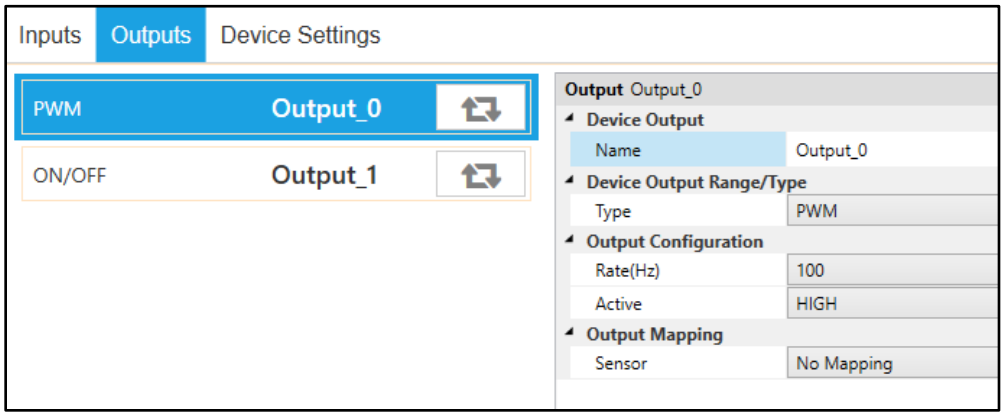

Figure 14: SYNC interface Output Configuration

Outputs may be configured as either Active High or Active Low. When configured as Active High the output conducts normally and becomes high impedance when activated. When configured as Active Low, the Open-Drain output is high impedance normally and will conduct when activated.

Option	Value	Description
Active	LOW	When the output is inactive, it is in a high impedance state.
	HIGH	When the output is active, it is in a high impedance state.

An output may be controlled in one of three ways – a scaled mapping to an input, an on/off control from an input setpoint, or as an input alarm. Sections **5.4.2** through **5.4.4** describe these output control methods.

5.4.1 Device Output Range/Types

There are three types of output options – On/Off, Pulse-Width Modulation (PWM), or Servo. This section describes these output options.

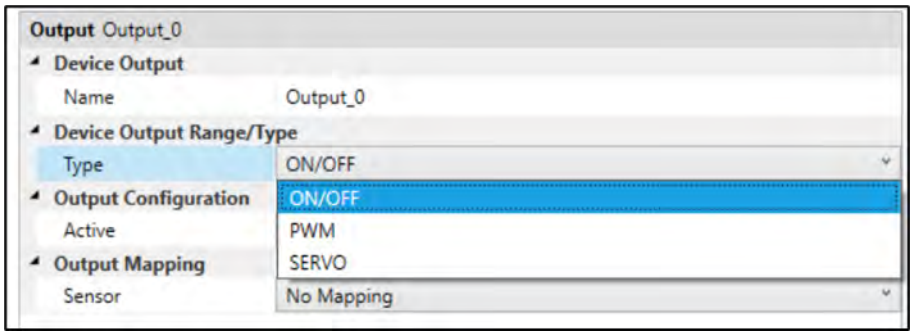

Figure 15: SYNC interface output type selection

5.4.1.1 ON/OFF Output Type

The ON/OFF output mode switches the output to be a binary ON or OFF. Depending on if the output is configured as Active Low or Active High, the ON/OFF mode can correspond to different polarities.

5.4.1.2 Pulse-Width Modulation (PWM) Output Type

Pulse-Width Modulation (PWM) controls the amount of power given to a device by cycling the on/off phases of a discrete signal. PWM consists of a duty cycle and frequency. The Duty Cycle measures the amount of time a signal is in the ON state as a percentage. The frequency controls how fast the PWM cycle is repeated. Users can select between the following settings:

Option	Value	Description
Rate	100 Hz	Signal has a constant 100 Hz frequency with 0-100% Duty Cycle
	10 Hz	Signal has a constant 10 Hz frequency with 0-100% Duty Cycle
	1 Hz	Signal has a constant 1 Hz frequency with 0-100% Duty Cycle
	0.1 Hz	Signal has a constant 0.1 Hz frequency with a 0-100% Duty Cycle
Signal Type	Active LOW	When the output is active, it is pulled to ground (LOW)
	Active HIGH	When the output is active, it is in a high impedance state

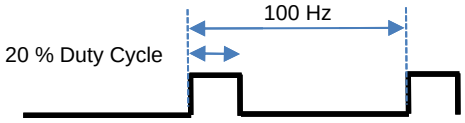

Figure 16: PWM function diagram

Example shows a PWM output signal configured with a 100 Hz frequency and active HIGH outputs. The duty cycle has been set to 20%.

5.4.1.3 *SERVO Output Type*

The SERVO output allows driving servo motors that control position. A Servo output is a special case of the PWM output, where the ON time varies between 1.0 msec and 2.0 msec or between 0.5 msec and 2.5 msec, with the lower bound representing 0 degrees and the upper bound representing 180 degrees of angular travel. The typical non-critical frequency is 50 or 100 Hz. Servo outputs are always active high.

Option	Value	Description
Rate	100 Hz	Signal has a constant 100 Hz frequency
	50 Hz	Signal has a constant 50 Hz frequency
Pulse Width Range	1.0-2.0 msec	On time varies between 1 and 2 msec
	0.5-2.5 msec	On time varies between 0.5 and 2.5 msec

Example: For the percent of angular travel, if the pulse width range is set to a range of 1.0-2.0 msec, then an output of 50% of angular travel represents 1.5 msec or 90 degrees of travel.

