1 YEAR WARRANTY

OMEGA™

User's Guide

5" Tube Housing

3" Tube Housing

3" Bulkhead Housing

SP-003 / SP-004

Omega Link Environmental Monitoring Smart Probe

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Table of Contents

1 Notes, Cautions and Warnings

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-003/SP-004 Environmental Monitoring Smart Probe provides temperature, relative humidity, and barometric pressure readings. The SP-003-2 and SP-004-2 also offer dewpoint, humidex, and heat index readings. The SP-003/SP-004 accepts Omega Link Smart Interfaces through its M12 8-pin connector.

The Omega Link SP-003/SP-004 features 2 configurable digital I/O pins. These can be used for a myriad of applications including driving relays, physical alarms, or sensing dry contacts like door switches. The SP-003/SP-004 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.

Included with your SP-003/SP-004

- SP-0003/SP-004 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
- A compatible Omega Link Gateway
- An Omega Link Cloud account or a qualifying Omega Enterprise Gateway license tier (Pro, Business, or Business Pro)

Optional Materials

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

Figure 1: SP-003 SP-004 Series probes

Refer to the following table for the available variants of the Omega Link SP-003/SP-004 Smart Probes.

Product Number	Mechanical Housing	Description
SP-003-1	3" Tube	Temperature, Humidity, and Barometric Pressure Smart Probe with discrete I/O
SP-003-2	3" Tube	Temperature, Humidity, Barometric Pressure, Dewpoint, and Humidex/Heat Index Smart Probe with discrete I/O
SP-004-1	3" Tube	Temperature and Humidity Smart Probe with discrete I/O
SP-004-2	5" Tube	Temperature, Humidity, Dewpoint, and Humidex/Heat Index Smart Probe with discrete I/O
SP-004-4	3" Bulkhead	Temperature and Humidity Smart Probe with discrete I/O

3 Specifications

INPUT POWER

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

DIO DIGITAL INPUTS

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

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

V_{inMAX} = 30 V_{DC}

DIO DIGITAL OUTPUTS

2x Open Drain 100 mA max

V_{MAX} = 30 V_{DC}

ACCURACY

Temperature

Range: -40 to 85°C (-40 to 185°F)

Accuracy at 25°C: ±0.3°C (±0.6°F)

Response Time: Less than 1 second

Temperature Coefficient: less than 0.01 C/C

Repeatability: ±0.15°C

Relative Humidity

Accuracy at 25°C: ±2.5% (0 to 80%), non-condensing ±3.5% (80 to 100%), non-condensing

Hysteresis: ±0.8%

Response Time: 8 seconds

Repeatability: ±0.21% RH

Barometric Pressure

Accuracy Over Full Range: ±6 mbar from 300 to 1100 mbar

Accuracy @ 25°C: ±4 mbar from 700 to 1100 mbar

Dewpoint (Calculated)

Accuracy: ±2°C

Heat Index (Calculated)

Accuracy: ±2°C

Humidex (Calculated)

Accuracy: ±2°C

ENVIRONMENTAL

Operating Temperature: -40 to 85°C (-40 to 185°F)

MECHANICAL

Tube Housing

Construction: Stainless Steel

Dimensions: 72 mm L x 15.9 mm OD (2.83” x 0.62”) (5” model available)

Bulkhead Housing

Construction: Aluminum

Dimensions: 73 mm L x 15.9 mm OD x 18.5 mm Panel Opening (2.83” x 0.62” x 0.72”)

GENERAL

Agency Approvals: CE, UKCA

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

Software: Compatible with OEG, SYNC, and OMEGA Cloud

4 Hardware Setup

4.1 Connecting to your Omega Link Smart Interface

The SP-003/SP-004 requires an Omega Link Smart Interface to connect to a computer. OMEGA offers a variety of Smart Interfaces such as the wired IF-001 or wireless IF-006. Use the M12 8-Pin Connector diagram below to connect your SP-003/SP-004 to your Omega Link Smart Interface. To access discrete I/O, an M12.8.T-SPLIT and an M12.8-S-M-FM are needed.

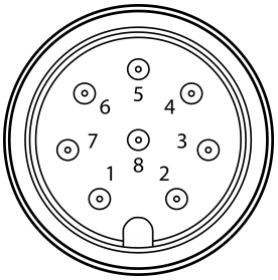


Figure 2: M12 8-Pin Male Connector Front View

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

4.1.1 Discrete I/O

If the smart probe discrete I/O will be utilized, an M12.8-T-SPLIT and an M12.8-S-M-FM will need to be connected between the Smart Interface and Smart Probe. Refer to the previous pin diagram and the wiring diagram below to connect the accessories:

4.2 Bulkhead Mechanical Dimensions in Inches

Refer to the following mechanical drawing and dimensions for the Bulkhead hole cut out diameter.

Close Fit – 19 mm (0.75 inches)
Medium Fit – 20 mm (0.79 inches)
Free Fit – 21 mm (0.83 inches)

