1 YEAR WARRANTY

OMEGA™

User's Guide

M12.5-S-M-FM screw terminal adapter sold separately

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SS-015 (-NA)

Long Range Wireless Process and Pulse Input Smart Sensor

omega.com info@omega.com

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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 the equipment.

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

Note: Provides information that is important to successfully set up and use the SS-015.

Caution or Warning: Informs about the risk of electrical shock.

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

2 Introduction

The Omega Link SS-015 Smart Sensor provides an easy way to integrate process and digital pulse inputs into an Omega Link ecosystem. SS-015 Smart Sensors provide a wireless sub-GHz interface that reads process and digital pulse inputs and transmits them to an Omega Link Gateway and the Cloud. External process and digital signal devices connect to the SS-015 through an M12 5-pin connector (recommended M12.5-S-M-FM screw terminal accessory sold separately) and easily pair to an Omega Link Gateway through a one-button pairing system. The device can be powered by internal batteries, USB power, or an optional power supply (sold separately).

The SS-015 may be configured to monitor the on/off state of the input signals, the pulse rate/duty cycle of the primary input, or the pulse delay between the two signals. The pulse totalizing function supports both standard counting and up/down counting.

A mixed-mode configuration option allows for the measurement of one process input and one digital pulse input which supports frequency (rate), pulse width, pulse duty cycle, and pulse counting (totalizer).

Important: Do not power off ther Omega Link Gateway or the Omega Link SS-015 before the gateway registration is Complete for Omega Link Cloud connections.

Included with the SS-015

- SS-015 unit
- Quick Start Guide
- 2x C-Cell Batteries

Optional Materials

- M12.5-S-M-FM Screw Terminal Accessory
- UNIV-AC-100/240-5-M8 Universal AC Adapter with M8 Connector

Additional Materials Needed

- Micro USB 2.0 cable
- Omega Link Gateway (wireless model only)
- A computer with Windows OS
- SYNC Configuration software
  -Downloadable for free on the Omega website
- Philips screwdriver

For Omega Link Cloud Integration

- A registered user account with cloud.omega.com

For Local-Area Network Omega Enterprise Gateway Integration

- An OEG non-trial, paid, license tier

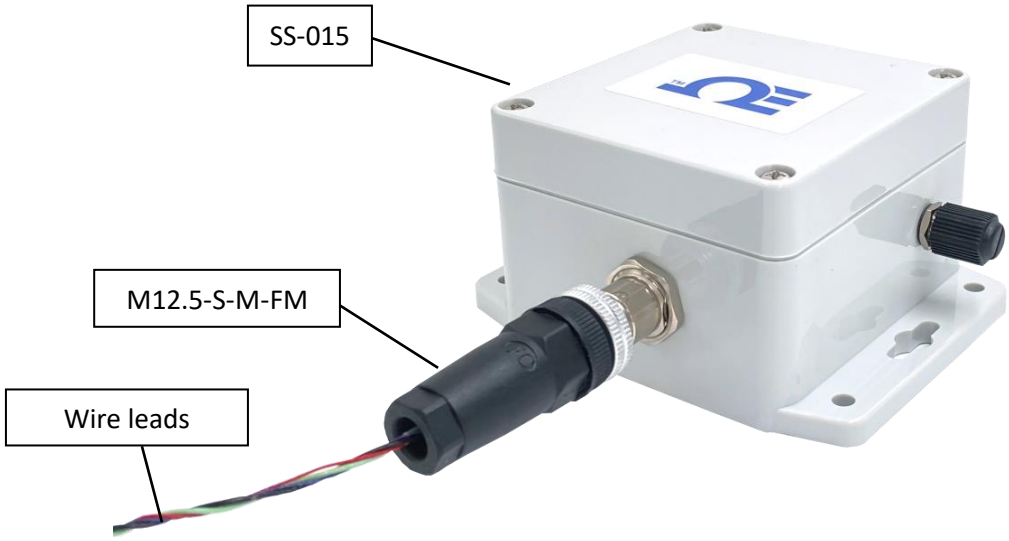


Figure 1: SS-015 setup

3 Specifications

Digital Pulse Input Signals

ON: 1.0 V_{DC}

OFF: 0.7 V_{DC}

Internal Pull Up/Down: 1.5k to 3.0 V_{DC}

Comparator (Clock) Input: 100 mV, 500 mV, 1.0 V_{DC}, 2.0 V_{DC}

Type	Range	Operating Conditions	Accuracy
Frequency (Rate)	0.01 Hz to 100 Hz	$T_{PW\ MIN}$ = 200 uS	± 0.5%
Frequency (Rate)	100 Hz to 1000 Hz	$T_{PW\ MIN}$ = 200 uS	± 1 Hz Averaged over 1s
Counter	0 to +8388608	1 kHz Max Rate	± 1 Count Max
Up/Down Counter	-8388608 to +8388608	1 kHz Max Rate	± 1 Count Max
Pulse Width (T_{PW})	200 uS min		± 50 uS ± 1%
Pulse Width (T_{PW})	200 uS min		± 50 uS ± 1%
Duty Cycle	1% to 99%	0.01 Hz to 1000 Hz, $T_{PW\ MIN}$ = 200 uS	±1.5% Max

Analog (Process) Input Signals

Type	Range	Resolution	Min	Max	Accuracy	Input Impedance
Current Loop	0-24 mA	± 0.1 mA	0 mA	24 mA	± 0.2 mA	50 ohm
Voltage	0 – 1.0 V_{DC}	± 10 mV	0 V_{DC}	1.20 V_{DC}	± 10 mV	100k ohm
Voltage	0 – 2.0 V_{DC}	± 10 mV	0 V_{DC}	2.50 V_{DC}	± 20 mV	100k ohm

Wireless Communications

Frequency: 915 MHz

Range*: Up to 1.2 km in low power mode. Up to 3.2 km in high power mode - Power Range is user selectable via SYNC configuration software.

*Clear line of sight. The actual range may vary depending on the environment.

Power

Alkaline Battery: 2x C-Cell batteries (included)

Lifetime: Up to 1.5 years with frequency of 1 reading per hour

External Power*: 5V DC @ 1.75 W

*External power adapter optional. External power specification based on Omega-specific power adapter.

Environmental

Operating Conditions for Base Unit: -20°C to 70°C (4°F to 158°F), 90% RH non-condensing

Rating: IP65

General

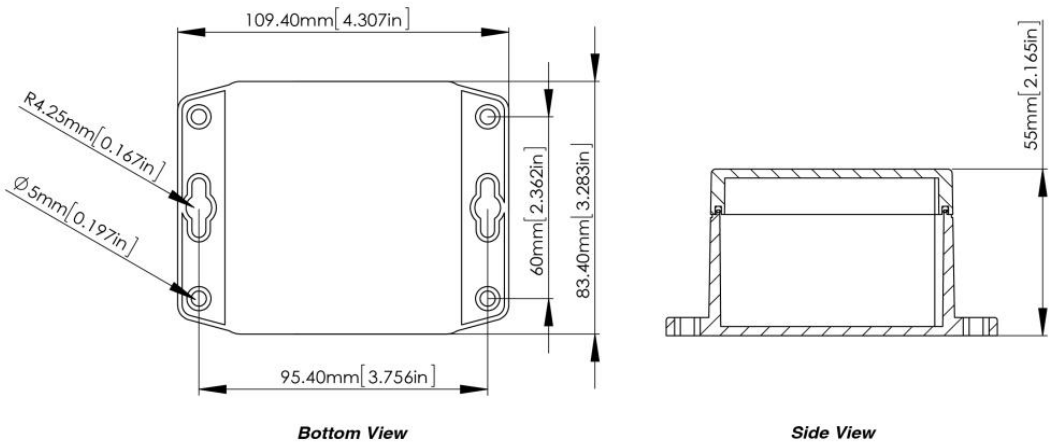
Software: Compatible with SYNC configuration software and Omega Link Cloud