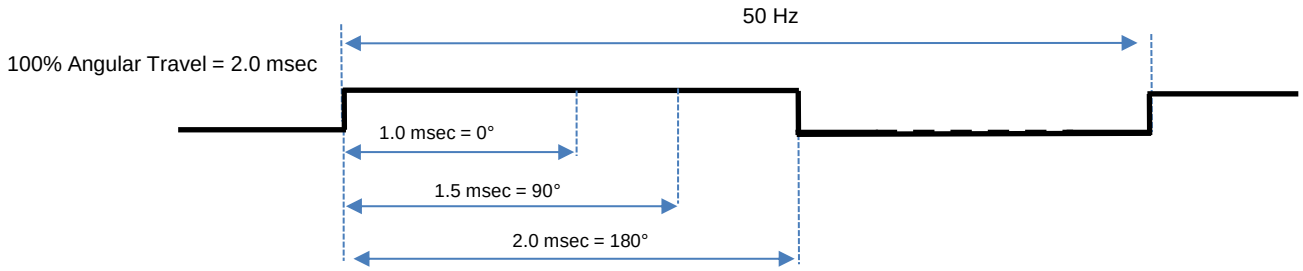

Figure 17: SERVO output example

5.4.2 Sensor Output Mapping

The SP-006 allows mapping a scaled copy of any of the input values to any of the outputs. To set a mapped output, it must not be associated with any alarm or ON/OFF control module. Two user-defined values, **Scaling Minimum** and **Scaling Maximum**, define the sensor range that is mapped to the output. A Factory Reset sets the Input Minimum to 0 and the Input Maximum to 100.

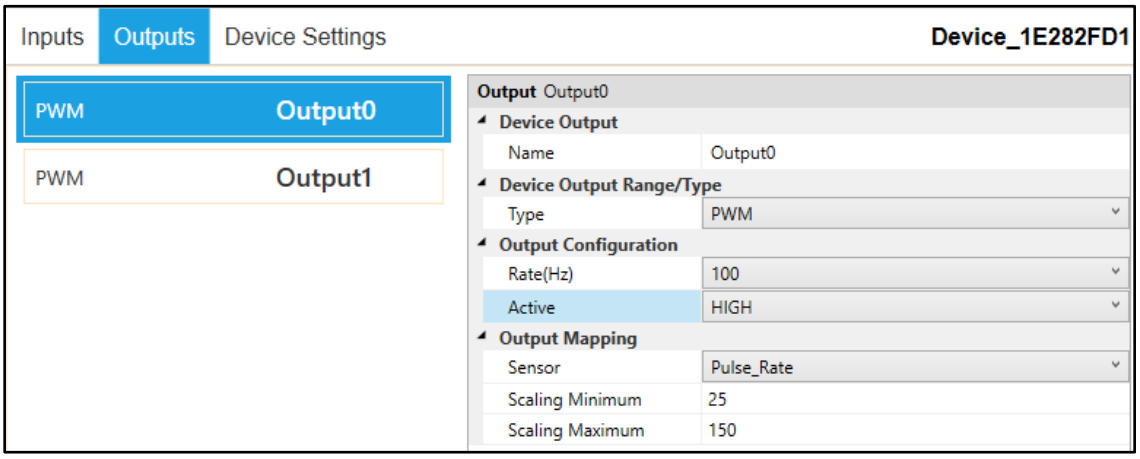

Figure 18: Sensor output mapping configuration example

The scaling equations for direct and reverse output percentages are given below.

$$Output\ Percent_{Direct} = \left(\frac{Scaling\ Maximum - Input\ Reading}{Scaling\ Maximum - Scaling\ Minimum}\right) \times 100\%$$

$$Output\ Percent_{Reverse} = \left(\frac{Scaling\ Minimum - Input\ Reading}{Scaling\ Minimum - Scaling\ Maximum}\right) \times 100\%$$

Example: The figures below and above display a PWM output direct-mapped to a Rate input. The minimum expected input rate is 25 Hz and the maximum expected rate is 150 Hz. A value of 50 Hz read at the input is then mapped to a PWM output with an 80% duty cycle.

$$Output\ Percent_{Direct,Example} = \left(\frac{150\ Hz - 50\ Hz}{150\ Hz - 25\ Hz}\right) \times 100\% = 80\%$$

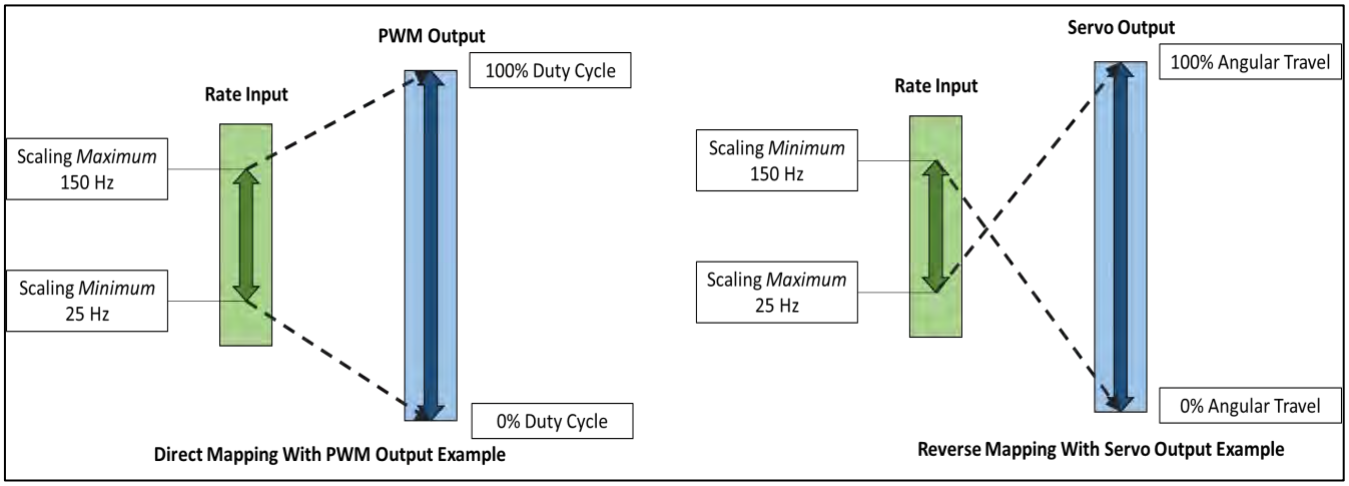

Figure 19: Sensor output mapping diagram

5.4.3 ON/OFF Control Module

To configure an ON/OFF control module on a device, first ensure that the desired output pin is not associated with any input alarms and that it is set as **No Mapping** in the Output Mapping menu in the **Outputs** tab. The ON/OFF control module can be used with any selected output type including ON/OFF, PWM, and SERVO. When enabled in PWM mode, ON corresponds to 100% duty cycle. When enabled in SERVO mode, ON corresponds to 100% angular travel.