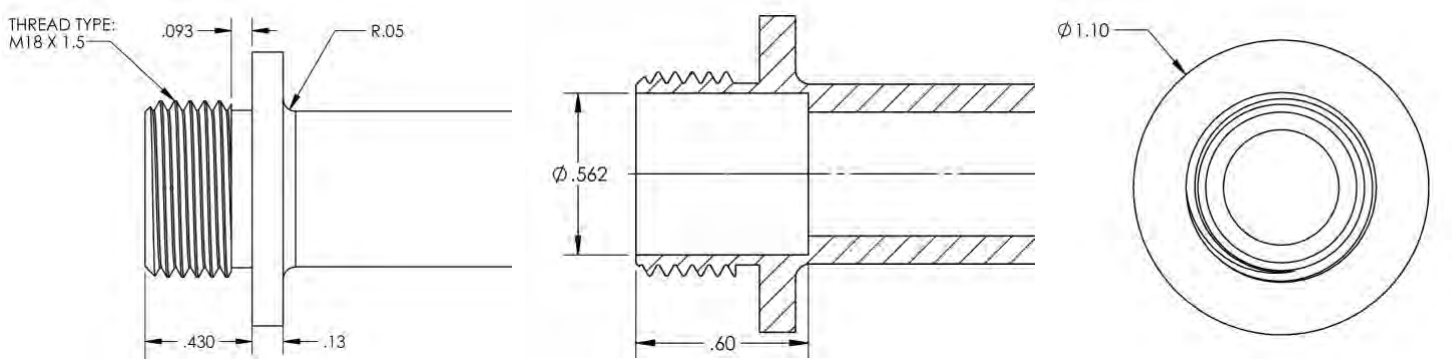


Figure 3: SP-004-4 Mechanical Drawing

5 SYNC Configuration

Omega Link Smart Probe products are easily configured through Omega's free SYNC configuration software. Ensure SYNC is running on a Windows OS computer before continuing. Connect the SP-003/SP-004 to the computer using 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-003/SP-004 and Omega Link Smart Interface are connected to the computer, SYNC will automatically detect the probe and begin displaying readings.

Note: If living readings from the SP-003/SP-004 are displayed on SYNC, skip ahead to section **5.3 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.

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

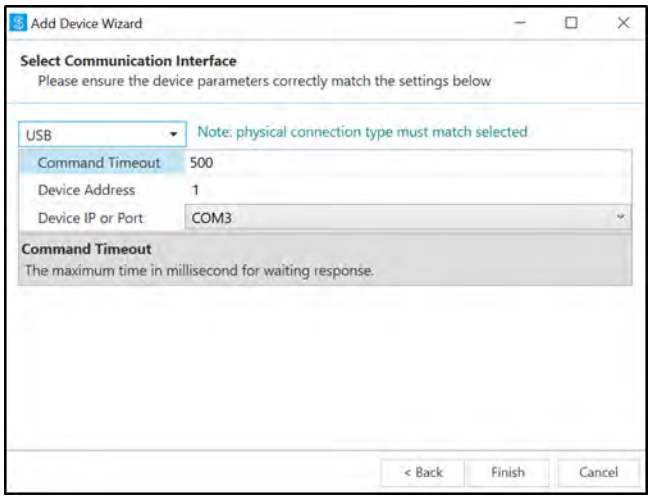


Figure 5: USB Communication Interface

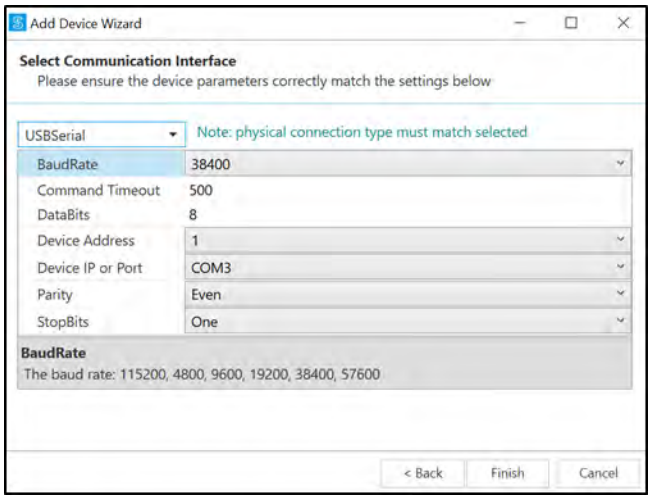


Figure 4: USB Serial Communication Interface

- **Connection Type:** Select the type of connection you have between your SP-003/SP-004 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 alone to avoid communication errors.

- **Device Address:** If your Smart Interface is part of a network, enter the Network Address here. The default network address is 1 for most devices. Please refer to the manual of your Smart Interface for more information.

Note: The default Device Address is 1.

- **Device IP or Port:** The COM port number that your device is connected to on your computer.

Important: The following parameters should **NOT** be changed. These settings should **NOT** be changed unless the configuration has been done on the interface.

- **BaudRate:** Controls bits per second
- **DataBits:** The number of 'bits' in each character sent.
- **Parity:** A means of checking the correctness of 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-003 provides input readings for Temperature, Humidity, and Barometric Pressure with the SP-003-2 and SP-004-2 also offering Dewpoint, Humidex, and Heat Index readings.

5.3.1 Temperature, Humidity, and Barometric Pressure (SP-003 Only)

To configure these inputs, click the **Inputs** configuration tab on SYNC and choose your preferred input sensor mix from the **Type** dropdown.