Certification

Contains FCC ID: WR3-MOD16370915

Contains IC ID: 8205A-MOD16370915

IF-006 Dimensions



4 Hardware Setup

4.1 Digital and Process Input Wiring

The Omega Link SS-015 accepts digital and process inputs through its M12 5-pin connector. Users connecting wires directly to the SS-015 may refer to the wiring diagram provided below:

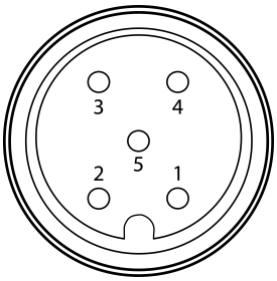


Figure 2: M12 5-pin female connector front view

Pin	Process Mode	Digital Pulse Mode	Mixed Mode
Pin 1	Excitation Power (3.3 V_{DC}, 100 mA)	Excitation Power (3.3 V_{DC}, 100 mA)	Excitation Power (3.3 V_{DC}, 100 mA)
Pin 2	Process 0	DIN 0/Pulse A	DIN 0 / Pulse A
Pin 3	Ground Reference	Ground Reference	Ground Reference
Pin 4	Process 2	DIN 2/Enable/ Direction/Pulse B	Process 0
Pin 5	Process 1	DIN 1/Reset	DIN 1 / Reset

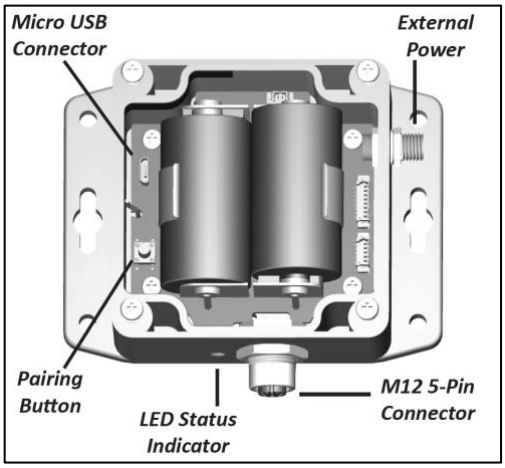


Figure 3: SS-015 top view

The table below denotes the LED status indicator and provides a description for each behavior:

LED Color	Status
Amber (solid)	SS-015 powered on; not connected to the Gateway
Green (blinking repeatedly)	SS-015 is in Pairing Mode
Amber (blinking repeatedly)	SS-015 is paired and is reconnecting to the paired Gateway
Green (flash periodically)	SS-015 is communicating to the Gateway
Red (solid)	Reset button has been held for Gateway radio factory reset
No light	SS-015 is in sleep mode or the batter is drained

5 Gateway Registration and Firmware Update

Important: If you are adding an SS-015 to a previously registered Omega Link Gateway, it is required to update the Gateway to the latest firmware to ensure the Gateway and SS-015 communicate and operate correctly. Follow the steps below to update the Gateway. During the update process, your Gateway will not be able to send or receive readings until the update process is complete.

Ensure you have setup and registered your Omega Link Gateway in the Omega Link Cloud or with OEG. After registering your gateway, navigate to the Gateway Internal User Interface to download the latest firmware (see the Omega Link Gateway User's Manual for more information). Once the update is complete, the gateway will re-boot. Once the pairing button is green, you may continue.

6 SYNC Configuration

Omega Link Smart devices are easily configurable through Omega's SYNC configuration software. Ensure SYNC is running on a Windows OS computer before continuing. Connect the SS-015 to a computer running SYNC using a micro-USB 2.0 cable.

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

6.1 Connecting to SYNC - Automatic Detect

Once the SS-015 is connected to a computer, SYNC will automatically detect the device and display readings.

Note: If live readings from the SS-015 are displayed on SYNC, skip ahead to the section titled **Input Configuration**.

6.2 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**.

6.2.1 Communication Interface

Set the communication parameters for the Omega Link Smart Interface that will be connected.

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

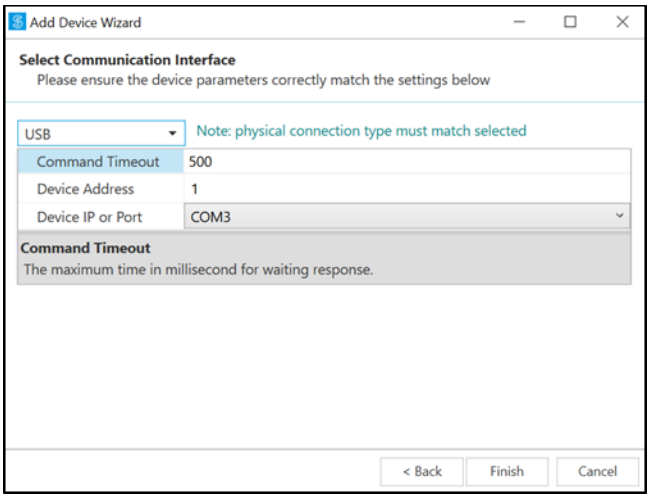


Figure 4: USB Communication Interface

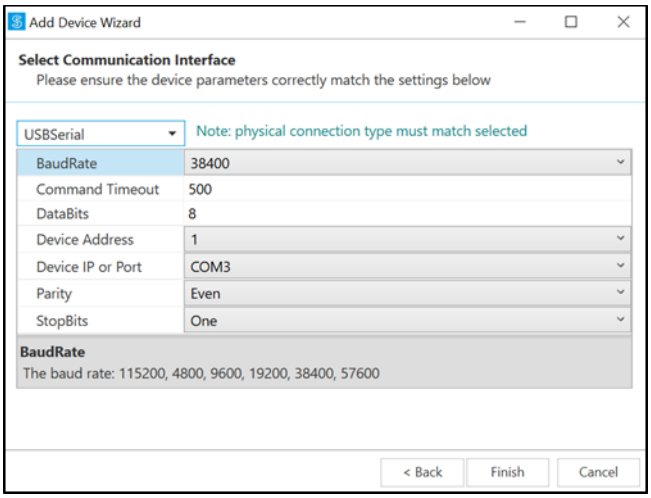


Figure 5: USB Serial Communication Interface

- **Connection Type:** Select the type of connection that is established between the SS-015 and the computer.
- **Command Timeout:** The maximum time (in milliseconds) for a command to be completed before the command is aborted.

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

- **Device Address:** The default device address is 1. The numerical value will automatically increase to the next available device address for every new device added to prevent duplicate addresses.
- **Device IP or Port:** The COM port number that the device is connected to on the computer.
- **BaudRate:** Controls bits per second
- **DataBits:** The number of bits in each character sent.
- **Parity:** A means of checking the correctness of a character by adding an extra bit to the character and setting the value based on all the other bits in the character.
- **StopBits:** The number of bits used to indicate the end of the character.

When the user has completed setting the communication parameters for the device, click **Finish**.

6.3 Input Configuration

The SS-015 can accept up to three 0-24 mA, 0-1.0 V_{DC}, or 0-2.0 V_{DC} process inputs, one digital pulse input, or a mix of one process and one digital input. These modes are detailed in the below sections.

