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User's Guide

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SP-005

Omega Link Thermocouple and RTD Smart Probe

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Table of Contents

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-005 Thermocouple and RTD Smart Probe provides an easy way to integrate your thermocouple and RTD probes to the Omega Link Ecosystem. The SP-005 accepts standard M12 thermocouples and RTDs through its M12 4-pin connector and Omega Link Smart Interfaces through its M12 8-pin connector. The optional M12-S-M-FM connector can be utilized to easily connect wire leads typically found on thermocouples or RTD probes to your SP-005. The SP-005 supports up to 2 thermocouple inputs or a single 2, 3, or 4-wire RTD input.

The Omega Link SP-005 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-005 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-005
- SP-005 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 Enterprise Gateway license tier (Pro, Business, or Business Pro)
- A compatible Omega Link Gateway
- RTD or Thermocouple Probe

Figure 1: SP-005 Omega Link Smart Probe

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

IF-006 Wireless Smart Interface

SP-005

PR22 Series RTD probe

M12.8-S-M-FM and M12.8-T-SPLIT
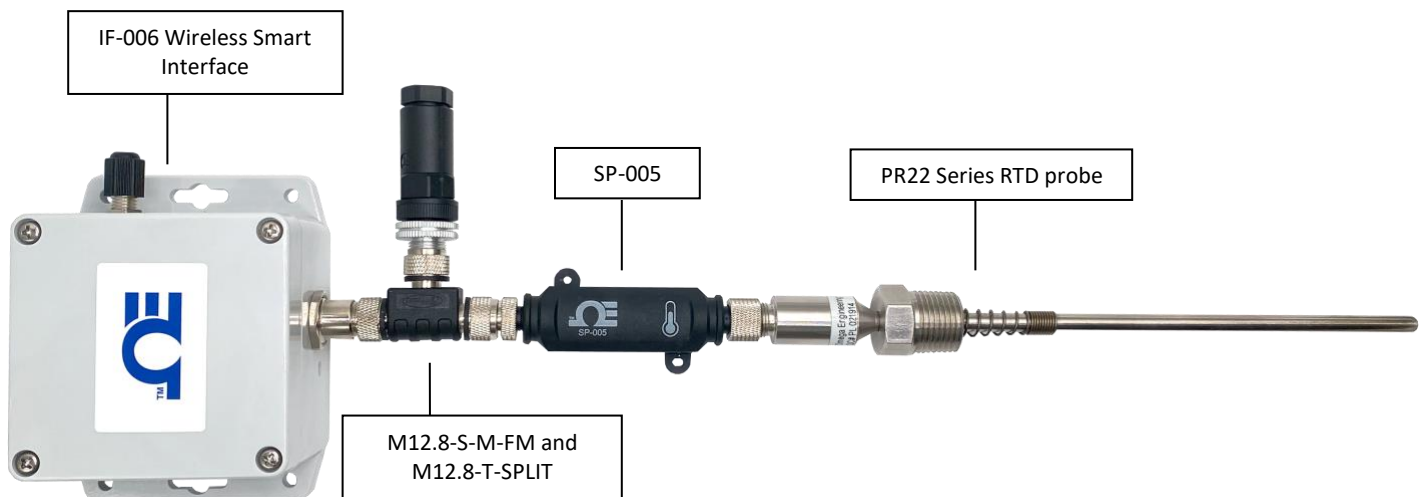
Figure 2: SP-005 Wireless Setup with DIO example

3   Hardware Setup
3.1   Connecting to your Omega Link Smart Interface

The SP-005 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-005 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.
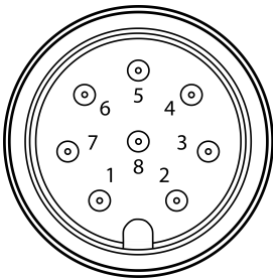
Figure 3: M12 8-pin male connector front view

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

3.2   Thermocouple and RTD Wiring Diagram

Most M12 thermocouple and RTD probes can be connected directly to the SP-005. If you are connecting wire directly to the SP-005, view the wiring diagrams provided below:
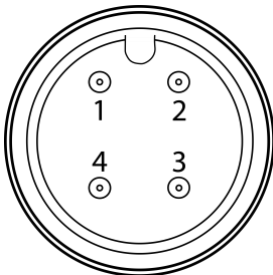
Figure 4: M12 4-pin male connector front view

Pin	Thermocouple
Pin 1	TC 2 Negative
Pin 2	TC 1 Positive
Pin 3	TC 1 Negative
Pin 4	TC 2 Positive
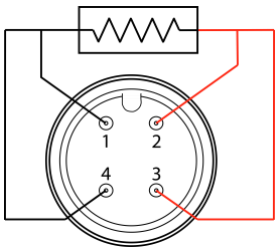
Figure 5: RTD 4-pin Wiring Option 1
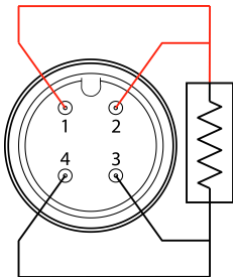
Figure 6: RTD 4-pin Wiring Option 2
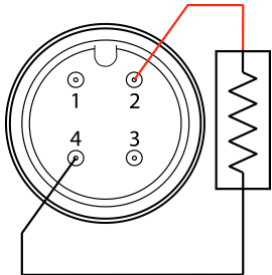
Figure 8: RTD 3-pin Wiring
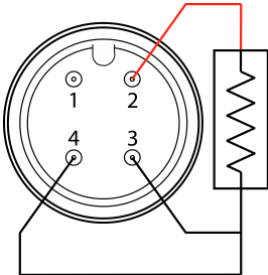
Figure 7: RTD 2-pin Wiring

3.2.1 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:
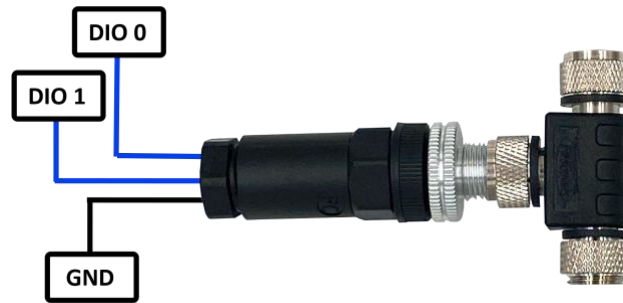
Figure 9: M12.8-T-SPLIT and M12.8-S-M-FM accessories for Discrete I/O access

4   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-005 to the computer using your Omega Link Smart Interface to begin.

Note 📝   **Note:** SYNC is available to download for free on the OMEGA website.

4.1   Connecting to SYNC - Automatic Detect

Once the SP-005 and Omega Link Smart Interface are connected to the computer, SYNC will automatically detect the probe and begin displaying readings.