In the **Outputs Tab** in SYNC click on the  icon located to the right of the available outputs. Clicking the icon will open the **Define ON/OFF Control** dialog box as seen below.

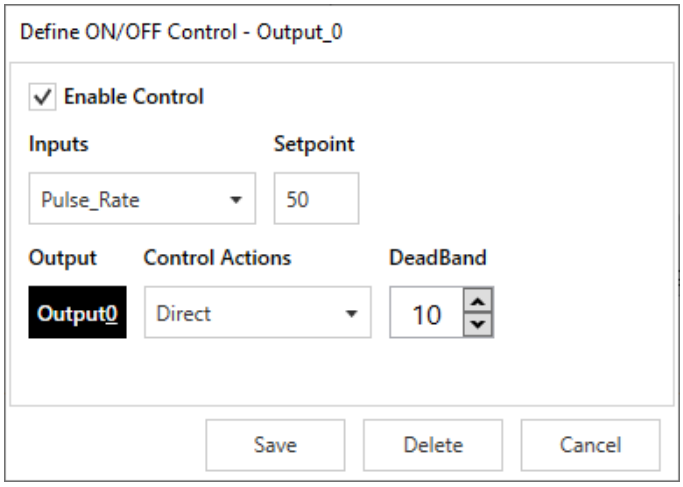

Figure 20: SYNC interface ON/OFF control module functions

The **Enable Control** checkbox enables the ON/OFF control module. If this box is unchecked, the output will be disabled but the module with all its settings will remain available to be enabled at a later time.

The **Inputs** dropdown lists the available input sources and will depend on how the device is configured in the Inputs tab.

The **Setpoint** field sets the threshold for activating the ON/OFF control module. The unit of the Setpoint field will be the same as the unit of the chosen Input.

The **Control Actions** dropdown has options for direct or reverse control. In direct mode, once the Setpoint value is reached then the output will be set to ON. In reverse mode, once the Setpoint value is reached then the output will be set to OFF.

The **DeadBand** field together with the direct or reverse control action configures a deadband range around the Setpoint where the ON/OFF control does not toggle. The unit of the DeadBand field will be the same as the unit of the chosen Input.

- **Example 1:** the setpoint is configured for a 50 Hz rate input with a deadband of 10 Hz with *direct* control action. The output will activate if the input rises above 60 Hz. Conversely, the output will become inactive if the input falls below 50 Hz.
- **Example 2:** the setpoint is configured for a 50 Hz rate input with a deadband of 10 Hz with *reverse* control action. The output will activate if the input falls below 40 Hz. Conversely, the output will become inactive if the input rises above 50 Hz.

The **Save** button saves and applies the configurations settings to the ON/OFF control module. The **Delete** button only appears for a previously saved ON/OFF control module and it removes the module and allows

other output types to be configured such as an alarm or mapping.

5.4.4 Setting an Alarm

Alarms are set by clicking the  icon in SYNC on the desired input signal found in the **Input Tab**.

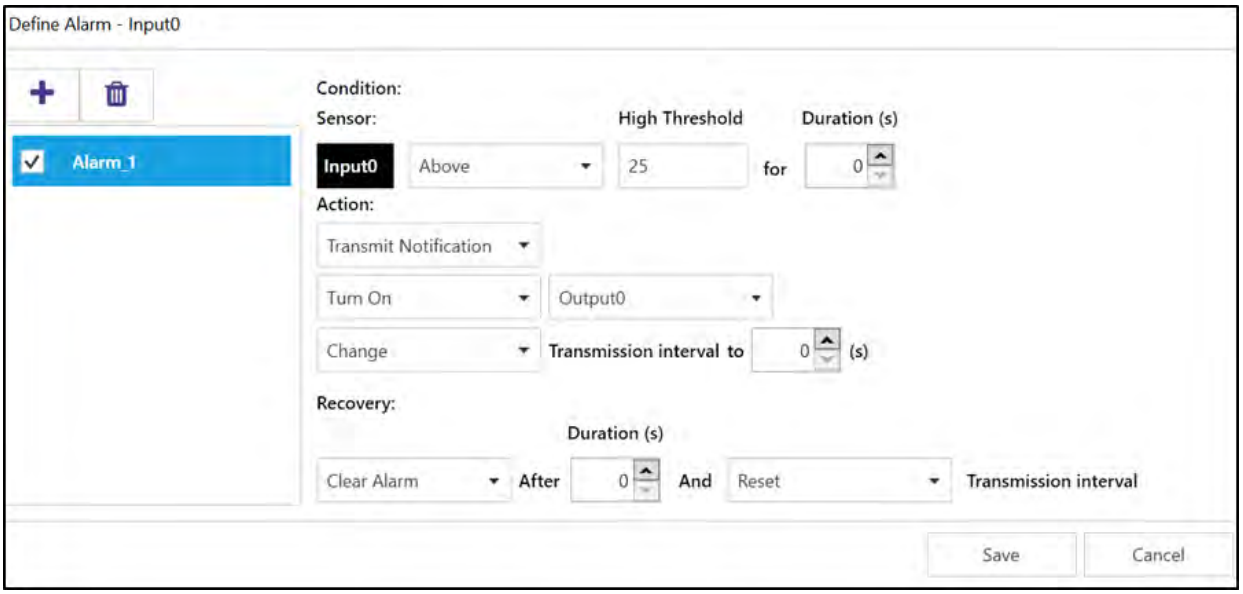

Figure 21: SYNC alarm configuration interface

Configure the **Condition** that triggers the alarm by selecting an option from the drop-down such as *Above, Below, Outside the Range, or Within the Range.* The **Threshold** field(s) will change to display whatever is appropriate for the option chosen such as a High Threshold for an Above condition or a Low Threshold for a Below condition. A **Duration** can be set for the trigger as well where the condition must be met for a certain amount of time before the alarm flags.