6.3.1 Process Inputs Interface

To configure the process inputs, follow the steps below:

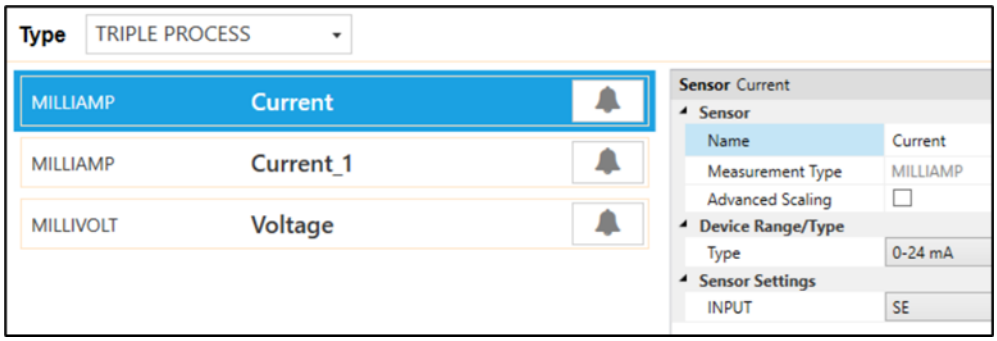


Figure 6: SYNC interface triple process

Step 1: Click the **Inputs** configuration tab on SYNC and choose from Single, Dual, or Triple Process in the **Type** dropdown.

Step 2: Click on each input channel and choose between the mA and mV options from the **Device Range/Type** drop-down. Click **Apply Settings** when done.

6.3.1.1 4-20 mA Device Connection

The Current Loop interface measures the current into the selected input by converting it to a voltage measurement across a fixed 49.9-ohm resistor.

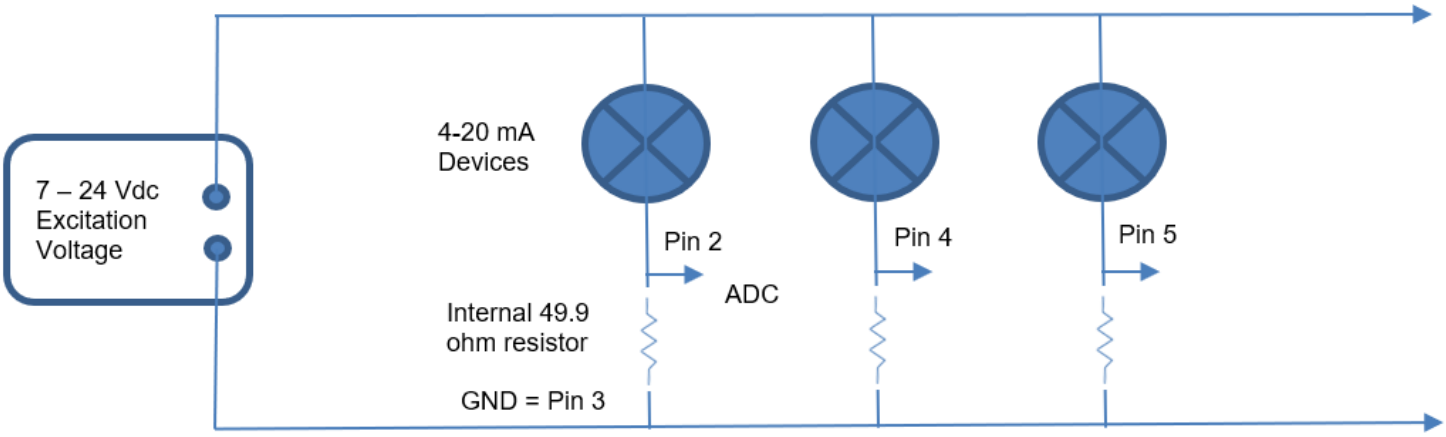


Figure 7: 4-20 mA device connection diagram

6.3.2 Digital Inputs Interface

In digital inputs mode, the SS-015 accepts digital pulse inputs and may be configured to monitor the on/off state of the input signals, the pulse rate or pulse duty cycle of the primary input, the up/down count of the primary input, or the pulse delay between two signals. To configure the Digital Inputs, follow the steps below:

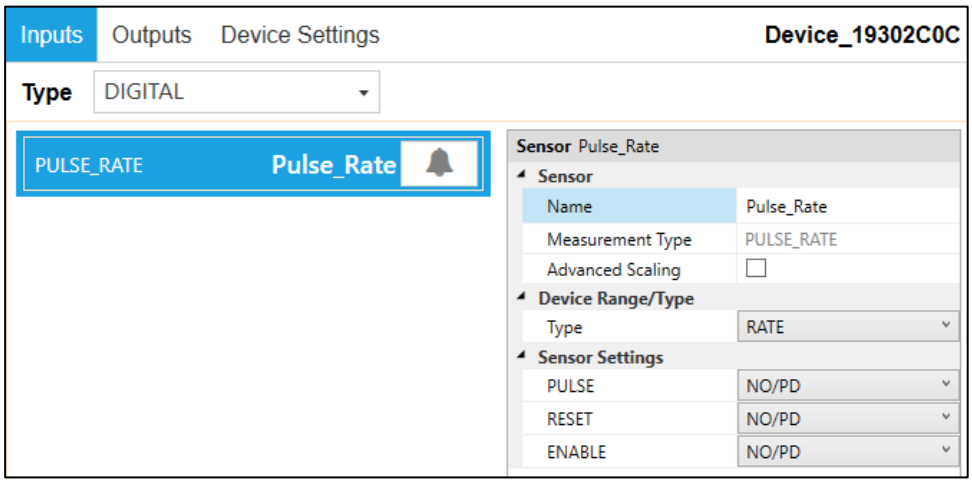


Figure 8: SYNC interface digital inputn

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

Step 2: Select the type of digital input in the Device Range/Type dropdown in SYNC. The following types are available:

Selection	Measurement	Description
DIN	Digital Input	3-bit Binary Digital Input
RATE	Frequency	Measure the frequency of rising edges
WIDTH	Pulse Width	Measure the active time of a signal
DUTY	Duty Cycle	Measure the % of active time of a signal
DELAY	Phase Delay Timer	Measure the time between the rising edges of Pulse A and Pulse B
COUNT	Up Counter / Totalizer	Counter with Enable and Reset
UP/DOWN COUNT	Up/Down Counter/Totalizer	Counter with Direction and Reset

Digital Input Binary								
DIN_0	Inactive	Active	Inactive	Active	Inactive	Active	Inactive	Active
DIN_1	Inactive	Inactive	Active	Active	Inactive	Inactive	Active	Active
DIN_2	Inactive	Inactive	Inactive	Inactive	Active	Active	Active	Active
Digital_Input Display (Binary)	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0

6.3.2.1 *Pulse Measurements*

Pulse measurements include Digital Input (DIN), Frequency (RATE), Pulse Width (WIDTH), Duty Cycle (DUTY), Phase Delay Between Pulse Inputs (DELAY), Up Counter/Totalizer (COUNT), and Up/Down Counter/Totalizer (UP/DOWN COUNT). All measurements are derived from signal transitions and an internal 32.768 kHz time reference. The pulse input signal is read on the Pulse A input (pin 2) and the reset input signal is read on the Reset input (pin 5). The third input on pin 4 changes its functionality depending on the pulse measurement type and can be Enable, Direction, or Pulse. When the reset input is *activated* then the pulse input value is zeroed for all pulse measurement types. When the third input pin is configured as an enable input and is *deactivated* then the pulse input value is zeroed. Unless otherwise stated, the third input pin defaults to Enable functionality which must be set HIGH to allow measurement.

The **Digital Input (DIN)** mode reports the binary value on the DIN pulse input pins. Note the DIN inputs replace the functionality of the Pulse, Reset, and Enable inputs.