Note 📝   **Note:** If living readings from the SP-005 are displayed on SYNC, skip ahead to section Error! Reference source not found. Error! Reference source not found.**.**

4.2   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**.

4.2.1   Communication Interface

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

Note 📝   **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.
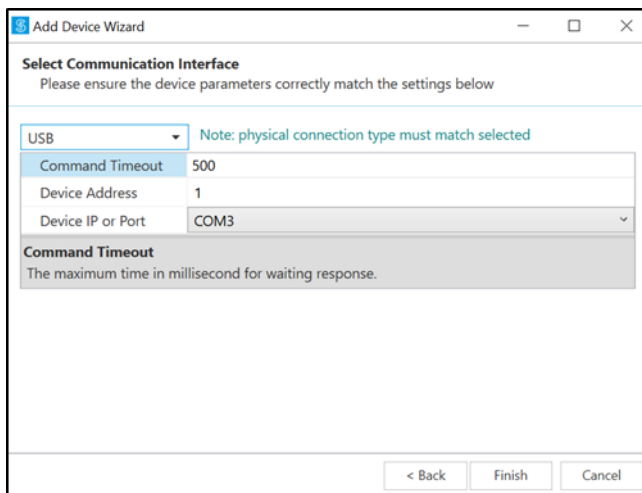
Figure 11: USB Serial Communication Interface
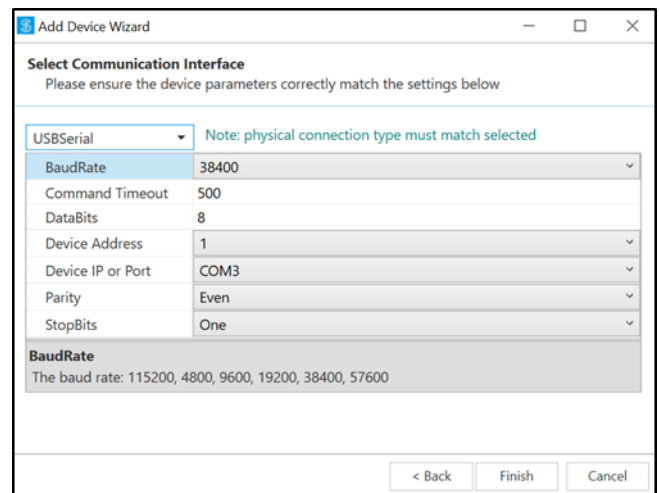
Figure 10: USB Communication Interface

- **Connection Type:** Select the type of connection you have between your SP-005 and your computer.
- **Command Timeout:** The maximum time (in milliseconds) for a command to be completed before the command is aborted.

Note 📝   **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 ☞ **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**.

4.3   Input Configuration

The SP-005 provides interfaces to type J, K, T, E, N, R, S, B and C thermocouples with the capability of enabling or disabling the open detect feature. It also supports 100-, 500-, and 1000-ohm Platinum RTD sensors in 2, 3, and 4-wire configurations.

4.3.1   Thermocouple Configuration

To configure the thermocouple(s) connected to the SP-005, follow the steps below:
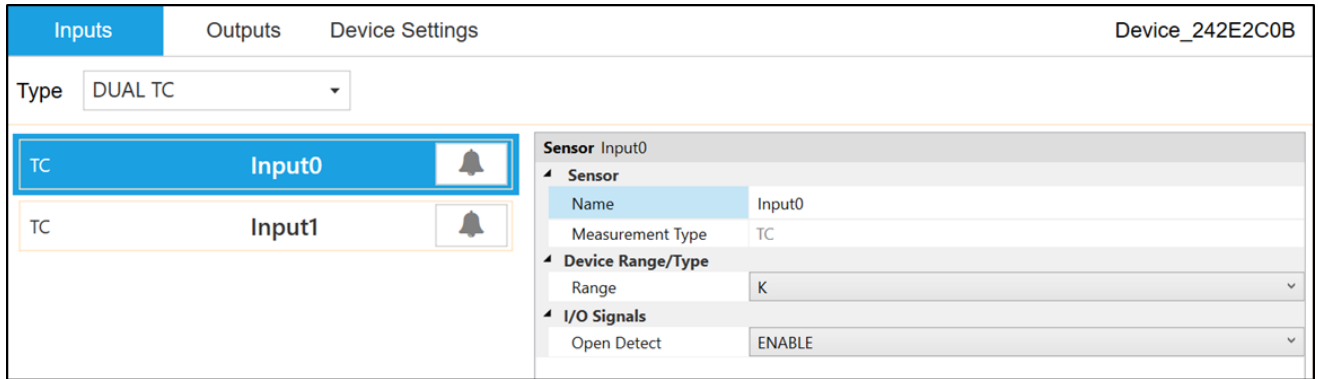
Figure 12: SYNC UI – Thermocouple Configuration

Step 1: Click the **Inputs** configuration tab on SYNC and choose your input type from the **Type** dropdown.

Step 2: Click the input channel you wish to configure and select your thermocouple type from the **Device Range/Type** dropdown.

Step 3: Click the **Open Detect** dropdown and choose to enable or disable it.

4.3.1.1 *Cold Junction Calibration*

The SP-005 has automatic Cold Junction Compensation and is factory calibrated so that in most cases it needs no adjustment. If increased accuracy is desired, Cold Junction Calibration can be performed as described below:
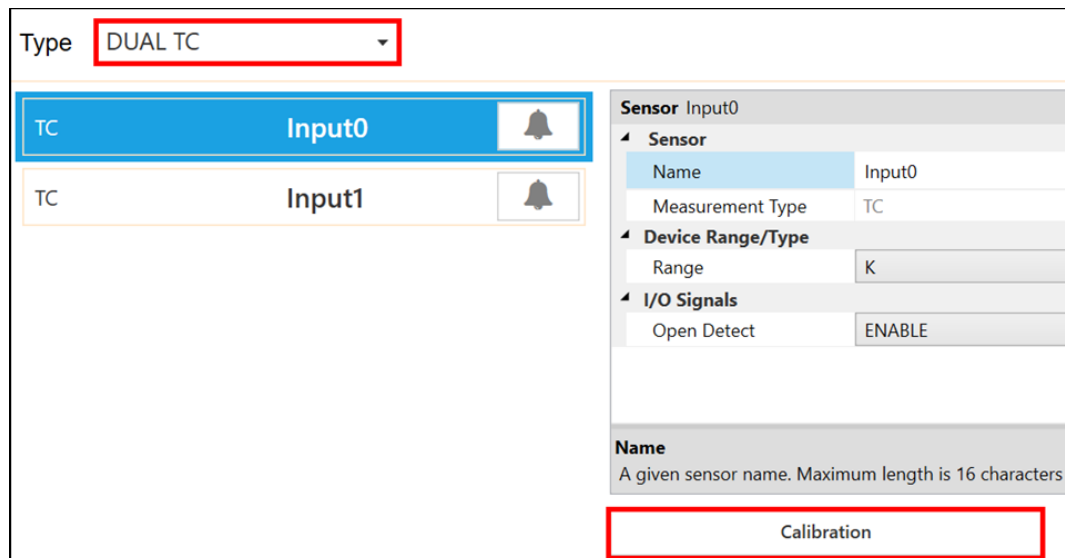
Figure 13: SYNC UI – Cold Junction Calibration