Under the **Action** menu, the option to transmit or not transmit a notification can be set. The option to enable "Turn On" an output can also be set. The output chosen must not be currently used in a sensor mapping or ON/OFF control module. The data transmission interval may also be changed upon triggering an alarm, e.g. increase the rate of transmission if an excessive value is detected.

The **Recovery** menu allows the option to clear the alarm after a certain **Duration** (in Seconds) once the trigger condition is no longer met. The transmission interval can also be **Reset** to the normal system setting once the alarm is cleared.

To create a new alarm, click the plus icon  and a new alarm will be added. To remove an alarm once it is created, select the alarm in question on the left side of the alarm panel and click the delete icon  .

6 Pairing a Sensing Device to an Omega Link Gateway

Refer to either the Wired or Wireless instructions to pair an Omega Link Smart Probe & Interface to an Omega Link Gateway. Before continuing to the pairing instructions, ensure the following prerequisites are met:

- Ensure that the Omega Link Gateway has been properly setup, powered on, and in close physical proximity.
- (*For Wired pairing*) Ensure the user has access to a PC and the internal Gateway UI (*refer to the Omega Link Gateway manual for instructions on how to access the internal Gateway UI*).

6.1 Wireless Pairing

Pairing a wireless Smart Interface (IF-006) with probe attached is made easy with a one-button pairing system between the IF-006 and the Omega Link Gateway.

Step 1: When the Smart Probe and relevant accessories have been securely connected to the IF-006, push the pairing button once on the IF-006. The LED status indicator will blink green indicating the device is in Pairing Mode.

Step 2: Quickly push the pairing button on the Omega Link Gateway. The LED on the Gateway will blink green indicating the Gateway is in Pairing Mode.

When the IF-006 or Smart Sensor has been successfully paired to the Omega Link Gateway, the LED will stop blinking on both devices. Readings for the newly added device will then appear on the Omega Link Cloud or OEG interface.

6.2 Wired Pairing

Wired Smart Probes connected directly to an Omega Link Gateway with an IF-001 cable or IF-002 will need to be added to the Gateway Internal User Interface.

The **Connected Devices** tab is the default page set once you are signed in to the internal gateway UI. From here, you can add devices to your gateway to have them appear in your Omega Link Cloud account.

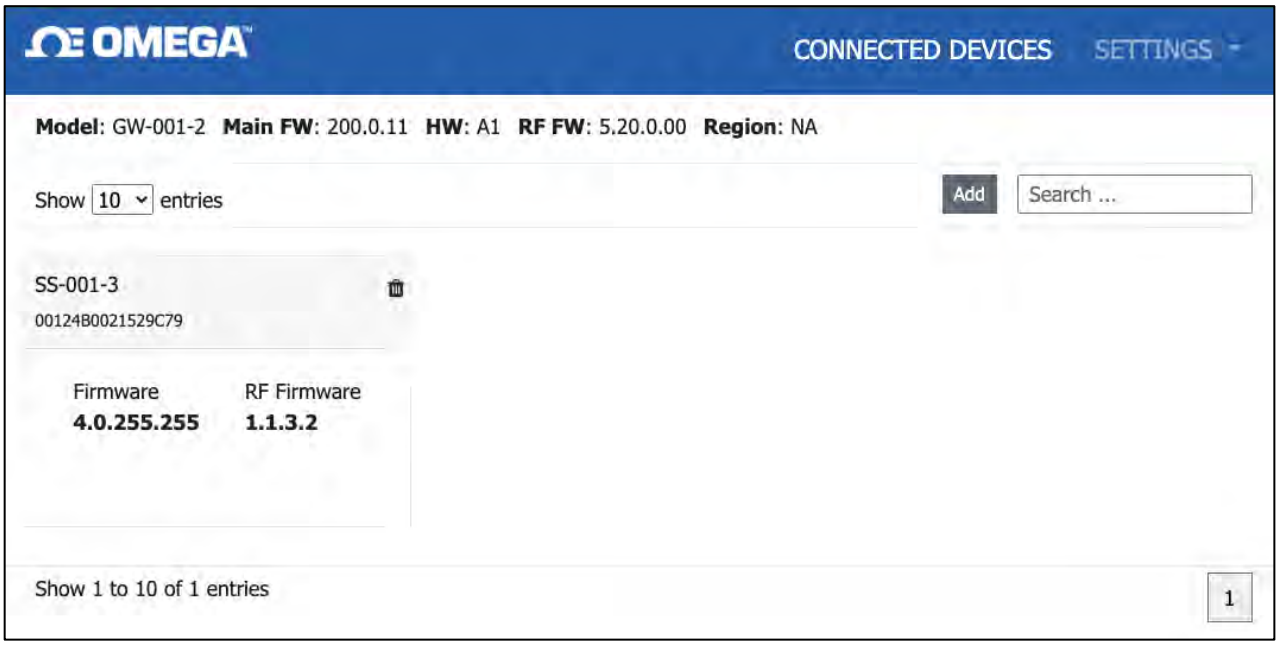

Figure 22: Gateway Internal User Interface

To add a device to your gateway from the internal gateway web UI, begin by clicking the 

button at the top right of the web page. Fill out the Add Device menu with the parameters of the Smart Probe connection.

7 Appendix: SP-006 Registers

The following Appendix provides the registers and list index for the Omega Link SP-006 Pressure monitoring Smart Probe. This information is intended to aid users who will be making configurations and adjustments to their Omega Link SP-006 Pressure monitoring Smart Probe through the Command Line Interface or other custom interfaces.