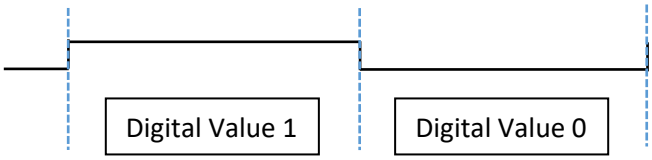


Figure 9: Digital Input example

Two measurement modes are used when measuring **Frequency (RATE)**. If the measured frequency is greater than 100 Hz the total number of pulses/second is used to determine the frequency. If the measured frequency is less than 100 Hz the time between rising edges is used to calculate the frequency.

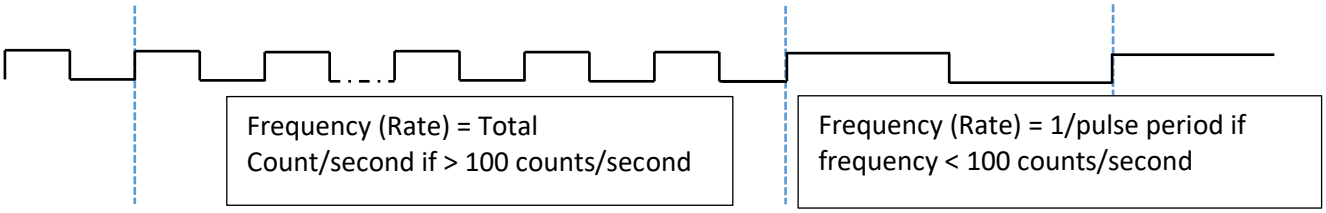


Figure 10: Frequency (rate) example

The **Pulse Width (WIDTH)** setting measures the active portion of a periodic signal in msec. The pulse input may be configured to be active high or active low to measure the positive or negative portion of the pulse width. See the Input Configuration Diagrams section for details.

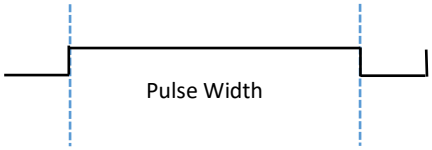


Figure 11: Positive pulse width example

The **Duty Cycle (DUTY)** setting measures the percentage of time a pulse is active (high) over the total period of the signal. The duty cycle measurement allows reading the input from PWM control signals.

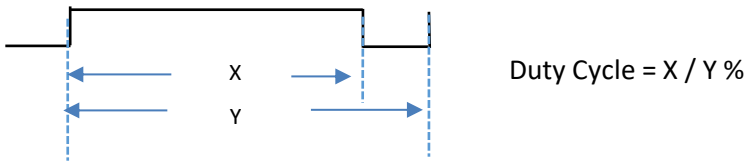


Figure 12: Duty cycle example

The **Phase Delay (DELAY)** mode measures the delay time in msec between the rising edges of Pulse A and Pulse B inputs. Note the Pulse B input replaces the functionality of the Enable input. This function is intended to be used on two input pulses operating at the same frequency but with different phase offsets.

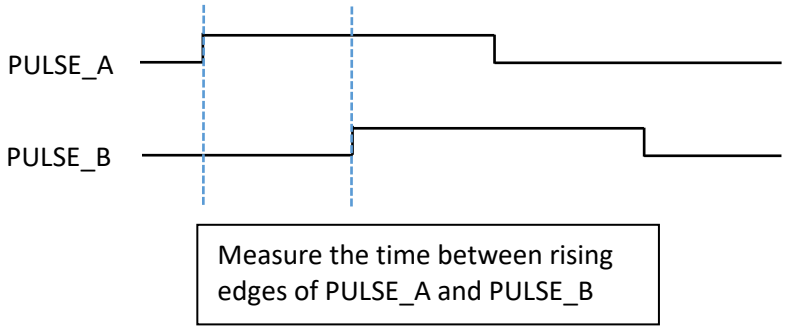


Figure 13: Phase Delay example

The **Up Counter/Totalizer (COUNT)** mode counts the number of rising edges while the Enable input is active until the Reset input is activated. The Enable Input (Pin 4) acts as a Stop/Start for the Up Counter when pulled up to 3.3 V. If the Enable Input is *Inactive*, it will pause/stop the up counter until it is re-enabled. If the Enable Input is *Active*, it will start the up-count. Activating the Reset input (Pin 5) will reset the counter back to 0. The Reset and Enable inputs can be configured to be active high or active low by configuring the Enable Input to Pull-Down (PD). See the ***Input Configuration Diagrams*** section for details.

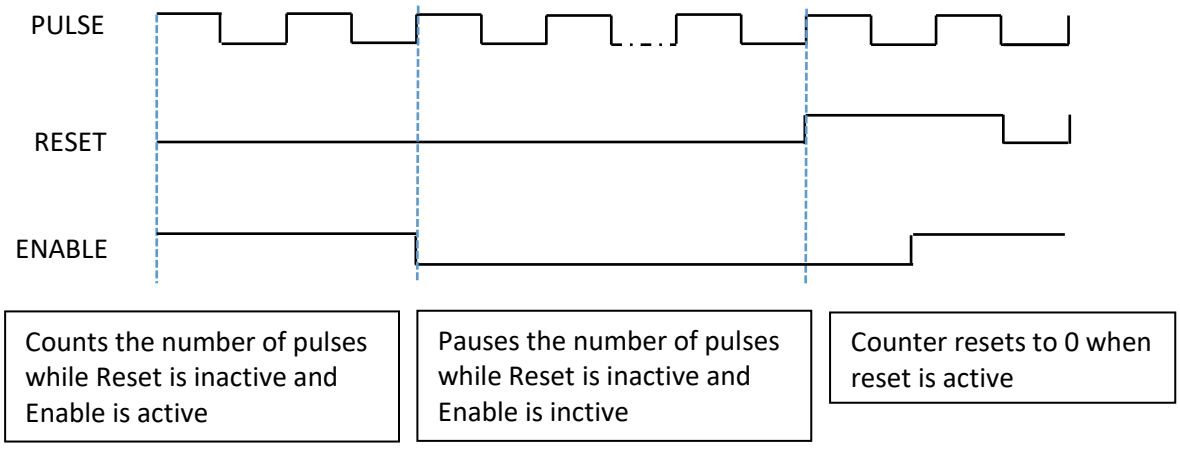


Figure 14: Up Counter/Totalizer example with Active High Reset and Enable

The **Up/Down Counter/Totalizer (UP/DOWN COUNT)** mode counts the number of rising edges until the Reset input is activated. Additionally, the direction of the counter may be controlled using the Direction input (Pin 4) so that it counts up when *Active* and down when *Inactive*. Note the Direction input replaces the functionality of the Enable input. The Reset and Direction input can be configured to be *active high* or *active low*. See the ***Input Configuration Diagrams*** section for details.