Step 1: Ensure your thermocouple has been configured in the previous section and click **Calibration** beneath the input interface.
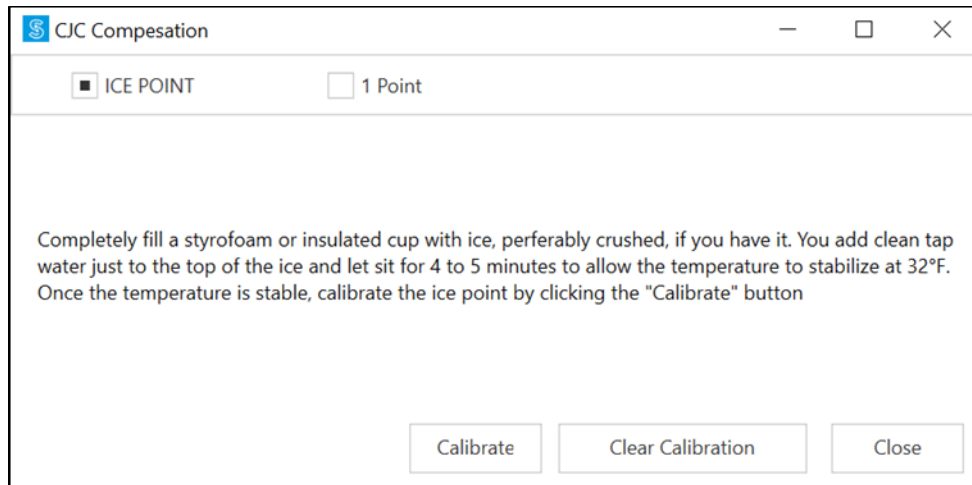
Figure 14: Cold Junction Calibration menu

Step 2: Insert the probe into 0°C (32°F) reference as outlined in SYNC and allow it to stabilize. Once the thermocouple is stable in a 0°C environment, click **Calibrate**.

For thermocouples that do not read to 0°C, One-Point Calibration can be used instead of Ice-Point Calibration.

4.3.2 RTD Interface

To configure the thermocouple(s) connected to the SP-005, follow the steps below:

Note ☞   **Note:** A single RTD connection is supported.
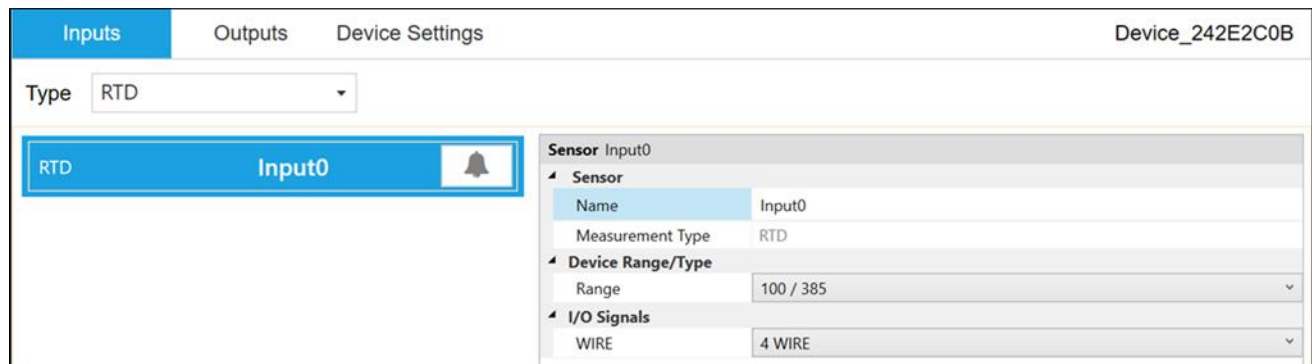
Figure 15: SYNC UI -RTD Configuration
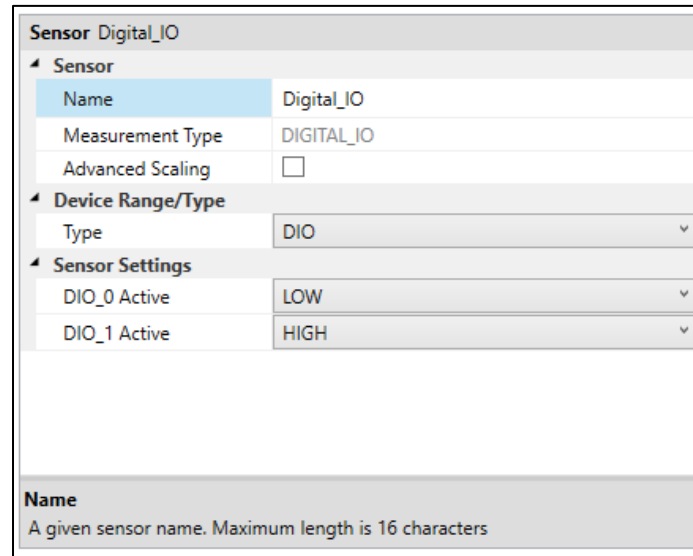
Step 1: Click the **Inputs Configuration Tab** on SYNC and choose your input type from the **Type** dropdown.

Step 2: Click the input you wish to configure and select your RTD type from the **Device Range/Type** dropdown.

Step 3: Click the **Wire** dropdown and choose your wiring configuration.

4.3.3 Discrete Input/Output (DIO)

The Omega Link SP-005 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 16: 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}.
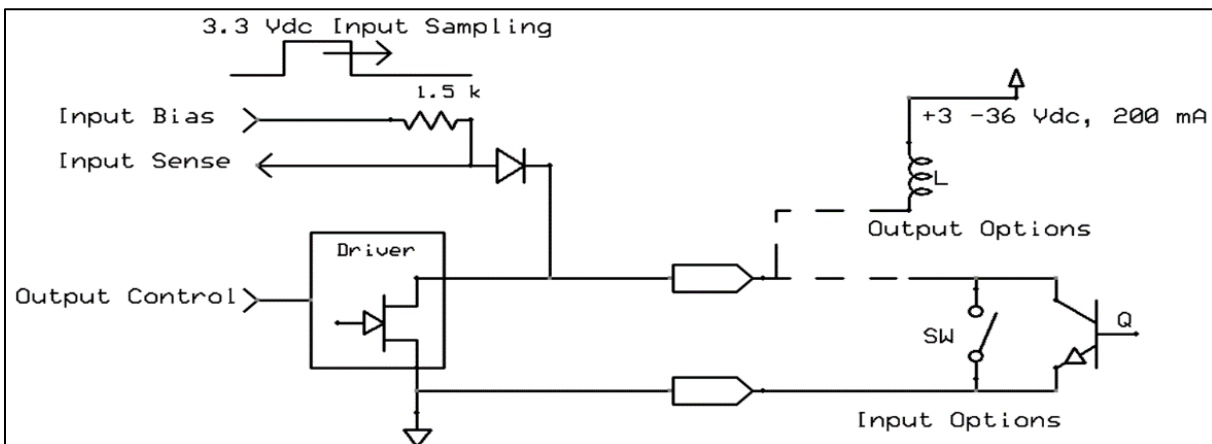
Figure 17: Digital/Discrete I/O circuitry