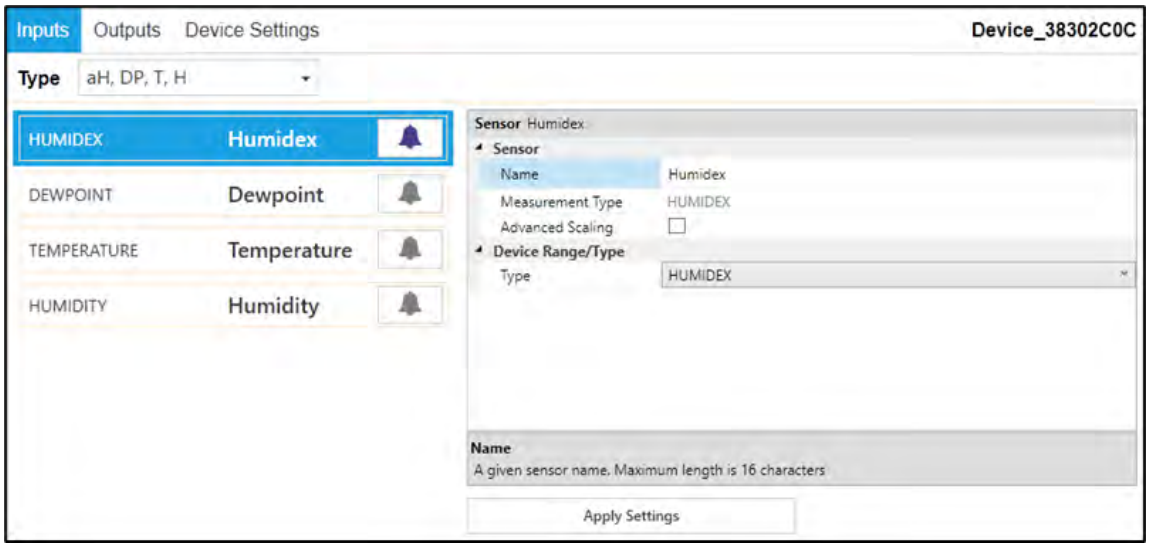


Figure 6: SP-003-2 inputs configuration interface

5.3.1.1 *Dewpoint, Humidex, and Heat Index Sensor (SP-003-2 and SP-004-2 only)*

The SP-003-2 and SP-004-2 add Dewpoint, Humidex, and Heat Index sensor readings in addition to temperature, humidity, and barometric pressure. To access the dewpoint, Humidex, or Heat index sensor through SYNC, click the **Inputs** configuration tab and choose the input sensor mix that includes *DP (Dewpoint) or aH (Apparent Heat = Humidex and Heat Index)*.

5.3.2 Temperature and Humidity Interface (SP-004 Only)

The SP-004 provides readings for temperature and humidity only. The SP-004-2 adds Dewpoint, Humidex, and Heat Index sensor readings in addition to Temperature and Humidity readings. To configure these features, click the **Inputs** configuration tab on SYNC and choose your preferred input sensor mix from the **Type** dropdown.

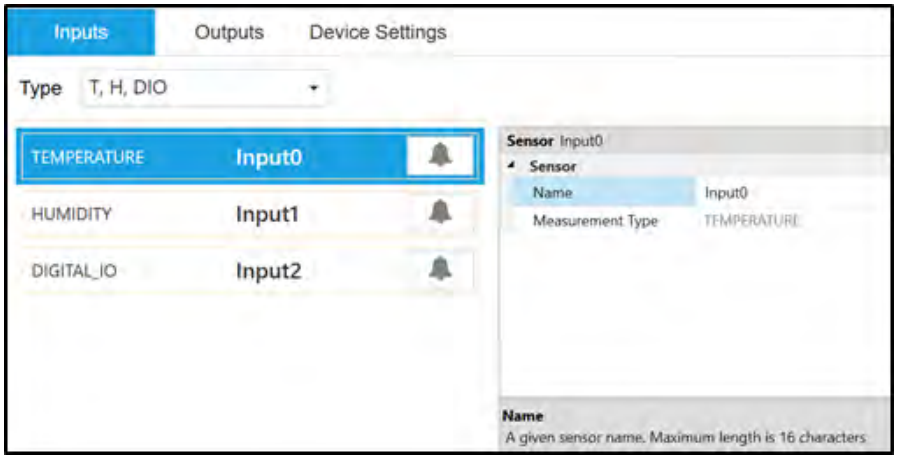


Figure 7: SP-004 input configuration interface

5.3.3 Discrete Input/Output (DIO)

The Omega Link SP-003/SP-004 features 2 configurable discrete I/O pins. These 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).

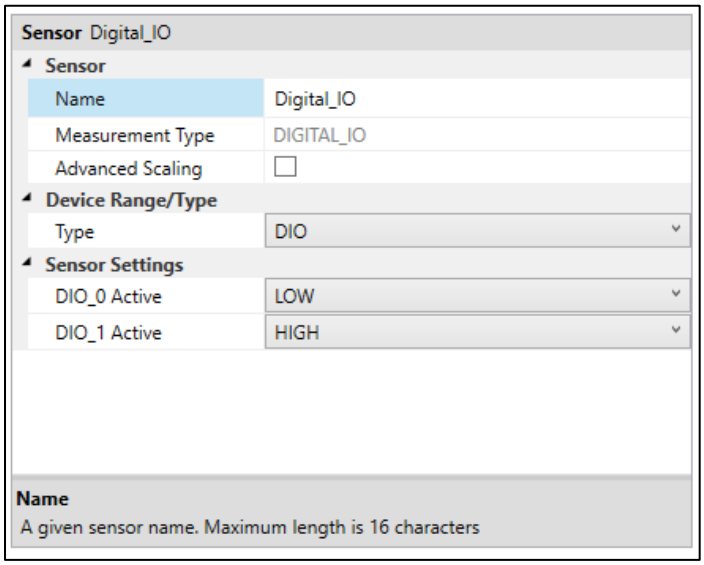


Figure 14: SYNC interface discrete I/O input configuration

The Discrete I/O input shares the output circuitry. 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}.

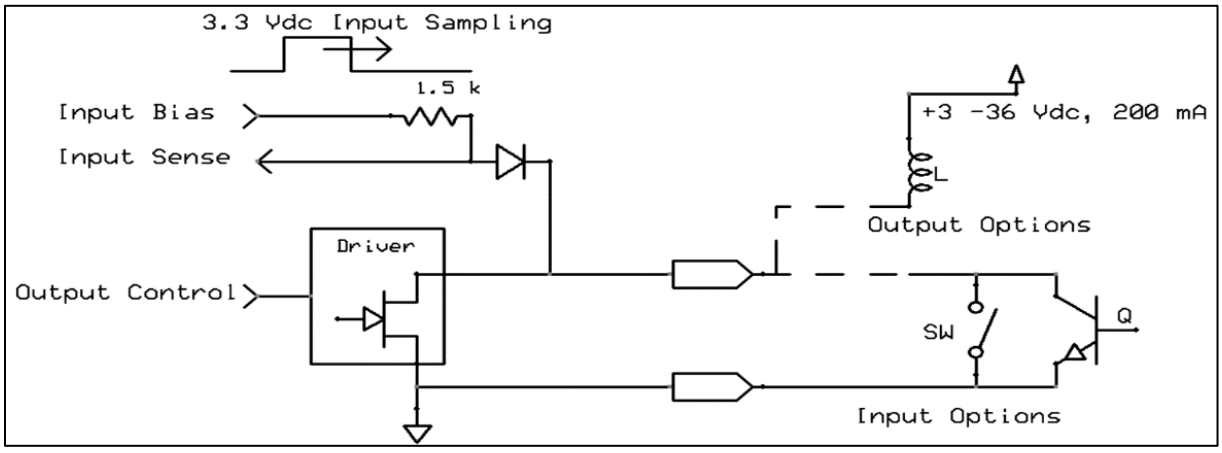


Figure 15: Digital/Discrete I/O circuitry

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.