7.1 Register Base Addresses

Smart Probe devices share a common platform architecture that provides extensive monitoring and control capabilities through a set of platform generic registers. These registers may be accessed using I2C based commands directly to the Smart Probe devices or through a set of Modbus-based registers when using Omega Interface devices. Refer to the *Smart Sensor Device Interface* manual for further information.

When powered on, or after a device reset, each Smart Sensor-based device will enumerate 1 or more sensor instances which are described by the device-specific Sensor Descriptors which include configuration options, measurement type, and units of measure for the corresponding sensor values. Additional sensor information is provided in sensor-specific IPSO object descriptions which include extended measurement type, precision, and tracking of minimum/maximum readings.

Sensors are always enumerated in the order Pressure, Temperature (T), and DIO.

Each enumerated Sensor has a Descriptor Base address location and a Sensor IPSO / Configuration structure address location based on the sensor mix selected.

7.2 Pressure Sensor

Sensor	Descriptor Base	IPSO/Configuration	Enumerated Sensor Mix	
			SP-006-0	SP-006-1
0	0x0060 (0xf030)	0x08a8 (0xf454)	Pressure	
1	0x0068 (0xf034)	0x09a8 (0xf4d4)	Temperature	Temperature
2	0x0070 (0xf038)	0x0aa8 (0xf554)		DIO
3	0x0078 (0xf03c)	0x0ba8 (0xf5d4)		

7.2.1 Pressure Descriptor

The SP-006 configures the sensors based on the factory device list and user-specified list index. The Sensor Configuration and Sensor Device fields may be written to provide control of the overall function of the channel and the signal types used.

Offset	Name	Value	Description
0x00	Sensor Type	0x28	Pressure
0x01	Data Type/Format	0x06	Float type
0x02	Configuration Byte	??	See subsections below
0x03	Device Byte	0x00	Not Used
0x04..0x08	UOMR	“kPa”	Units of measure

7.2.1.1 Pressure Sensor Type

Sensor Type	SI Derived Units	Measurement
0x28	kPa	Pressure

7.2.1.2 Pressure Data Type/Format

The SP-006 supports extended configuration and provides factory calibration. All data values are returned as 32-bit floating-point values.

Pressure Data Type/Format							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Smart Sensor	Configuration Enable	Factory Calibrate		Data Type			
0	0	0	0	6 == Floating point			

7.2.1.2.1 Data Type

The 4-bit Data Type field determines the type of data of the specific sensor.

7.2.1.2.2 Factory Calibrate

Factory calibration is available for the SP-006 process inputs. Clearing this bit will disable the factory calibration values.

7.2.1.2.3 Writeable

The writeable bit is cleared, indicating that the sensor values may not be overwritten.

7.2.1.3 Temperature Configuration Byte

Pressure Sensor Configuration							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Available	Assigned/ Channel	Apply Scaling	Lock	Sensor Range/Type			
0	0	?	?	Read Only – Indicates pressure range			

7.2.1.3.1 Lock

If set, the user-specified units of measure string (4-character maximum) will be used in place of the default**.**

7.2.1.3.2 Apply Scaling

For more information on Gain and Offset, refer to the Smart Sensor Manual. If set, the user-defined Offset, and Gain values will be used to adjust the sensor reading:

Result = (Raw Reading * Gain) + Offset

7.2.1.3.3 Assigned

The Assigned bit will always read as 0. Refer to the *Smart Sensor Device Interface* documentation for further information.

7.2.1.3.4 Available

The Available bit will always read as 0. Refer to the *Smart Sensor Device Interface* documentation for further information.

7.2.1.3.5 Sensor Range / Type

The lower 4-bits of the Range byte are ***read-only***.

Sensor Type	Sensor Input Type (Range)	Measurement Type	
0x00	Reserved		
0x01	Reserved		
0x02	100 kPa (15 psi)	0x28	Pressure (Kilo Pascal)
0x03	200 kPa (30 psi)	0x28	Pressure (Kilo Pascal)
0x04	350 kPa (50 psi)	0x28	Pressure (Kilo Pascal)
0x05	700 kPa (100 psi)	0x28	Pressure (Kilo Pascal)
0x06	Reserved		
0x07	Reserved		
0x08	+/- 100 kPa (+/- 15 psi)	0x28	Pressure (Kilo Pascal)
0x09..0x0e	Reserved		
0x0f	Variable Pressure (special order)	0x28	Pressure (Kilo Pascal)

7.2.2 Pressure Sensor Device Byte

The Device byte is ***read-only***.

Pressure Sensor Device Byte							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Reserved						Type	
0	0	0	0	0	0	0x00	Absolute
						0x01	Gauge
						0x02	Sealed Gauge

7.2.3 Pressure User Calibration Parameters

The SP-006 provides four User Calibration registers that allow setting a 2-point calibration/linearization. The four parameters may only be set while the device is in the User Calibrate mode. When the calibration function is triggered the device will calculate the Gain and Offset used in the linearization process. The calibration process is performed by the following steps:

1) Send Sensor Function **Calibrate Mode** trigger to set the device to calibration mode.
2) Apply a known pressure and record in the User Calibration register 1 (Actual Low).
3) Record the measured value in User Calibration register 0 (Reading Low)
    a. A Sensor **Capture Low** trigger function allows automatic capturing of the value.
4) Apply a 2nd known pressure and record in the User Calibration register 3 (Actual High)
5) Record the measured value of the 2nd weight in User Calibration register 2 (Reading High)
    a. A Sensor **Capture High** trigger function allows automatic capturing of the value.
6) Send the Sensor Function **Start Calibrate** trigger to generate the Gain and Offset values

The four calibration parameters represent two sets of reading, where X = actual applied pressure and Y represents the reading captured by the device. After the calibration process:

Result = Reading * *Gain* + *Offset*

Where:

Gain = (Y2 – Y1) / (X2 – X1)
Offset = (X1 * Gain) – Y1

Note: The device must be put into the **Calibration Mode** to access the User Calibration parameters.