4.3.3.1 *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.
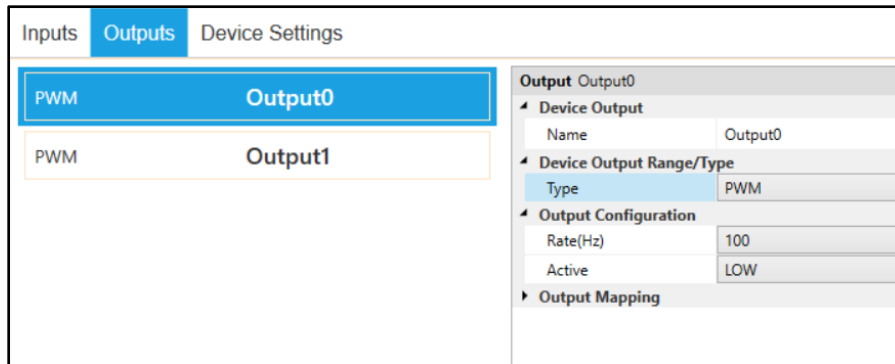
Figure 18: SYNC interface outputs tab

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.
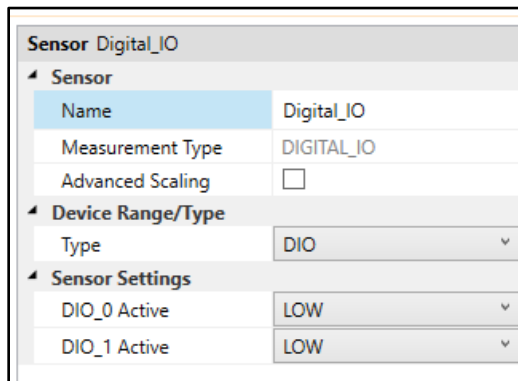
Figure 19: SYNC interface Digital_IO

4.3.4   Advanced Scaling Options

The Omega Link SP-005 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.

4.4 Output Configuration

The SP-005 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 **4.3.3 Discrete Input/Output (DIO)** for more information.

There are three types of output options – On/Off, Pulse-Width Modulation (PWM), or Servo.
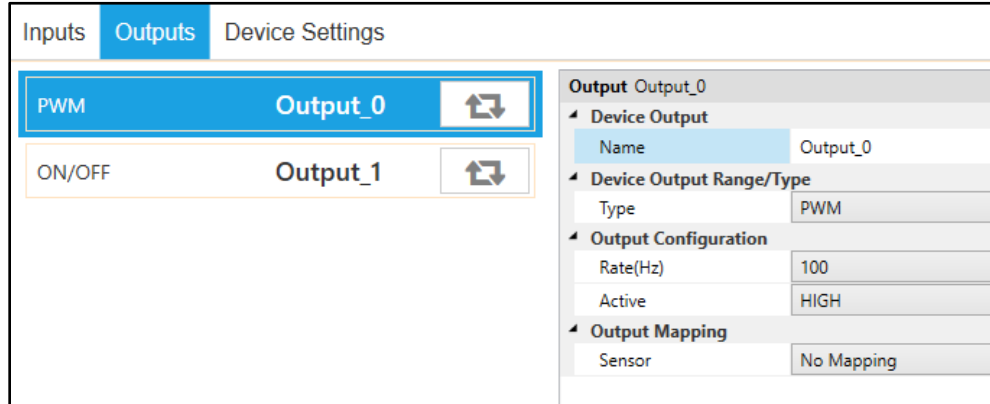
Figure 20: SYNC interface Output Configuration

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.

4.4.1 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.
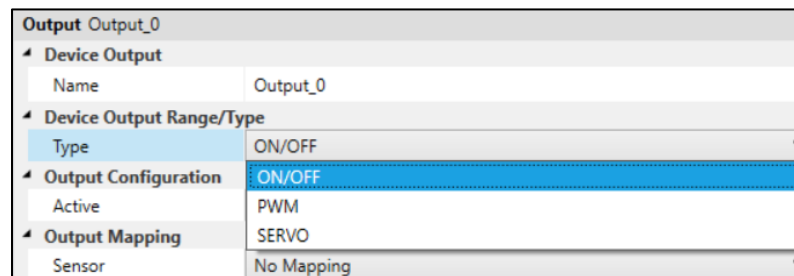
Figure 21: SYNC interface output type selection

4.4.1.1 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.

4.4.1.2 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
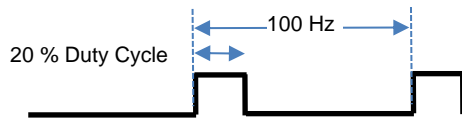
Example shows a PWM output signal configured with a 100 Hz frequency and active HIGH outputs. The duty cycle has been set to 20%.

Figure 22: PWM function diagram

4.4.1.3 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.
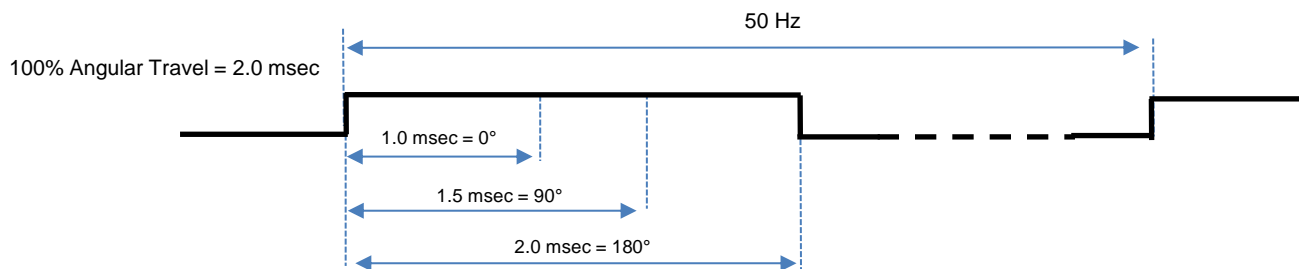
Figure 23: SERVO output example

4.4.1 Sensor Output Mapping

The SP-005 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.