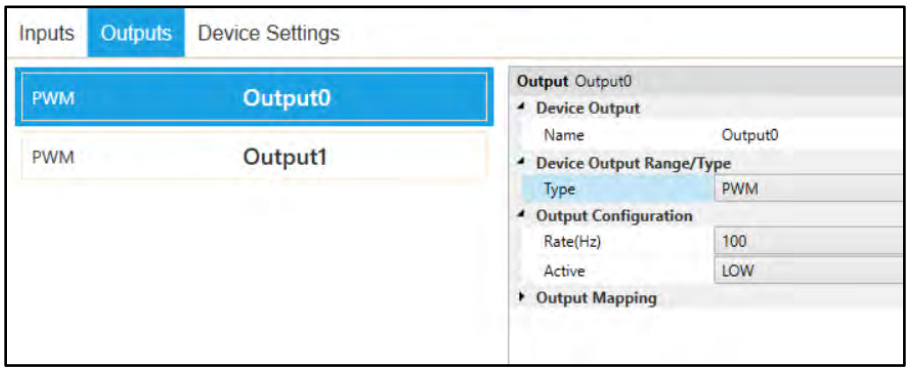


Figure 16: SYNC interface outputs tab

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.

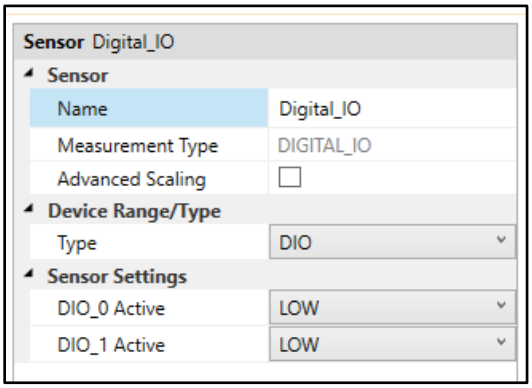


Figure 17: SYNC interface Digital_IO

5.3.4 Advanced Scaling Options

The Omega Link SP-003/SP-004 allows for advanced scaling options on process and pulse inputs only. 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 **Scaling** menu and ensure that **Apply Scaling** is checked. There, 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.

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

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-003/SP-004 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 ***5.3.1 Discrete Input/Output (DIO)*** for more information.

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.

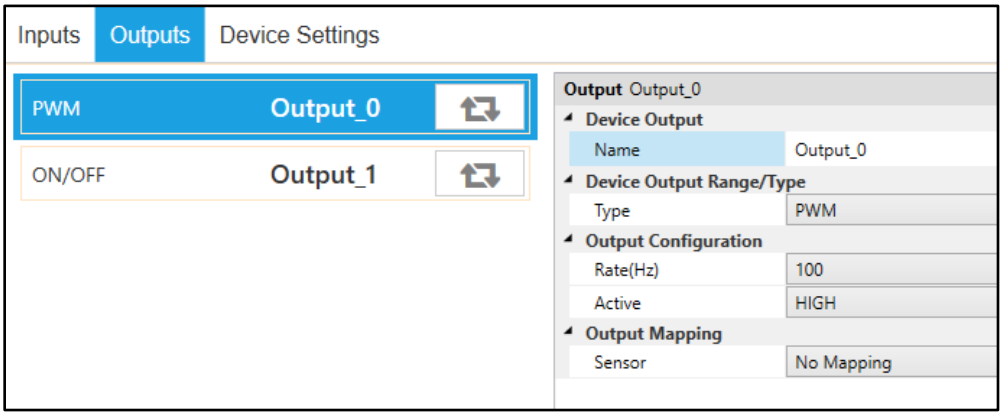


Figure 18: SYNC interface Output Configuration

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.

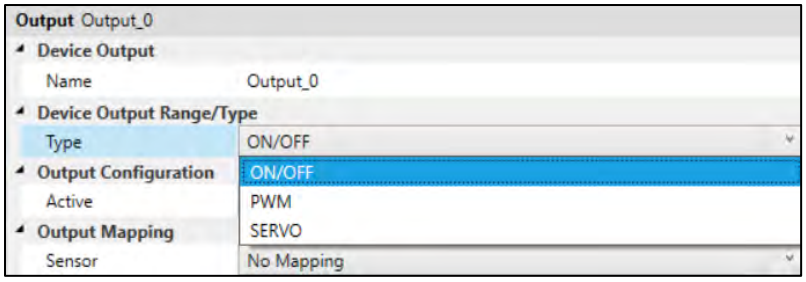


Figure 19: SYNC interface output type selection

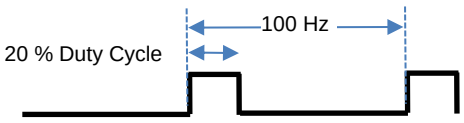
5.4.1.1 *ON/OFF Output Type*

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 digital 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



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

Figure 20: PWM function diagram

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 selecting 50% of angular travel represents 1.5 msec or 90 degrees of travel.

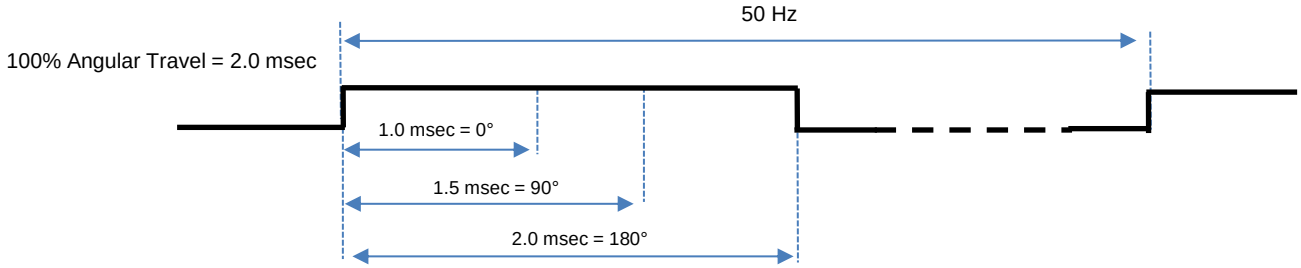


Figure 21: SERVO output example

5.4.2 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.