While in the Calibration mode, the raw Reading value will be displayed. To perform a single point calibration (Offset only), set the *High Actual* equal to the *Low Actual* (Gain) or the *High Reading* equal to the *Low Reading* value.

User Calibration Parameter	Name	Range	Factory Reset	Description
0	Low Reading (X1)	+/- 100000	0.0	Value read by SP-006 (lower value)
1	Low Actual (Y1)	+/- 100000	0.0	Actual applied load (lower value)
2	High Reading (X2)	+/- 100000	Full Scale	Value read by SP-006 (higher value)
3	High Actual (Y2)	+/- 100000	Full Scale	Actual applied load (higher value)

7.2.4 IPSO Pressure Sensor Definition

The SP-006 IPSO pressure definition provides signal range, measured min/max values, IPSO object type information.

Offset	Name	Value	Description
0x00	Sensor Type	3323	Pressure (kPa)
0x02	Precision	1	Provides reading of xxx.y kPa
0x04	Sensor Trigger	??	Write any value to force a reset of min/max
0x08	Min Measured	??	Minimum reading since the last reset
0x0c	Max Measured	??	Maximum reading since the last reset
0x10	Min Range	-40.0	
0x14	Max Range	+85.0	

Type	Min Range	Max Range
100 KPa	0	100
200 KPa	0	200
350 KPa	0	300
700 KPa	0	700

7.2.4.1 Precision

The measured pressure value is rounded to provide +/- 0.5 kPa degree resolution.

7.2.4.2 Sensor Trigger Function

The Sensor Trigger function is used to reset the IPSO min/max values and to control the Calibration process.

Sensor Trigger Function							
7	6	5	4	3	2	1	0
							Reset Min/Max
0	0	0	0	0	0	0	?
15	14	13	12	11	10	9	8
		Calibration Reset	Calibration Status	Calibration Mode	Capture High	Capture Low	Calibration Start
0	0	0	0	0	0	0	0

Setting the Reset Min/Max bit to 1 will reset the Min/Max values recorded by the IPSO process.

The Calibration mode is entered by writing a 1 to the Calibration Mode bit. While in the calibration mode the calibration registers may be accessed, the Capture High/Low may be used to capture real-time values and the Calibration Start may be set.

When the Calibration Start bit is set the Calibration Status bit will remain set until the calibration process is complete.

Setting the Calibration Reset bit will clear the calculated Gain and Offset values.

7.2.4.1 Max Range

The SP-006 allows pressures of 150% of the full range value.

7.3 Temperature Sensor

The SP-006 provides a discrete temperature sensor interface.

7.3.1 Temperature Descriptor

The SP-006 configures the sensors based on the factory device list and user-specified list index. The Sensor Configuration and Sensor Device fields may be written to provide control of the overall function of the channel and the signal types used.

Offset	Name	Value	Description
0x00	Measurement Type	0x01	Temperature in °C
0x01	Data Type/Format	0x06	Float type
0x02	Configuration Byte	??	See subsections below
0x03	Device Byte	0x00	Not Used
0x04..0x08	UOMR	“oC”	Units of measure

7.3.1.1 Temperature Sensor Type

Sensor Type	SI Derived Units	Measurement
0x01	°C	Temperature

7.3.1.2 Temperature Data Type/Format

The SP-006 supports extended configuration and provides factory calibration. All data values are returned as 32-bit floating-point values.

Temperature Data Type/Format							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Smart Sensor	Configuration Enable	Factory Calibrate		Data Type			
0	0	0	0	6 == Floating point			

7.3.1.2.1 Data Type

The 4-bit Data Type field determines the type of data of the specific sensor.

7.3.1.2.2 Factory Calibrate

Factory calibration is available for the SP-006 process inputs. Clearing this bit will disable the factory calibration values.

7.3.1.2.3 Writeable

The writeable bit is cleared, indicating that the sensor values may not be overwritten.

7.3.1.3 Temperature Configuration Byte

Temperature Sensor Configuration							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Available	Assigned/ Channel	Apply Scaling	Lock	Sensor Range/Type			
0	0	?	?	0x01 (Internal Use)			

7.3.1.3.1 Lock

If set, the user-specified units of measure string (4-character maximum) will be used in place of the default.

7.3.1.3.2 Apply Scaling

For more information on Gain and Offset, refer to the Smart Sensor Manual. If set, the user-defined Offset and Gain values will be used to adjust the sensor reading:

Result = (Raw Reading * Gain) + Offset

7.3.1.3.3 Assigned

The Assigned bit will always read as 0. Refer to the *Smart Sensor Device Interface* documentation for further information.

7.3.1.3.4 Available

The Available bit will always read as 0. Refer to the *Smart Sensor Device Interface* documentation for further information.

7.3.1.4 Temperature Device Byte

The Temperature Device Byte is not used.

7.3.2 Temperature Parameters

There are no user-accessible parameters for the temperature sensor.

7.3.3 Temperature User Calibration

There are no temperature user calibration registers assigned.

7.3.4 IPSO Temperature Sensor Definition

The SP-006 IPSO temperature definition provides signal range, measured min/max values, IPSO object type information.

Offset	Name	Value	Description
0x00	Sensor Type	3303	Temperature (°C)
0x02	Precision	1	Provides reading of xxx.y
0x04	Sensor Trigger	??	Write any value to force a reset of min/max
0x08	Min Measured	??	Minimum reading since the last reset
0x0c	Max Measured	??	Maximum reading since the last reset
0x10	Min Range	-40.0	Minimum reading
0x14	Max Range	+85.0	Maximum reading

7.3.4.1 Precision

The measured temperature value is rounded to provide ±0.1 degree resolution.

7.3.4.2 *Sensor Trigger Function*

The Sensor Trigger function is used to reset the IPSO min/max values and to control the Calibration process.