Inputs	Outputs	Device Settings		Device_1E282FD1

PWM	Output0
PWM	Output1

Output Output0

▲ **Device Output**

Name	Output0

▲ **Device Output Range/Type**

Type	PWM ⌄

▲ **Output Configuration**

Rate(Hz)	100 ⌄
Active	HIGH ⌄

▲ **Output Mapping**

Sensor	Pulse_Rate ⌄
Scaling Minimum	25
Scaling Maximum	150

Figure 24: 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.

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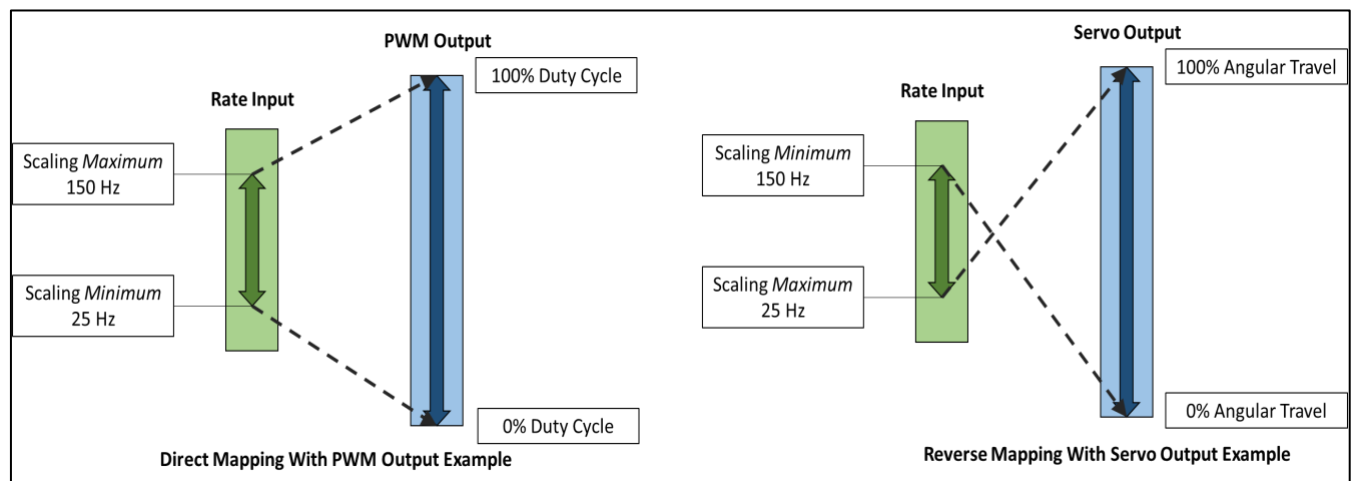
Figure 25: Sensor output mapping diagram

4.4.2   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] icon located to the right of the available outputs. Clicking the icon will open the **Define ON/OFF Control** dialog box as seen below.
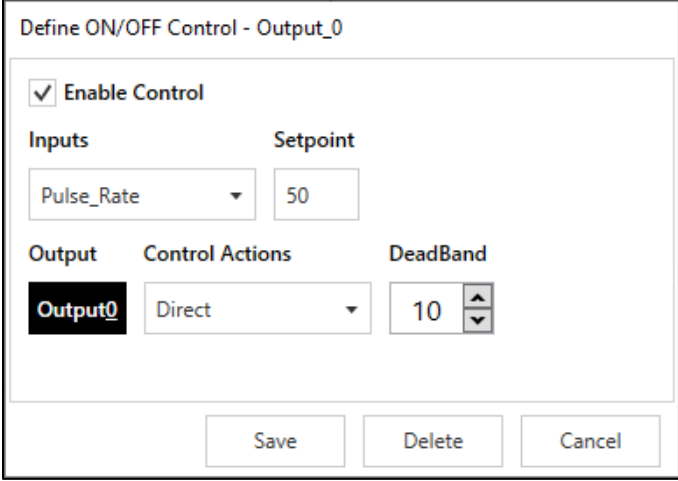
Figure 26: SYNC interface ON/OFF control module functions

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.

4.4.3   Setting an Alarm

Alarms are set by clicking the [🔔] icon in SYNC on the desired input signal found in the **Input Tab**.
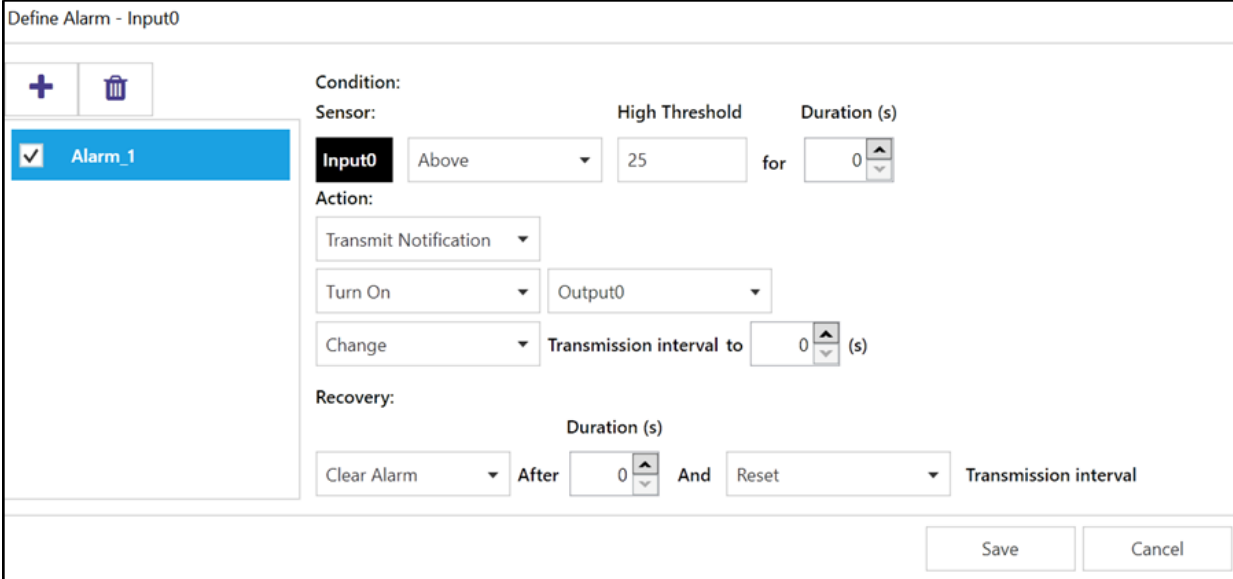
Figure 27: SYNC alarm configuration interface

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. increate 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 [🗑️].

5   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 U*I).

5.1   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.