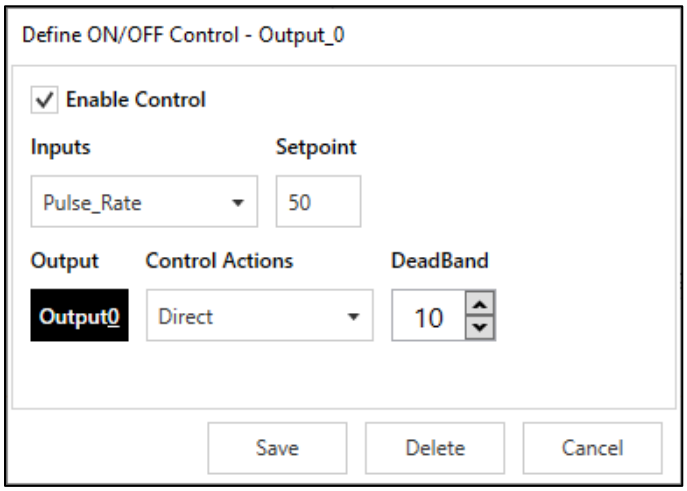


Figure 22: SYNC interface ON/OFF control module functions

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.

5.4.3 Setting an Alarm

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

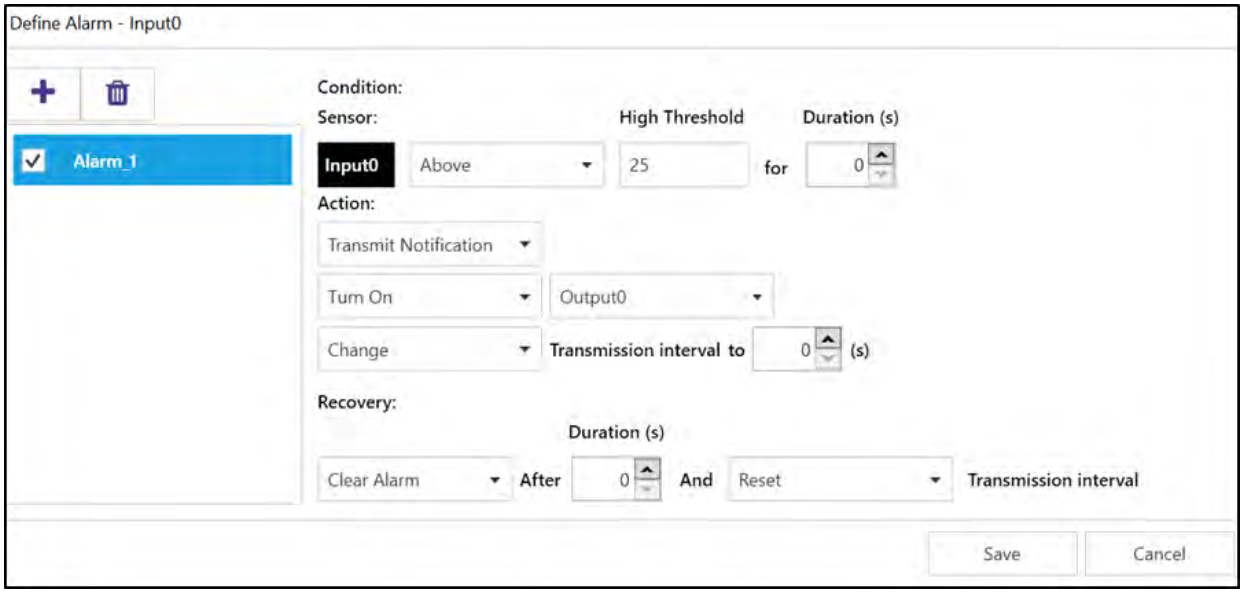


Figure 23: SYNC alarm configuration interface

Configure the **Condition** that triggers the alarm by selecting an option from the drop down such as Above or Below. 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 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** 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.

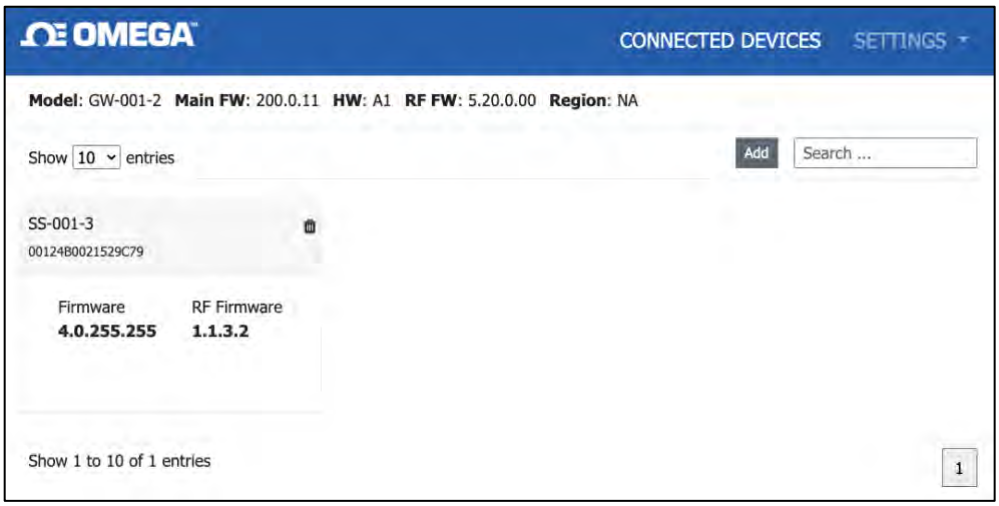


Figure 84: Gateway Internal User Interface

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-003/SP-004 Registers

The following Appendix provides the registers and list index for the Omega Link SP-003/SP-004 Environmental Monitoring Smart Probe. This information is intended to aid users who will be making configurations and adjustments to their Omega Link SP-003/SP-004 Environmental Monitoring Smart Probe through the Command Line Interface or other custom interfaces.