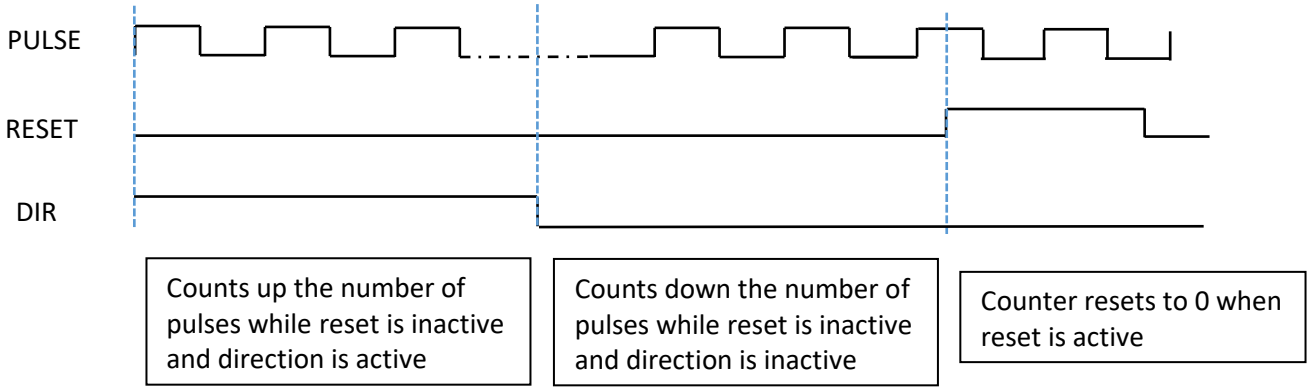


Figure 15: Up/Down Counter/Totalizer example with Active High Reset and Direction

6.3.2.1.1 *Input Configuration Diagrams*

The digital pulse input pins can be independently set to either have an internal 1.5k **Pull Up (PU)** or **Pull Down (PD)** and can be set to be either Active High or Active Low by selecting **Normally Open (NO)** or **Normally Closed (NC)** in the SYNC input configuration interface. Some typical circuits are shown below:

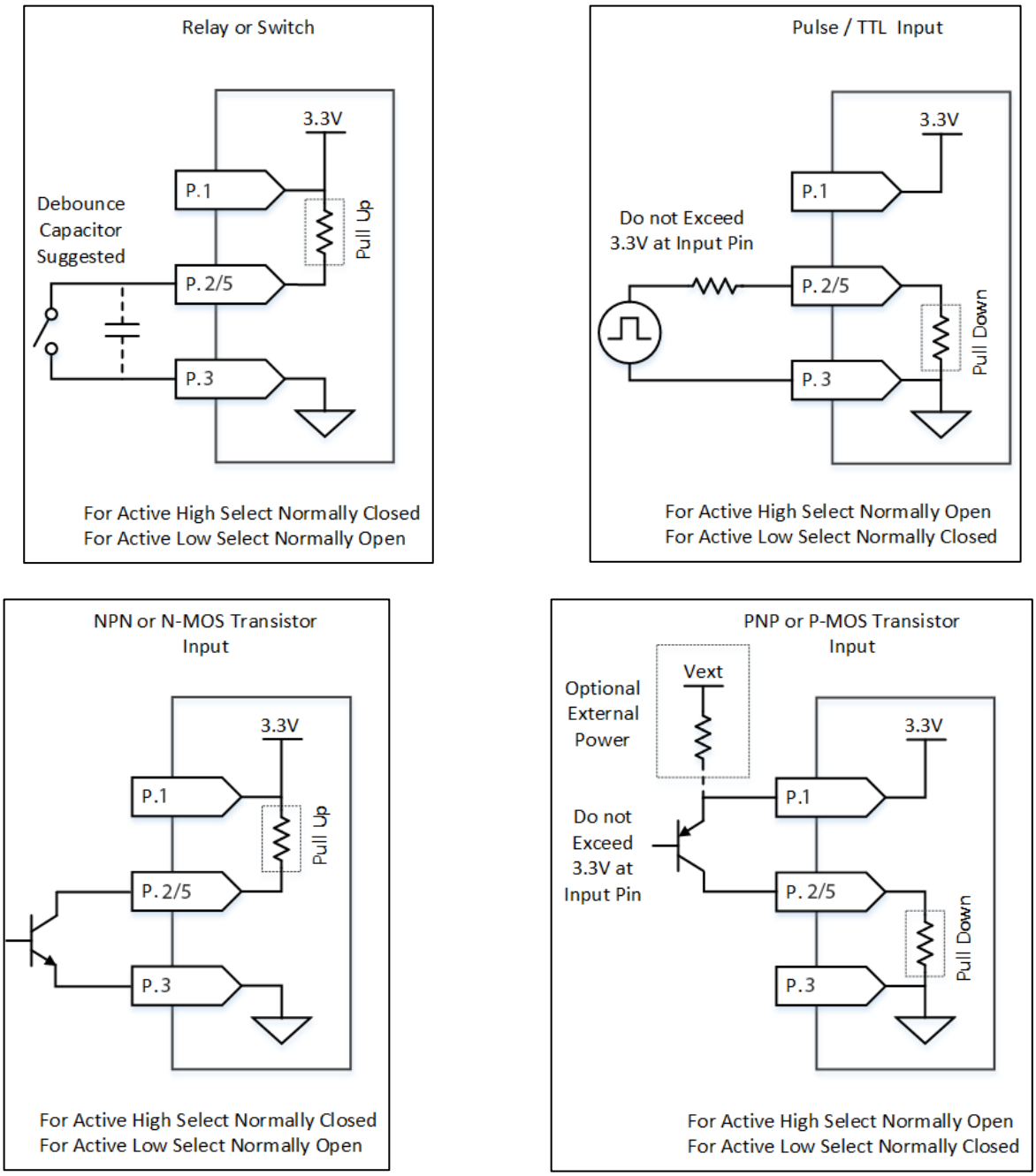


Figure 16: Active High/Low Circuit Examples

The DIN 0 / Pulse A input pin may also be configured for low-level mV input signals. The four selectable ranges determine the **turn-on threshold (TH)** and the **turn-off threshold (TL)** which are used to set the ACTIVE level of the digital input.

Setting	High Threshold (ON)	Low Threshold (OFF)
100 mV	75 mV	37.5 mV
500 mV	375 mV	187.5 mV
1.0 V	0.75 V_{DC}	0.375 V_{DC}
2.0 V	1.5 V_{DC}	0.75 V_{DC}

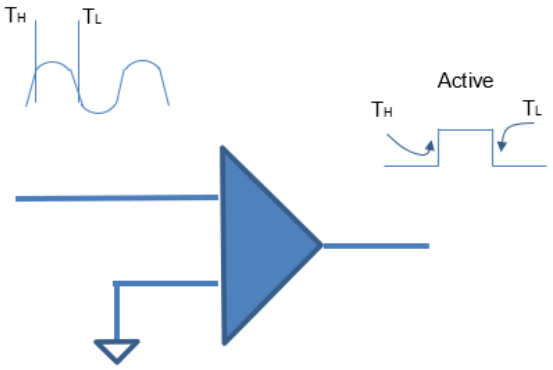


Figure 17: Active High/Low Threshold example

6.3.2.2 Mixed Input Interface

When set to the mixed input mode, the SS-015 can accept one process signal and one digital pulse input. To configure the digital pulse and process inputs, follow these steps:

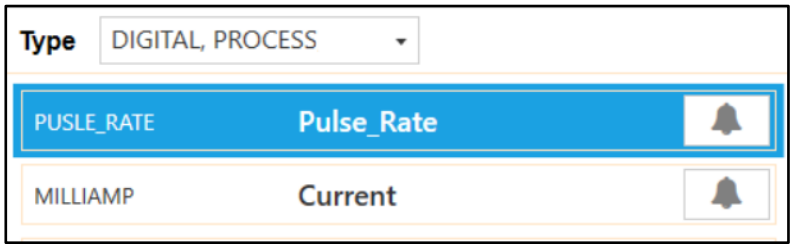


Figure 18: SYNC interface digital and process configuration

Step 1: Click the **Inputs** configuration tab on SYNC and choose the **Digital, Process** type from the **Type** drop-down.

Step 2: For each respective channel, select the type of digital or process input in the **Device Range/Type** drop-down. Click **Apply Settings** when done.

For additional information regarding pin wiring for the single digital and single process mixed mode, refer to the wiring diagrams on page 7.

6.3.2.3 *Digital Inputs (Mixed Mode)*

The following table lists the available digital input configuration options available when in mixed mode. Some options available in digital-only mode are not available in mixed mode. Descriptions and example diagrams are provided starting in section ***5.3.1.1 Pulse Measurements***.