5.2   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.
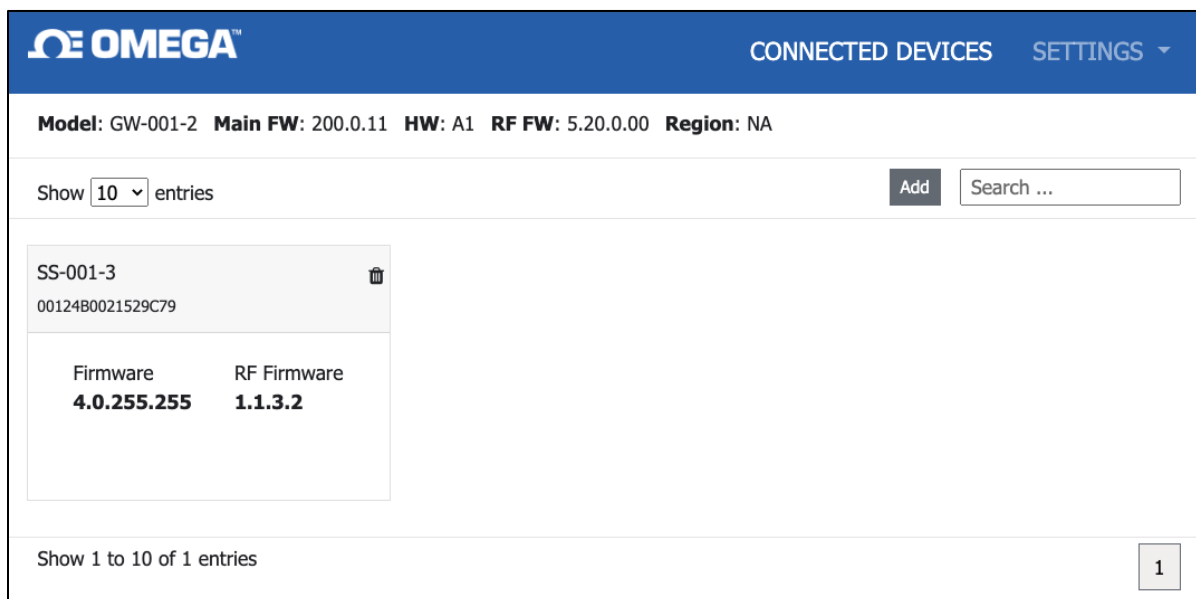

Figure 28: Gateway Internal User Interface

To add a device to your gateway from the internal gateway web UI, begin by clicking the [Add] button at the top right of the web page. Fill out the Add Device menu with the parameters of the Smart Probe connection.

6 Appendix: SP-005 Registers

The following Appendix provides the registers and list index for the Omega Link SP-005 Thermocouple and RTD Smart Probe. This information is intended to aid users who will be making configurations and adjustments to their Omega Link SP-005 Thermocouple and RTD 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.

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	Sensor Enumeration		
0	0x0060 (0xf030)	0x08a8 (0xf454)	Thermocouple 1	Thermocouple 1	RTD
1	0x0068 (0xf034)	0x09a8 (0xf4d4)	DIO (SP-005-1)	Thermocouple 2	DIO (SP-005-1)
2	0x0070 (0xf048)	0x0aa8 (0xf554)		DIO (SP-005-1)	
3					

6.1 Thermocouple Descriptor

The Thermocouple Input Interface provides interfaces to type J, K, T, E, N, R, S, B and C thermocouples. The Sensor Configuration and Sensor Device fields may be written to provide control of the overall function of the channel and the thermocouple types used.

Offset	Name	Value	Description
0x00	Measurement Type	0x20	Thermocouple Temperature
0x01	Data Type/Format	0x66	Float, writeable
0x02	Configuration	0x4?	Determines Thermocouple type
0x03	Sensor Device	0x??	Determines connection type
0x04..0x08	UOMR	"°C"	Units of measure

6.1.1 Thermocouple Measurement Type

The Thermocouple interface provides a measurement of temperature in °C.

Sensor Type	SI Derived Units	Measurement
0x20	°C	Thermocouple Temperature

6.1.2 Thermocouple Input Data Type/Format
The SP-005 supports extended configuration and provides factory calibration. All data values are returned as 32-bit floating point values.

Thermocouple Input Data Type							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Smart Sensor	Sensor Writeable	Factory Calibrate	Reserved	Data Type			
0	0	?	0	0x06 == FLOAT			

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

6.1.2.2 *Factory Calibrate*
The Factory Calibrate bit is used during factory calibration. If set, the factory calibration attributes are applied to the sensor reading before the sensor scaling. If clear, not factory calibration attributes are applied. If the sensor does not support factory calibration the Factory Calibrate bit is ignored and will always read as 0.

6.1.2.3 *Sensor Writeable*
If the Sensor Writeable bit is set the sensor value may be overwritten with a preset value. This capability is useful in sensors such as up/down counters, where a preset, or possibly a zero value must be written to the sensor value.

6.1.3 Thermocouple Configuration

Thermocouple Configuration							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Available	Assigned	Apply Scaling	Lock	Sensor Type (Range)			
0	*	?	?	See Below			

6.1.3.1 *Sensor Type / Range*

Sensor Type	Sensor Input Type (Range)	Measurement Type	
0x00	Type J	0x20	Temperature (°C)
0x01	Type K	0x20	Temperature (°C)
0x02	Type T	0x20	Temperature (°C)
0x03	Type E	0x20	Temperature (°C)
0x04	Type N	0x20	Temperature (°C)
0x05	Reserved	0x20	Temperature (°C)
0x06	Type R	0x20	Temperature (°C)
0x07	Type S	0x20	Temperature (°C)
0x08	Type B	0x20	Temperature (°C)
0x09	Type C	0x20	Temperature (°C)

6.1.3.2 *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:

$$Result = (Raw\ Reading * Gain) + Offset$$

6.1.3.3 *Lock*

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

6.1.4 Thermocouple Device Byte

The Sensor Device byte determines whether the Open Circuit detection is enabled.

I/O (TC)							
7	6	5	4	3	2	1	0
0	0	0	Open Circuit Detect	0	0	0	0
			0 — Disabled				
			1 — Enabled				

6.1.5 IPSO Thermocouple Temperature Sensor Definition

The Thermocouple sensor IPSO definition provides signal range, measured min/max values, and IPSO object type information. The Range information is Thermocouple Type dependent.

Offset	Name	Value	Description
0x00	Sensor Type	3303	Temperature (oC)
0x02	Precision	1	Provides reading of xxx.x
0x04	Sensor Trigger Function	??	See 4.1.5.1
0x08	Min Measured	??	Minimum reading since last reset
0x0c	Max Measured	??	Maximum reading since last reset
0x10	Min Range	??	
0x14	Max Range	??	

Type	Min Range	Max Range
J	-210	1200
K	-160	1272
T	-190	400
E	-220	1000
N	-100	1300
R	40	1788
S	100	1768
B	640	1820
X	0	2320

6.1.5.1 *Sensor Trigger Function*

The Sensor Trigger function is used to reset the IPSO min/max values as well as control the ICE Point / Single-Point 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	0	Capture Low	Calibration Start

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 may be used to capture real time value 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 Offset values.