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 Apparent Heat (EH), Dewpoint (D), Temperature (T), Relative Humidity (RH), Barometric Pressure (P) 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.

Sensor	Descriptor Base	IPSO/Configuration	Enumerated Sensor Mix				
0	0x0060 (0xf030)	0x08a8 (0xf454)	T	T	T	D	EH
1	0x0068 (0xf034)	0x09a8 (0xf4d4)	DIO	RH	RH	T	D
2	0x0070 (0xf038)	0x0aa8 (0xf554)		DIO	B	RH	T
3	0x0078 (0xf03c)	0x0ba8 (0xf5d4)			DIO	B	RH

7.1 Sensor Values

Sensors use *float* values which represent the measured value in the indicated units of measure.

Sensor	Name	Modbus Address	I2C Address	Size	Description
0	Sensor 0 Data	0xf01e	0x003c	float	Sensor Reading
1	Sensor 1 Data	0xf020	0x0040	float	Sensor Reading
2	Sensor 2 Data	0xf022	0x0044	float	Sensor Reading
3	Sensor 3 Data	0xf024	0x0048	float	Sensor Reading

7.2 Sensor Names

Each sensor has a name. The default names for the outputs are **created based on the value being measured**. The default names may be overwritten, such as 'Room_Temp' or 'Oven_Temp'. Names are restricted to 16 characters.

Output	Name	Modbus Address	I2C Address	Size	Description
0	Sensor 0 Name	0xf700	0x0e00	char[16]	Defaults depends on Sensor
1	Sensor 1 Name	0xf708	0x0e10	char[16]	Defaults depends on Sensor
2	Sensor 2 Name	0xf710	0x0e20	char[16]	Defaults depends on Sensor
3	Sensor 3 Name	0xf718	0x0e30	char[16]	Defaults depends on Sensor

The Sensor 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 sensor names on a particular device are unique – if duplicate functions are supported append a '_x' string, where x represents the instance. For example, *Temperature_1* and *Temperature_2* could be used if 2 temperature devices are present.

7.3 Temperature Sensor

The Temperature sensor provides temperature readings in the range -40 to +85 °C.

7.3.1 Temperature Descriptor

Offset	Name	Value	Description
0x00	Sensor Type	0x01	Temperature in °C
0x01	Data Type/Format	0x06	Float type
0x02	Configuration	??	See subsections below
0x03	Sensor Device	0x00	Not Used
0x04	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*

Temperature 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			

7.3.1.2.1 *Data Type*

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

7.3.1.2.2 *Factory Calibrate*

Factory calibration is available for the SP-003 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.

7.3.1.2.4 *Smart Sensor*

This bit is cleared.Temperature Configuration Byte

Temperature Configuration Byte							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Available	Assigned	Apply Scaling	Lock	Sensor Selection			
0	0	?	?	0x01(Internal Use)			

7.3.1.2.5 *Lock*

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

7.3.1.2.6 *Apply Scaling*

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

Result = (Raw Reading * Gain) + Offset

7.3.1.2.7 *Assigned*

The Assigned bit will always read as 0.

7.3.1.2.8 *Available*

The Available bit will always read as 0.

7.3.2 Temperature Device Byte

The Temperature Device Byte is not used.

7.3.3 Temperature Parameters

There are no user accessible parameters for the temperature sensor.

7.3.4 Temperature User Calibration

There are no temperature user calibration registers assigned.

7.3.5 IPSO Temperature Definition

The 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	Reset Min/Max	??	See below
0x08	Min Measured	??	Minimum reading since last reset
0x0c	Max Measured	??	Maximum reading since last reset
0x10	Min Range	-40.0	Minimum reading
0x14	Max Range	+85.0	Maximum reading

7.3.5.1 *Precision*

The measured temperature value is rounded to provide +/- 0.1 degree resolution.

7.3.5.2 *Sensor Trigger*

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	Calibration Reset	Calibration Status	Calibration Mode	Capture High	Capture Low	Calibration Start

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 Temperature input and all Calibration bits should be written as 0.

7.4 Humidity Sensor Interface

The Humidity sensor provides readings of 0 to 100 % Relative Humidity.

7.4.1 Humidity Descriptor

Offset	Name	Value	Description
0x00	Sensor Type	0x02	Relative humidity (%)
0x01	Data Type/Format	0x06	Float type
0x02	Configuration	??	See below
0x03	Sensor Device	0x00	Not Used
0x04	UOMR	"%RH"	Units of measure

7.4.1.1 *Humidity Sensor Type*

The Humidity interface provides a measurement of Relative Humidity (%).

Sensor Type	SI Derived Units	Measurement
0x02	%RH	Relative Humidity

7.4.1.2 *Humidity Data Type/Format*

Humidity Data Type/Format							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Smart Sensor	Writeable	Factory Calibrate		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 used during factory calibration. If set, factory calibration is performed on the raw sensor reading PRIOR to user scaling.

7.4.1.2.3 *Writeable*

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

7.4.1.2.4 *Smart Sensor*

This bit is cleared.

7.4.1.3 *Humidity Configuration Byte*

Humidity Sensor Configuration							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Available	Assigned	Apply Scaling	Lock	Sensor Selection			
0	0	?	?	0x02 (Internal use)			

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 units of measure.

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.

7.4.1.3.4 *Available*

The Available bit will always read as 0.

7.4.2 Humidity Device Byte

The Humidity Device Byte is not used.

7.4.3 Humidity Parameters

There are no user accessible parameters for the Humidity sensor.

7.4.4 Humidity User Calibration

There are no Humidity user calibration registers assigned.

7.4.5 IPSO Relative Humidity Definition

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

Offset	Name	Value	Description
0x00	Sensor Type	3304	Relative Humidity (%)
0x02	Precision	1	Provides reading of xxx.y
0x04	Reset Min/Max	??	See below
0x08	Min Measured	??	Minimum reading since last reset
0x0c	Max Measured	??	Maximum reading since last reset
0x10	Min Range	0.0	Minimum reading
0x14	Max Range	100.0	Maximum reading

7.4.5.1 *Precision*

The Relative Humidity value is rounded to provide ±0.1 resolution.