Selection	Measurement	Description
DIN	Digital Input	2-bit binary digital input
RATE	Frequency	Measures the frequency of rising edges
WIDTH	Pulse Width	Measures the active time of a signal
DUTY	Duty Cycle	Measures the % of active time of a signal
COUNT	Up Counter / Totalizer	Counter with Enable and Reset

Important: Digital input signals (pulse inputs) ***must*** be referenced to ground when *Mixed Mode* is used. Negative offsets at pulse inputs may cause interference and noisy/incorrect readings in analog (mA/V) process input signals.

The table below shows the binary-weighted values for the 2-bit Digital Input (DIN) function in mixed mode.

Input 1	Input 0	Reading
Inactive	Inactive	0
Inactive	Active	1
Active	Inactive	2
Active	Active	3

6.3.2.4 *Process Inputs (Mixed Mode)*

The following process input configuration options are available in mixed input mode: 4-20 mA current loop, 0-1.0 V voltage input, 0-2.0 V voltage input. Current loop readings are rounded to the nearest 0.1 mA and voltage readings are rounded to the nearest 10 mV.

6.3.2.4.1 *4-20 mA Device Connection*

The Current Loop interface measures the current into the selected input by converting it to a voltage measurement across a fixed 49.9-ohm resistor.

6.3.3 Advanced Scaling

The Omega Link SS-015 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.

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

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.

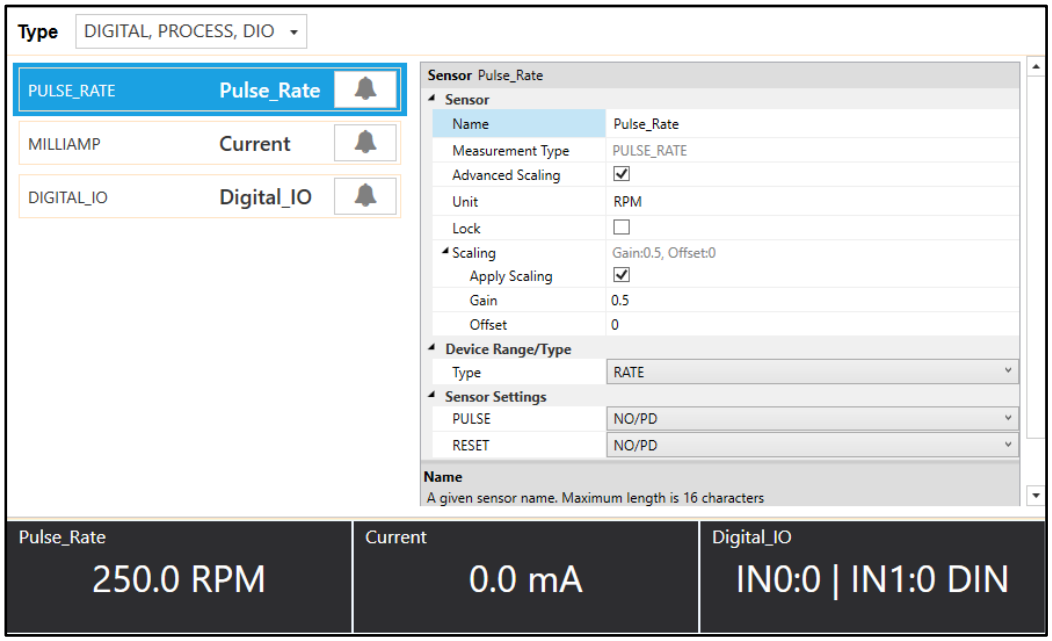


Figure 19: Advanced Scaling Example

The screenshot above shows an example application for advanced scaling with renamed units. A fan tachometer with a 500 Hz signal is connected to the Pulse Rate input. The fan outputs 2 pulses per revolution, so to convert to rotations per minute (RPM) the reading must be divided by 2 which is accomplished by setting the Gain to 0.5. The units can then be renamed to RPM and will display as such.

6.3.4 Setting an Alarm

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

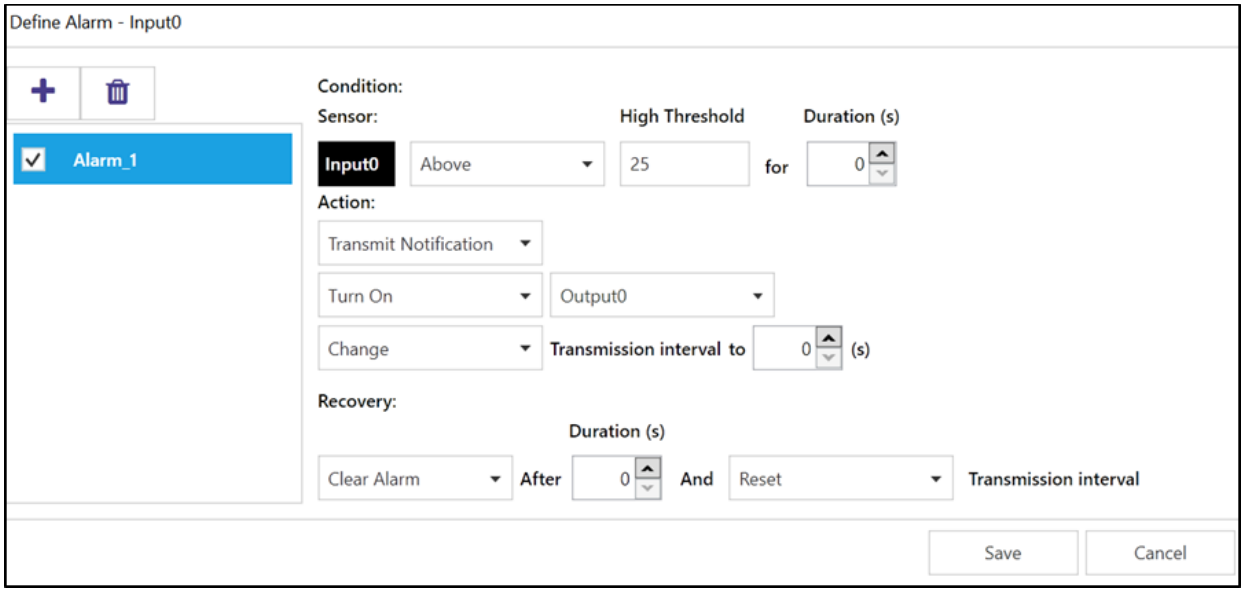


Figure 20: SYNC alarm configuration interface

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

Under the **Action** menu, the option to transmit or not transmit a notification can be set. The option to enable "Turn On" an output can also be set. The output chosen must not be currently used in a sensor mapping or ON/OFF control module. The data transmission interval may also be changed upon triggering an alarm, e.g. 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** (in Seconds) once the trigger condition is no longer met. The transmission interval can also be **Reset** to the normal system setting once the alarm is cleared.

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

6.4 Device Settings

The Device Settings Tab allows users to configure various features on the SS-015 such as saving and loading configuration presets, performing a factory reset of the device, firmware updates, changing between Low Power and High Power Mode, and more.