6.2   RTD Descriptor

The RTD Input interface provides interfaces to type 100-, 500- and 1000-ohm 385 Curve, 100 ohm 392 Curve and 100 ohm 3916 Curve RTD devices in 2, 3 and 4 wire configurations. A single RTD connection is supported. The Sensor Configuration and Sensor Device fields may be written to provide control of the overall function of the channel and the RTD type used.

Offset	Name	Value	Description
0x00	Measurement Type	0x21	RTD (Temperature)
0x01	Data Type/Format	0x66	Float, writeable
0x02	Configuration	0x4?	Determines RTD type
0x03	Sensor Device	0x??	Determines connection type
0x04..0x08	UOMR	"°C"	Units of measure

6.2.1   RTD Measurement Types

The RTD interface provides a measurement of Temperature in °C.

Sensor Type	SI Derived Units	Measurement
0x21	°C	RTD Temperature

6.2.2   RTD Input Data Type/Format

The SP-005 supports extended configuration and provides factory calibration. All data values are returned as 32-bit floating point values.

RTD Input Data Type							
7	6	5	4	3	2	1	0
Smart Sensor	Sensor Writeable	Factory Calibrate	Reserved	Data Type			
0	0	?	0	0x06 == FLOAT			

6.2.2.1   *Data Type*

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

6.2.2.2 *Factory Calibrate*

The Factory Calibrate bit is used during factory calibration. It is a read only bit that applies to specific sensor types. If set, factory calibration is performed on the raw sensor reading PRIOR to user scaling.

6.2.2.3 *Configurable Enable*

The Configurable bit indicates that the Sensor Configuration and Sensor Device fields may be overwritten by user configuration information. If clear, only the Sensor Configuration LOCK bit may be set, allowing the user to overwrite the Unit of Measure string.

6.2.2.4 *Sensor Writeable*

If the Sensor Writeable bit is set the sensor value may be overwritten with a preset value. This capability is useful in sensors such as up/down counters, where a preset, or possibly a zero value must be written to the sensor value.

6.2.3   RTD Configuration

RTD Configuration							
7	6	5	4	3	2	1	0
Available	Assigned	Apply Scaling	Lock	Sensor Type (Range)			
0	*	?	?	See Below			

6.2.3.1 *Sensor Type / Range*

Sensor Type	Sensor Input Type (Range)	Measurement Type	
0x00	100 Ohm, 385 Curve	0x21	Temperature (°C)
0x01	500 Ohm, 385 Curve	0x21	Temperature (°C)
0x02	1000 Ohm, 385 Curve	0x21	Temperature (°C)
0x03	100 Ohm, 392 Curve	0x21	Temperature (°C)
0x04	100 Ohm, 3916 Curve	0x21	Temperature (°C)

6.2.3.2 *Apply Scaling*

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

$$Result = (Raw\ Reading * Gain) + Offset$$

6.2.3.3 *Lock*

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

6.2.4   RTD Input Sensor Device

The Sensor Device field determines the connector signal configuration.

I/O (RTD)								
7	6	5	4	3	2	1	0	Description
X	X	X	X	X	X	0	0	Not Available/Used
X	X	X	X	X	X	0	1	2 Wire, configuration
X	X	X	X	X	X	1	0	3 Wire, configuration
X	X	X	X	X	X	1	1	4 Wire, configuration

6.2.5   RTD Input Connector

A (bit 6)	Description	M12-4 Connector Pins			
		1	2	3	4
0x00	Wiring Option #1	S+	P+	P-	S-
0x01	Wiring Option #2	S+	S-	P-	P+

6.2.6 RTD IPSO Definition

The RTD sensor IPSO definition provides signal range, measured min/max values, IPSO object type information. The Min / Max range values depend on the type of RTD.

Offset	Name	Value	Description
0x00	Sensor Type	3303	Temperature (°C)
0x02	Precision	1	Provides reading of xxx.x
0x04	Sensor Trigger Function	??	See 4.2.6.1
0x08	Min Measured	??	Minimum reading since last reset
0x0c	Max Measured	??	Maximum reading since last reset
0x10	Min Range	??	<table><tr><th>Type</th><th>Min Range</th><th>Max Range</th></tr><tr><td>385 / 100 ohm</td><td>-200</td><td>850</td></tr><tr><td>385 / 500 ohm</td><td>-200</td><td>850</td></tr><tr><td>385 / 1000 ohm</td><td>-200</td><td>850</td></tr><tr><td>392 / 100 ohm</td><td>-200</td><td>660</td></tr><tr><td>3916 / 100 ohm</td><td>-200</td><td>660</td></tr></table>
0x14	Max Range		

6.2.6.1 Sensor Trigger Function

The Sensor Trigger function is used to reset the IPSO min/max values.

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

6.3 Digital Input / Output Interface

The DIO Interface provides 2 digital inputs which are hardwired to the Digital outputs. These may be used to detect the state of external switches (output off) or to monitor the state of the outputs. The DIO Input descriptor is at base addresses 0x0068.

6.3.1 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..0x08	UOMR	"DIN"	Units of measure

6.3.1.1 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

6.3.1.2 *DIO Data Type/Format*

DIO Data Type							
7	6	5	4	3	2	1	0
Smart Sensor	Sensor Writable	Factory Calibrate	reserved	Data Type			
0	0	0	0	6 == Floating point			

Note: Please refer to the Smart Sensor Interface Technical Guide for more information regarding this descriptor.

6.3.1.3 *Data Type*

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

6.3.1.4 *Factory Calibrate*

The Factory Calibrate bit is not used for DIO types.

6.3.1.5 *Sensor Writeable*

If the Sensor Writeable bit is set the sensor value may be overwritten with a preset value. This capability is useful in sensors such as up/down counters, where a preset, or possibly a zero value must be written to the sensor value.

6.3.2   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			

6.3.2.1 *Lock*

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

6.3.2.2 *Apply Scaling*

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

Result = (Raw Reading * Gain) + Offset

6.3.2.3 *Assigned*

The Assigned bit will always read as 0.

6.3.2.4 *Available*

The Available bit will always read as 0.

6.3.3 DIO Device Configuration

The DIO Device Configuration allows enabling each of the 2 input bits and selecting whether the input is active HIGH or active LOW. If the Invert Bit is set the signal will be Active Low.

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

6.3.4 DIO IPSO Definition

The DIO input IPSO definition provides signal range, measured min/max values, IPSO object type information. The SP-010 DIO IPSO definition is at base address 0x08a8.

Offset	Name	Value	Description
0x00	Sensor Type	3349	Bit Mapped Digital
0x02	Precision	0	Provides reading of xxx
0x04	Sensor Trigger Function	??	See section Sensor Trigger Function
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

6.3.4.1 *Sensor Trigger Function*

The Sensor Trigger function is used to reset the IPSO min/max values.