7.4.5.2 *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	Calibration Reset	Calibration Status	Calibration Mode	Capture High	Capture Low	Calibration Start

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 relative humidity input and all Calibration bits should be written as 0.

7.5 Barometric Pressure Interface

The Barometric pressure sensor provides readings in the range of 300 to 1100 mbar.

7.5.1 Barometric Pressure Descriptor

Offset	Name	Value	Description
0x00	Sensor Type	0x03	Barometric Pressure in mbar
0x01	Data Type/Format	0x06	Float type
0x02	Configuration	??	See below
0x03	Sensor Device	0x00	Not Used
0x04	UOMR	“mbar”	Units of measure

7.5.1.1 *Barometric Pressure Measurement Types*

The barometric pressure interface provides a measurement of mbar.

Sensor Type	SI Derived Units	Measurement
0x02	mbar	Barometric Pressure

7.5.1.2 *Barometric Pressure Data Type/Format*

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

7.5.1.2.1 *Data Type*

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

7.5.1.2.2 *Factory Calibrate*

The Factory Calibrate bit is used during factory calibration. If set, factory calibration is performed on the raw sensor reading PRIOR to user scaling.

7.5.1.2.3 *Writeable*

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

7.5.1.2.4 *Smart Sensor*

This bit is cleared.

7.5.1.3 *Barometric Pressure Sensor Configuration*

Barometric Pressure Sensor Configuration							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Available	Assigned	Apply Scaling	Lock	Sensor Selection			
0	1	?	?	0x02 (Internal use)			

7.5.1.3.1 *Lock*

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

7.5.1.3.2 *Apply Scaling*

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

Result = (Raw Reading * Gain) + Offset

7.5.1.3.3 *Assigned*

The Assigned bit will always read as 0.

7.5.1.3.4 *Available*

The Available bit will always read as 0.

7.5.2 Barometric Pressure Device Byte

The Barometric Pressure Device Byte is not used.

7.5.3 Barometric Pressure Parameters

There are no user accessible parameters for the Barometric Pressure sensor.

7.5.4 Barometric Pressure User Calibration

There are no Barometric Pressure user calibration registers assigned.

7.5.5 IPSO Barometric Pressure Definition

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

Offset	Name	Value	Description
0x00	Sensor Type	3315	Barometric Pressure (mbar)
0x02	Precision	1	Provides reading of xxx.y
0x04	Reset Min/Max	??	See below
0x08	Min Measured	??	Minimum reading since last reset
0x0c	Max Measured	??	Maximum reading since last reset
0x10	Min Range	100.0	Minimum reading
0x14	Max Range	1000.0	Maximum reading

7.5.5.1 *Precision*

The Barometric Pressure value is rounded to provide +/- 0.1 resolution.

7.5.5.2 *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	Calibration Reset	Calibration Status	Calibration Mode	Capture High	Capture Low	Calibration Start

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 barometric pressure input and all Calibration bits should be written as 0.

7.6 Dewpoint Interface

The Dewpoint sensor available on the SP-003-2 and SP-004-2 provides the calculated dewpoint based on the measured temperature and relative humidity.

7.6.1 Dewpoint Descriptor

Offset	Name	Value	Description
0x00	Sensor Type	0x36	Dewpoint temperature in oC
0x01	Data Type/Format	0x06	Float type
0x02	Configuration	??	See below
0x03	Sensor Device	0x00	Not Used
0x04	UOMR	“oC”	Units of measure

7.6.1.1 *Dewpoint Temperature Sensor Type*

Sensor Type	SI Derived Units	Measurement
0x36	°C	Dewpoint Temperature

7.6.1.2 *Temperature Data Type/Format*

Temperature 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			

7.6.1.2.1 *Data Type*

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

7.6.1.2.2 *Factory Calibrate*

The Factory Calibrate bit is used during factory calibration. If set, factory calibration is performed on the raw sensor reading PRIOR to user scaling.

7.6.1.2.3 *Writeable*

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

7.6.1.2.4 *Smart Sensor*

This bit is cleared.

7.6.1.3 *Dewpoint Temperature Configuration Byte*

Dewpoint Temperature Configuration Byte							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Available	Assigned	Apply Scaling	Lock	Sensor Selection			
0	0	?	?	0x06(Internal Use)			

7.6.1.3.1 *Lock*

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

7.6.1.3.2 *Apply Scaling*

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

Result = (Raw Reading * Gain) + Offset

7.6.1.3.3 *Assigned*

The Assigned bit will always read as 0.

7.6.1.3.4 *Available*

The Available bit will always read as 0.

7.6.2 Dewpoint Temperature Device Byte

The Dewpoint Temperature Device Byte is not used.

7.6.3 Dewpoint Temperature Parameters

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

7.6.4 Dewpoint Temperature User Calibration

There are no dewpoint temperature user calibration registers assigned.

7.6.4.1 *IPSO Dewpoint Temperature Definition*

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

Offset	Name	Value	Description
0x00	Sensor Type	33123	Dewpoint Temperature (°C)
0x02	Precision	0	Provides reading of xxx
0x04	Reset Min/Max	??	See below
0x08	Min Measured	??	Minimum reading since last reset
0x0c	Max Measured	??	Maximum reading since last reset
0x10	Min Range	-40.0	Minimum reading
0x14	Max Range	+100.0	Maximum reading

7.6.4.1.1 *Precision*

The measured temperature value is rounded to provide +/- 1 degree resolution.

7.6.4.1.2 *Sensor Trigger*

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	Calibration Reset	Calibration Status	Calibration Mode	Capture High	Capture Low	Calibration Start

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 Dewpoint temperature sensor and all Calibration bits should be written as 0.

7.7 Apparent Heat Interface

The Apparent Heat sensor provides a Heat Index (US) or Humidex (CAN) calculated value on the SP-003-2 and SP-004-2. These calculations are based on the measured temperature and relative humidity and the calculated Dewpoint value.