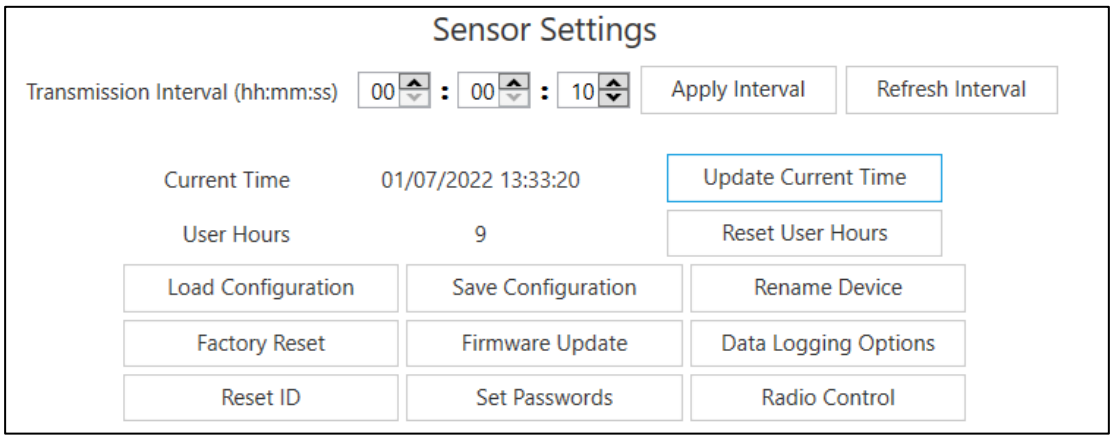


Figure 21: SYNC Device Settings tab

When a password is set in the Device Settings tab of SYNC configuration software, upon power cycling the device, SYNC will notify the user that the device is password locked. Right click the device to login.

6.4.1 Radio Control – Low Power and High Power Mode

The Radio Control button located under the Device Settings tab allows users to change between the default Low Power mode and the more power demanding High Power mode.

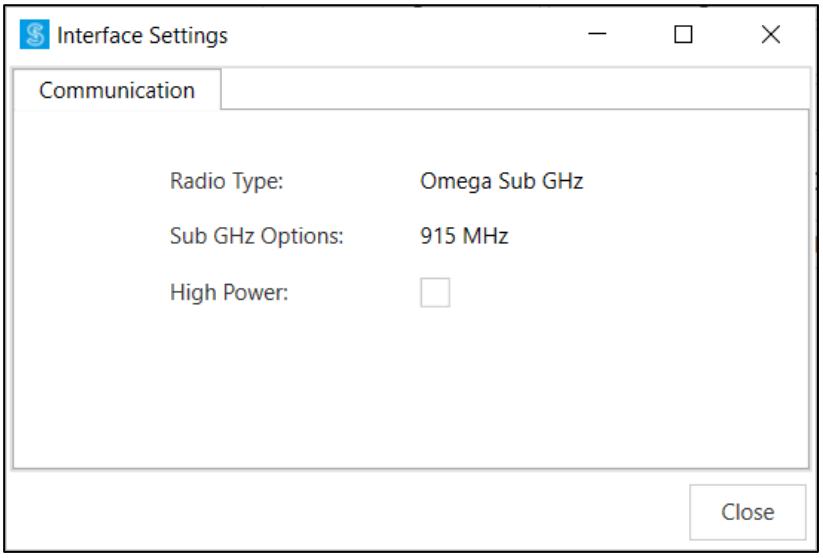


Figure 22: SYNC connected device communication interface settings

7 Connecting to your Omega Link Gateway

The SS-015 easily connects to an Omega Link Gateway with a one-button pairing feature. Follow the instructions below:

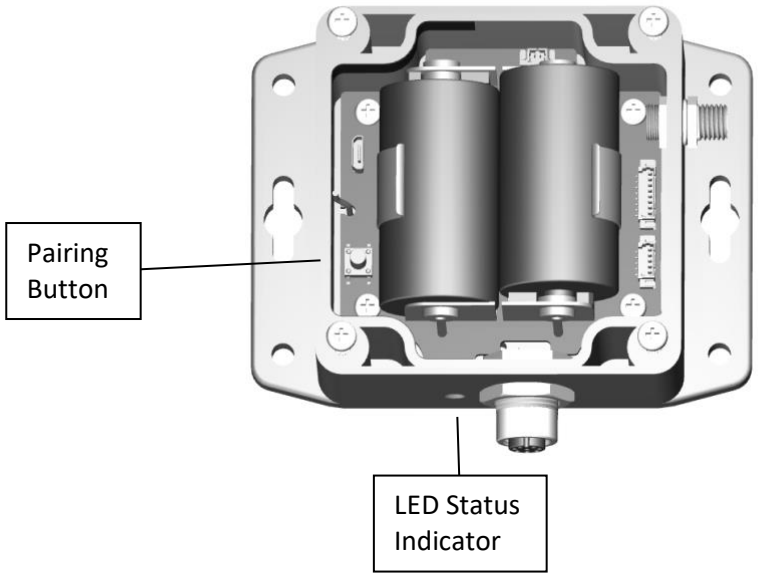


Figure 23: SS-015 without top cover

Step 1: Push the pairing button once on your SS-015. The LED Status Indicator will blink green repeatedly indicating it is in Pairing Mode.

Step 2: Push the pairing button once on the Omega Link Gateway. The LED on the Gateway will blink green repeatedly while it searches for the SS-015.

When the SS-015 has been successfully paired to the Omega Link Gateway, the LED on both devices will stop blinking, and a green LED will blink periodically on the SS-015 each time data is transmitted to the Gateway. Once the pairing process is complete, replace the cover of the SS-015 and fasten the four screws securely.

Once the SS-015 has successfully paired to the Gateway, the SS-015 readings will appear on the Omega Link Cloud interface or on OEG. When all configurations are complete, the Omega Link SS-015 setup process is complete.

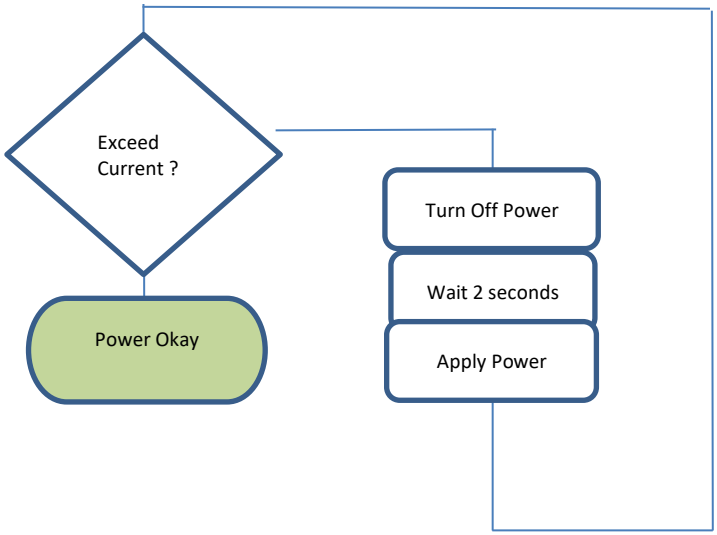
8 Appendix: SS-015 Registers

The following Appendix provides the registers and list index for the Omega Link SS-015 Smart Sensor. This information is intended to aid users who will be making configurations and adjustments to their Omega Link SS-015 Smart Sensor through the Command Line Interface or other custom interfaces.

The SS-015 radio or USB interface accesses the onboard Smart Sensor core device which provides interfaces to the external process and/or digital pulse signals. The Smart Sensor core manages these interfaces and presents a set of register mapped values. Refer to the Smart Sensor Interface specification for a complete description of the smart sensor register space.

8.1 Power Monitoring

The SS-015 monitors the current drawn on the M12.5 pin 1 and if an overcurrent condition is detected will shut down the external power, wait for 2 seconds, and then attempt to repower the external device.



8.2 Password Security

Smart Sensor devices provide a password mechanism to ensure that log data cannot be accessed without permission.

When a password is set in the Device Settings tab of SYNC configuration software, upon power cycling the device, SYNC will notify the user that the device is password locked. Right click the device to login.