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

6.3.5 DIO Input Circuitry

The DIO input circuitry shares the output circuitry. The internal processor 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 3.0 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 provides protection of external positive voltages, allowing the Output driver to activate loads greater than the internal 3.3 V_{DC}.
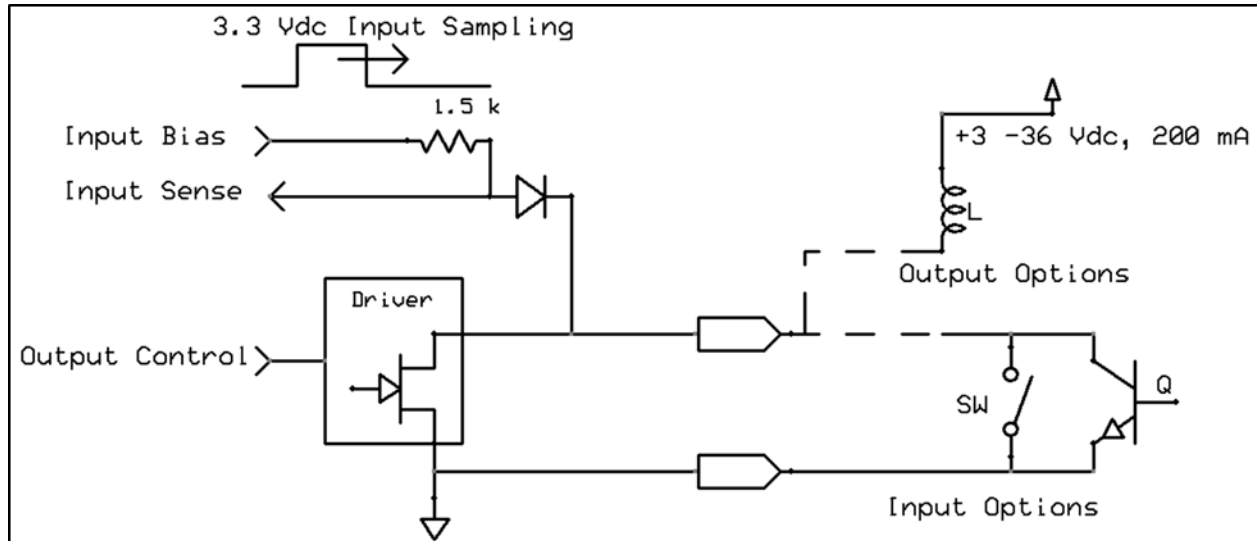
6.4 Outputs

Two output signals are available which may be configured for ON/OFF or PWM outputs through the Output Configuration registers 0x0124 and 0x0126 (Modbus 0xf092 and 0xf093).

Note: The Output Drive Type (Open Drain, inverting driver) is fixed.

Outputs							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Output Driver			Active State			PWM Rate	

<table>
<tr><td colspan="2">Output Driver</td><td></td><td colspan="2">Active State</td><td></td><td></td><td colspan="2">PWM Rate</td><td></td></tr>
<tr><td>0</td><td>Open Drain, Non inverting Driver</td><td></td><td>LOW</td><td>0</td><td></td><td></td><td>100 Hz</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>Open Drain, Inverting Driver</td><td></td><td>HIGH</td><td>1</td><td></td><td></td><td>10 Hz</td><td>0</td><td>1</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1 Hz</td><td>1</td><td>0</td></tr>
<tr><td>3</td><td>Open Drain, Inverting Driver</td><td></td><td></td><td></td><td></td><td></td><td>0.1 Hz</td><td>1</td><td>1</td></tr>
</table>

15	**14**	**13**	**12**	**11**	**10**	**9**	**8**

<table>
<tr><td></td><td></td><td></td><td></td><td colspan="4">Output Type</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2">Null</td><td>0 0</td><td>0 0</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2">**ON/OFF**</td><td>0 0</td><td>0 1</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2">PWM</td><td>0 0</td><td>1 0</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2">Reserved</td><td>x 1</td><td>x x</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2"></td><td>1 x</td><td>x x</td></tr>
</table>

6.4.1 PWM Rate

The SP-005 probe outputs support 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

6.4.2 Active State

The SP-005 probe 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 when active. The Factory reset value is 0.

6.4.3 Output Drive

The Output Drive is permanently set to 3, indicating that the output is configured as an Open Drain driver, allowing the DIN signal to override and read back the state of the output signal.

6.4.4 Output Type

The SP-005 probe supports NULL (0), ON/OFF (1) or PWM (2) outputs. When set to NULL the output signal will be left in a high impedance state. When set to ON/OFF the Rate information has no effect.

7   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}

ENVIRONMENTAL

    Operating Temperature: -40 to 850°C (-40 to 185°F)

    Rating: IP67 when mated

MECHANICAL

    Dimensions: 22.1 mm W x 96.7 mm L (0.87" x 3.80") not including mounting tabs

GENERAL

    Agency Approvals: CE, UKCA

    Compatibility: Compatible with OEG, SYNC configuration software, Omega Link Cloud, and Modbus Networks

THERMOCOUPLE ACCURACY TABLE

Type	Range	Accuracy
J	-210°C to 1200°C	0.4°C
K	160°C to 1372°C	0.4°C
T	-190°C to 400°C	0.4°C
E	-200°C to 1000°C	0.4°C
N	-100°C to 1300°C	0.4°C
R	40°C to 1788°C	0.5°C
S	100°C to 1768°C	0.5°C
B	640°C to 1820°C	0.5°C
C	0°C to 2320°C	0.4°C

Temperature Stability @25°C: 0.04 C/C

RTD ACCURACY TABLE

Type	Range	Accuracy
385, 4 Wire	-200°C to 850°C	0.3°C
385, 3 Wire	-200°C to 850°C	0.3°C
385, 2 Wire	-200°C to 850°C	0.6°C
392, 4 Wire	-200°C to 660°C	0.3°C
392, 3 Wire	-200°C to 660°C	0.3°C
392, 2 Wire	-200°C to 660°C	0.6°C

Temperature Stability @ 25°C: 0.01 C/C

ACCURACY FOR mV INPUT

Range	Accuracy @ 25°C
±60 mV	±0.02% or ±4 uV

Stability over Temperature: ±1 uV/C

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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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.

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☑ Data Logging Systems
☑ Wireless Sensors, Transmitters, & Receivers
☑ Signal Conditioners
☑ Data Acquisition Software

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☑ Cartridge & Strip Heaters
☑ Immersion & Band Heaters
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☑ Laboratory Heaters

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☑ Refractometers
☑ Pumps & Tubing
☑ Air, Soil & Water Monitors
☑ Industrial Water & Wastewater Treatment
☑ pH, Conductivity & Dissolved Oxygen Instruments