7.7.1 Apparent Heat Descriptor

Offset	Name	Value	Description
0x00	Sensor Type	0x3a	Heat Index (°C)
		0x3b	Humidex (°C)
0x01	Data Type/Format	0x06	Float type
0x02	Configuration	??	See below
0x03	Sensor Device	0x0?	See Below
0x04	UOMR	"°C"	Units of measure

7.7.1.1 *Apparent Heat Sensor Type*

Sensor Type	SI Derived Units	Measurement
0x3a	°C	Heat Index Apparent Heat
0x3b	°C	Humidex Apparent Heat

7.7.1.2 *Apparent Temperature Data Type/Format*

Apparent Heat 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			

7.7.1.2.1 *Data Type*

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

7.7.1.2.2 *Factory Calibrate*

The Factory Calibrate bit is used during factory calibration. If set, factory calibration is performed on the raw sensor reading PRIOR to user scaling.

7.7.1.2.3 *Writeable*

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

7.7.1.2.4 *Smart Sensor*

This bit is cleared.

7.7.1.3 *Apparent Heat Configuration Byte*

Apparent Temperature Configuration Byte							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Available	Assigned	Apply Scaling	Lock	Sensor Selection			
0	0	?	?	Heat Index	0		
				Humidex	1		
				<reserved>	2..15		

7.7.1.3.1 *Lock*

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

7.7.1.3.2 *Apply Scaling*

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

Result = (Raw Reading * Gain) + Offset

7.7.1.3.3 *Assigned*

The Assigned bit will always read as 0.

7.7.1.3.4 *Available*

The Available bit will always read as 0.

7.7.2 Apparent Heat Device Byte

The Apparent Heat Device Byte is not used.

7.7.3 Apparent Heat Temperature Parameters

There are no user accessible parameters for the Apparent Heat sensor.

7.7.4 Apparent Heat User Calibration

There are no Apparent Heat user calibration registers assigned.

7.7.4.1 *IPSO Apparent Heat Definition*

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

IPSO Apparent Heat Definition				
Offset	**Name**	**Value**	**Description**	
0x00	Sensor Type	33124	HEAT_INDEX	Heat Index °C
		33125	HUMIDEX	Humidex °C
0x02	Precision	0	Provides reading of xxx	
0x04	Reset Min/Max	??	See below	
0x08	Min Measured	??	Minimum reading since last reset	
0x0c	Max Measured	??	Maximum reading since last reset	
0x10	Min Range	0	Minimum reading	
0x14	Max Range	70	Maximum reading	

7.7.4.1.1 *Precision*

The calculated Apparent Heat value is rounded to provide +/- 1 degree resolution.

7.7.4.1.2 *Sensor Trigger*

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	Calibration Reset	Calibration Status	Calibration Mode	Capture High	Capture Low	Calibration Start

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 Apparent Heat sensor and all Calibration bits should be written as 0.

7.8 Digital Input/Output (DIO) Interface

The SP-003/SP-004 supports a Digital Input/Output Interface that provides 2 digital inputs which are hardwired to the Digital outputs. The DIO inputs may be used to detect the state of external switches (output off) or to monitor the state of the outputs.

7.8.1 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

7.8.1.1 *DIO Sensor Type*

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

Sensor Type	SI Derived Units	Measurement
0x18	DIN	Bit mapped digital inputs

7.8.1.2 *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			

7.8.1.2.1 *Data Type*

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

7.8.1.2.2 *Factory Calibrate*

The Factory Calibrate bit is not used for DIO types.

7.8.1.2.3 *Writeable*

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

7.8.1.2.4 *Smart Sensor*

The bit is cleared.

7.8.1.3 *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			

7.8.1.3.1 *Lock*

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

7.8.1.3.2 *Apply Scaling*

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

Result = (Raw Reading * Gain) + Offset

7.8.1.3.3 *Assigned*

The Assigned bit will always read as 0.

7.8.1.3.4 *Available*

The Available bit will always read as 0.

7.8.1.4 *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

7.8.1.4.1 *Invert*

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

7.8.1.4.2 *Enable*

If the Enable bit is set the input is enabled.

7.8.2 DIO IPSO Definition

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

Offset	Name	Value	Description
0x00	Sensor Type	3349	Bit Mapped Digital
0x02	Precision	0	Provides reading of xxx
0x04	Reset Min/Max	??	Write 0x0001 force reset of min / max
0x08	Min Measured	??	Minimum reading since last reset
0x0c	Max Measured	??	Maximum reading since last reset
0x10	Min Range	0	Minimum reading
0x14	Max Range	3	Maximum reading

7.8.2.1 *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	Calibration Reset	Calibration Status	Calibration Mode	Capture High	Capture Low	Calibration Start

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 bits should be written as 0.

7.9 Digital Output Interface

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.

7.9.1 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.

7.9.2 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%. (see Sensor Scaling).

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%)

7.9.3 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	0xf720	0x0e40	char[16]	Defaults to **Output_0**
1	Output 1 Name	0xf728	0x0e50	char[16]	Defaults to **Output_1**
2	Output 2 Name	0xf730	0x0e60	char[16]	Defaults to **Output_2**
3	Output 3 Name	0xf738	0x0e70	char[16]	Defaults to **Output_3**

The Output names are retained until a factory reset occurs. It is strongly recommended that:

3) Spaces within the name should be replaced with the '_' character.
4) 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.

7.10 Digital Output Configuration

Two output signals are available which may be configured for ON/OFF, PWM or SERVO outputs through the Output Configuration registers (0x0124 and 0x0126). The remaining outputs are assigned as phantom devices which are non-configurable. The highlighted entries show typical default configurations.

Digital 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

7.10.1 Rate

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

7.10.1.1 *PWM Rate*

The SP-003/SP-004 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 sec 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

7.10.1.2 *SERVO Rate*

Smart Sensor probes support the following SERVO frequencies:

PWM 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

7.10.2 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.

7.10.3 Active State

Smart Sensor digital 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).

7.10.4 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.

7.10.5 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.

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M5748/0223