Sensor Trigger Function							
7	6	5	4	3	2	1	0
							Reset Min/Max
0	0	0	0	0	0	0	?
15	14	13	12	11	10	9	8
0	0	0	0	0	0	0	0

Setting the Reset Min/Max bit to 1 will reset the Min/Max values recorded by the IPSO process. No user calibration is supported in the temperature sensor and all configuration bits should be written as 0.

7.4 Discrete I/O Interface

The SP-006 supports a DIO Interface that provides 2 discrete inputs that are hardwired to the outputs. These may be used to detect the state of external switches (output off) or to monitor the state of the outputs.

7.4.1 DIO Descriptor

Offset	Name	Value	Description
0x00	Sensor Type	0x18	Digital Type (Bit mapped)
0x01	Data Type/Format	0x46	Configurable, Float type
0x02	Configuration	0x23	Scaling applied, Bits 0 and 1 enabled
0x03	Sensor Device	0x0f	DIN bits enabled / inverted
0x04	UOMR	“DIN”	Units of measure

7.4.1.1 *DIO Sensor Type*

The interface provides a bitmapped input of the 2 digital signal lines.

Sensor Type	SI Derived Units	Measurement
0x18	DIN	Bitmapped digital inputs

7.4.1.2 *DIO Data Type/Format*

DIO Data Type/Format							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Smart Sensor	Writeable	Factory Calibrate	reserved	Data Type			
0	0	0	0	6 == Floating point			

7.4.1.2.1 *Data Type*

The 4-bit Data Type field determines the type of data of the specific sensor.

7.4.1.2.2 Factory Calibrate

The Factory Calibrate bit is not used for DIO types.

7.4.1.2.3 Writeable

This indicates that the sensor value may be overwritten. Not used on DIO inputs.

7.4.1.2.4 Smart Sensor

Refer to the *Smart Sensor Device Interface* documentation.

7.4.1.3 DIO Input Configuration

DIO Input Configuration							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Available	Assigned	Apply Scaling	Lock	Sub Channel Selection			
0	0	1	?	0x03 == bits 0 and 1			

7.4.1.3.1 Lock

If set, the user-specified units of measure string (4 character maximum) will be used in place of the default **DIN.**

7.4.1.3.2 Apply Scaling

If set, the user-defined Offset and Gain values will be used to adjust the sensor reading:

Result = (Raw Reading * Gain) + Offset

7.4.1.3.3 Assigned

The Assigned bit will always read as 0. Refer to the *Smart Sensor Device Interface* documentation for further information.

7.4.1.3.4 Available

The Available bit will always read as 0. Refer to the *Smart Sensor Device Interface* documentation for further information.

7.4.1.4 DIO Device Configuration

The DIO Device Configuration allows enabling each of the 2 input bits and selecting whether the input is active HIGH (reads as 1 when input is not grounded) or active LOW (reads as 1 when input is grounded).

DIO Device Configuration							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Reserved				DIN 1		DIN 0	
0	0	0	0	ENABLE	INVERT	ENABLE	INVERT
				1	1	1	1

7.4.1.4.1 Invert

If the Invert bit is set the input is active LOW.

7.4.1.4.2 Enable

If the Enable bit is set the input is enabled.

7.4.2 DIO IPSO Definition

The DIO input IPSO definition provides signal range, measured min/max values, IPSO object type information.

Offset	Name	Value	Description
0xa8	Sensor Type	3349	Bit Mapped Digital
0xaa	Precision	0	Provides reading of xxx
0xac	Sensor Trigger	??	Write 0x0001 force reset of min / max
0xb0	Min Measured	??	Minimum reading since the last reset
0xb4	Max Measured	??	Maximum reading since the last reset
0xb8	Min Range	0	Minimum reading
0xbc	Max Range	3	Maximum reading

7.4.2.1 Sensor Trigger Function

The Sensor Trigger function is used to reset the IPSO min/max values as well as controlling the Calibration process.

Sensor Trigger Function							
7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	Reset Min/Max
15	14	13	12	11	10	9	8
0	0	0	0	0	0	0	0

Setting the Reset Min/Max bit to 1 will reset the Min/Max values recorded by the IPSO process. No User Calibration process is supported on the DIO inputs and all Configuration bits should be written as 0.

7.5 Output Configuration Registers

Outputs share a common structure which consists of 3-fields mapped to a 16-bit unsigned integer, accessible in the Smart Sensor register map.

Output	Name	Modbus Address	I2C Address	Size	Typical Description
0	Output 0 Descriptor	0xf09a	0x0134	uint16	PWM 0 (see below)
1	Output 1 Descriptor	0xf09b	0x0136	uint16	PWM 1 (see below)
2	Output 2 Descriptor	0xf09c	0x0138	uint16	Phantom (non-configurable)
3	Output 3 Descriptor	0xf09d	0x013a	uint16	Phantom (non-configurable)

Refer to the specific output type for further information.

7.5.1 Scaling Minimum / Maximum Values

When Input Mapping is used the user may specify the input signal range through the Input Minimum and Input Maximum parameters. There is one pair of registers for each of the 4 possible outputs.

Sensor	Name	Modbus Address	I2C Address	Size	Description
0	Output 0 Low Scale	0xf1f0	0x03e0	float	Sets lower input range
	Output 0 High Scale	0xf1f2	0x03e4	float	Sets upper input range
1	Output 1 Low Scale	0xf1f4	0x03e8	float	Sets lower input range
	Output 1 High Scale	0xf1f6	0x03ec	float	Sets upper input range
2	Output 2 Low Scale	0xf1f8	0x03f0	float	Sets lower input range
	Output 2 High Scale	0xf1fa	0x03f4	float	Sets upper input range
3	Output 3 Low Scale	0xf1fc	0x03f8	float	Sets lower input range
	Output 3 High Scale	0xf1f2e	0x03fc	float	Sets upper input range

When either the Low Scale or High Scale value changes an internal calculation is performed to calculate the linear transformation to be applied to the sensor reading.

7.5.2 Output Values

Outputs use *float* values which represent the percentage of full scale. If the output is not mapped, the value written (0 – 100%) is identical to the value that is read back.

If the output is mapped, the scaling values are used to transform the minimum input value to 0% and the maximum input value to 100%.

Output	Name	Modbus Address	I2C Address	Size	Description
0	Output 0 Value	0xf078	0x00f0	float	Percent of full-scale value (0-100%)
1	Output 1 Value	0xf07a	0x00f4	float	Percent of full-scale value (0-100%)
2	Output 2 Value	0xf07c	0x00f8	float	Percent of full-scale value (0-100%)
3	Output 3 Value	0xf07e	0x00fc	float	Percent of full-scale value (0-100%)

7.5.3 Output Names

Each output has a name. The default names for the outputs are **Output_0** through **Output_3**. The default names may be overwritten, such as 'Stack_Lite' or 'Control_Valve'. Names are restricted to 16 characters.

Output	Name	Modbus Address	I2C Address	Size	Description
0	Output 0 Name	0xf078	0xf720	char[16]	Defaults to **Output_0**
1	Output 1 Name	0xf07a	0xf728	char[16]	Defaults to **Output_1**
2	Output 2 Name	0xf07c	0xf730	char[16]	Defaults to **Output_2**
3	Output 3 Name	0xf07e	0xf738	char[16]	Defaults to **Output_3**

The Output names are retained until a factory reset occurs.

It is strongly recommended that:

1. Spaces within the name should be replaced with the '_' character.
2. All output names on a particular device are unique – if duplicate functions are supported append a '_x' string, where x represents the instance. For example, *Stack_Lite_1* and *Stack_Lite_2* could be used if 2 stack lights are being connected.

7.6 Output Configuration

The SP-006 provides two output signals which may be configured for ON/OFF, PWM, or SERVO outputs through the Output Configuration registers. The remaining outputs are assigned as phantom devices which are non-configurable.

The highlighted entries show typical default configurations.

Output Configuration

7	6	5	4	3		2	1	0
Output Configuration								

Servo Range

1.0 – 2.0	0
0.5 – 2.5	1

Active State

LOW	**0**
HIGH	1

Rate

100 Hz	**0**	**0**	**0**
10 Hz	0	0	1
1 Hz	0	1	0
0.1 Hz	0	1	1
50 Hz	1	0	0
33 Hz	1	0	1
25 Hz	1	1	0
20 Hz	1	1	1

15	14	13	12	11		10	9	8
Output Type								

Sensor Mapping

No Mapping	**0**	**-**	**-**
Sensor 0	1	0	0
Sensor 1	1	0	1
Sensor 2	1	1	0
Sensor 3	1	1	1

Mapping Enable

Not Enabled	0
Enabled	**1**

Output Type

Null	0	0	0	0
ON/OFF	**0**	**0**	**0**	**1**
PWM	0	0	1	0
Servo	0	0	1	1

7.6.1 Rate

The Rate determines the repetition rate, or frequency, of the discrete output. For On/Off outputs the rate field is ignored.

7.6.1.1 PWM Rate

The SP-006 supports the following PWM frequencies:

PWM Rate	Name	Description
0	100 Hz	PWM signal has constant 100 Hertz frequency (10 msec repetition rate) with 0 – 100 % duty cycle
1	10 Hz	PWM signal has constant 10 Hertz frequency (100 msec repetition rate) with 0 – 100 % duty cycle
2	1 Hz	PWM signal has constant 1 Hertz frequency (1 second repetition rate) with 0 – 100 % duty cycle
3	0.1 Hz	PWM signal has constant 0.1 Hertz frequency (10 second repetition rate) with 0 – 100 % duty cycle

7.6.1.2 SERVO Rate

Smart Sensor probes support the following SERVO frequencies:

Servo Rate	Name	Description
0	100 Hz	PWM signal has constant 100 Hertz frequency (10 msec repetition rate) with 0 – 100 % duty cycle
4	50 Hz	PWM signal has constant 50 Hertz frequency (20 msec repetition rate) with 0 – 100 % duty cycle

7.6.2 Output Type

Smart Sensor probes support NULL (0), ON/OFF (1), PWM (2) and SERVO (3) outputs. When set to NULL the output signal will be left in a high impedance state. When set to ON/OFF the Rate and Servo Range controls have no effect. When the SERVO type is selected the Duty-Cycle is restricted so the output signal is either 0.5 – 2.5 msec or 1.0 to 2.0 msec based on the Servo Range bit.

7.6.3 Active State

Smart Sensor discrete outputs may be configured as Active HIGH or Active LOW. When set to 1 (Active High), the output will be high impedance when active. When set to 0 (Active Low), the output will be low impedance (~ 0.0 volts) when active. The Factory reset value is 0 (Low).

7.6.4 Mapping Enabled

The read-only Mapping Enabled bit indicates that the output may be optionally directly mapped to a sensor input based on the Sensor Mapping field. If the Mapping Enabled bit is clear no mapping is supported, and the Sensor Mapping field is ignored.

7.6.5 Sensor Mapping

The Sensor Mapping value may select ‘no mapping’ or any of Sensor 0..3. If no mapping is selected the output may be directly controlled by writing a value from 0 – 100 % to the internal Output Value. If a Sensor is selected and the hardware supports the mapping the output will track the selected sensor value, scaled by the Input Minimum and Input Maximum values.

If Sensor Mapping is enabled for PWM outputs the scaling values are used such that a signal input at or below the Scaling Low-value results in a 0% output and a signal input at or above the Scaling High-value results in a 100% PWM duty cycle.

If Sensor Mapping is enabled for SERVO outputs the scaling values are used such that a signal input at or below the Scaling Low-value results in a minimum (0.5 or 1.0 msec) pulse width and a signal input at or above the Scaling High-value results in a maximum (2.0 or 2.5 msec) pulse width.

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.

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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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- Industrial Water & Wastewater Treatment
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