8.3 Extension Data Interface

The SS-015 platform includes the following Extension data I2C register address 0x0c00 – 0x0cff, when accessed by the connected radio device, or Modbus address 0xf600 – 0xf67f when access through the USB connector. The description strings are null-terminated text strings describing the parameter values. The register set is an expansion from the registers found in Legacy SS-001/002 products, with the addition of a Control register that allows configuration information for the radio subsystem to be programmed.

I2C Addr.	Modbus Addr.	Parameter Name	Parameter Description
0x0c00	0xf600	Structure Size	12 == 12 bytes of data, including this field
0x0c02	0xf601	VBat	Uint16_t - Battery voltage (mV)
0x0c04	0xf602	Vdc	Reserved for external power supply voltage, reads as 0. (mV)
0x0c06	0xf603	Status	< see below>
0x0c08	0xf604	Unused	
0x0c0a	0xf605	Capacity	Battery capacity as %. 0% indicates battery level below 1.8 Vdc. 100% indicates battery level above 3.3 Vdc
0x0c0c	0xf606	Control	< see below >
Extension description strings			
0x0c40	0xf620		'VBat'
0x0c46	0xf623		'Vdc'
0x0c4a	0xf625		'Status'
0x0c52	0xf629		'Unused'
0x0c5a	0xf62b		'Capacity'
0x0c5c	0xf62c		'Control'

8.3.1 VBat

The VBat register contains the measured battery voltage in mV. For example, 2970 represents 2.970 volts. This value is periodically updated by the internal SS-015 firmware.

8.3.2 Vdc

The Vdc register contains the measured USB/External voltage in mV. For example, 4770 represents 4.770 volts. This value is periodically updated by the internal SS-015 firmware.

8.3.3 Status

The Status register provides an indication of the battery status and results of the most recent enumeration.

Status Register							
7	6	5	4	3	2	1	0
Battery Capacity (%)					**Reset Pending**	**Battery Low**	**Battery Powered**
100	>75	>50	>25	0	1 if Battery < 1.6 Vdc	1 if Battery < 1.9 Vdc	1 == Battery Power
15	14	13	12	11	10	9	8
Extended Valid	Enum	Power Fault	Password Active	User Password Pending	Password Error	Authentication Error	Enumeration Complete

8.3.3.1 Battery Powered

Set to 1 if the device is operating under battery power, or 0 if the device is operating under USB power.

8.3.3.2 Battery Low

Set to 1 if the device is operating under battery power and the battery voltage is < 1.9 V DC.

8.3.3.3 Reset Pending

Set to 1 if the device is operating under battery power and the battery voltage is < 1.6 Vdc. The attached radio processor should monitor this bit and, if set, perform whatever shut down processes are required before issuing a Force Reset control command.

8.3.3.4 *Battery Capacity*

The Battery Capacity bits provide an approximate indication of the remaining battery power.

8.3.3.5 *Enumeration Complete*

The Enumeration Complete bit is set when the device successfully enumerates.

8.3.3.6 *Authentication Error*

This bit is always cleared (0).

8.3.3.7 *Password Error*

If the Password Fault bit is set the user-provided password does not match.

8.3.3.8 *User Password Pending*

The User Password Pending bit indicates that the user must enter a valid Password through the USB interface channel.

8.3.3.9 *Password Active*

The Password Active bit indicates that the attached device requires a password to be entered.

8.3.3.10 *Power Fault*

A power fault was detected on the external probe.

8.3.3.11 *Enumerating*

The interface is in the process of enumerating the attached probe.

8.3.3.12 *Extended Valid*

The Extended Valid bit is set if the Password Error, Authentication Error, and Probe Attached status bits are valid. Legacy Smart Sensor devices (SS-001, SS-002) have the Extended Valid bit clear, indicating that the Password Fault, Authentication Fault, and Probe Attached bits are not valid (always set to zero).

8.3.4 Control

The Extension Control register determines the processes required for probe enumeration, the configuration of the radio subsystem and allows the radio subsystem to acknowledge a shutdown request.

Extension Control Register							
7	6	5	4	3	2	1	0
Radio Type					**Reserved**	**Force Enumeration**	**Shutdown**
15	14	13	12	11	10	9	8
Radio Options							
< see below >							

8.3.4.1 *Shutdown*

The MSP processor advises the radio subsystem when power is too low to continue operation through the Reset Pending status bit. After appropriate processing by the radio subsystem, it should set the Shutdown bit in the control register which will force the MSP processor to shut down the sensor interface.

Failure to generate the Shutdown command may lead to unstable operation as the measured battery voltage continues to degrade.

8.3.4.2 Force Enumeration

If set, the enumeration process will be re-applied to the device.

8.3.4.3 Radio Type

The radio type field provides support for alternate radio technology.

Radio Type			
None	0	0	0
Omega Sub Ghz	**0**	**0**	**1**
BLE	0	1	0
reserved	.	.	.

8.3.4.4 Sub GHz Radio Options

The Radio Option byte provides additional configuration control and is radio-specific.

Radio Option Byte								
	15	14	13	12	11	10	9	8
		Reserved				Band		
Omega Sub GHz (??)						0	0	0
Omega Sub GHz (915 Mhz)						**0**	**0**	**1**
Omega Sub GHz (863 Mhz)						0	1	0
Omega Sub GHz (?? Mhz)						-	-	-
reserved						X	X	X

8.3.4.5 Radio Options (Sub GHz)

Radio Options Sub GHz							
15	14	13	12	11	10	9	8
Power Management			Reserved				
HIGH POWER	Reserved	Reserved					

Note: The Radio Type and Radio Options fields (bits 5..12) are locked for Factory only configuration.

8.3.4.6 High Power

The Sub GHz Power level bit enables the Power Amplifier on the Sub GHz radio assembly.

8.4 Sensor Interface

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 / Config	Enumerated Sensor		
			Digital	Process	Mixed Mode
0	0x0060 (0xf030)	0x08a8 (0xf454)	DIN, RATE, WIDTH, DUTY_CYCLE, DELAY or COUNT)	Process 0	DIN, RATE, WIDTH, DUTY_CYCLE, DELAY or COUNT **)
1	0x0068 (0xf034)	0x09a8 (0xf4d4)		Process 1	Process 0
2	0x0150 (0xf038)	0x0aa8 (0xf554)		Process 2	
3	0x0158 (0xf03c)	0x0ba8 (0xf5d4)			

** The Pulse Delay and Up/Down counter are not available in the Mixed Mode configuration.

8.4.1 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

8.4.2 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.

8.5 Digital Interface

The Digital interface manages the three digital inputs: Pulse, Enable/Pulse B, and Reset. These are used to drive user-configurable Rate, Delay, Pulse Width, Duty Cycle, Pulse Delay, and counter functions.

8.5.1 Digital Descriptor

Offset	Name	Value	Description
0x00	Sensor Type	0x??	DIN, FREQUENCY, WIDTH, DUTY_CYCLE, DELAY, or COUNT – set by Sensor Type field in Configuration byte.
0x01	Data Type/Format	0x46	Float, Writeable
0x02	Configuration	0x??	Determines channel and Measurement Type
0x03	Sensor Device	0x??	Determines DIN signal types
0x04	UOMR	"??"	Units of measure

8.5.1.1 Digital Measurement Types

The Digital interface provides a measurement dependent on the input range/type selected. The units of measure may be changed by the user.

Sensor Type	Measurement	SI Derived Units	Measurement
0x18	DIN	DIN	DIN (Digital Inputs)
0x19	FREQUENCY (RATE)	Hz	RATE
0x1a	PUSLE WIDTH	msec	PULSE WIDTH
0x1b	DUTY CYCLE	%	DUTY CYCLE
0x1c	PULSE DELAY	msec	DELAY
0x1d	COUNTER	CNT	COUNTER
0x1e	UP / DOWN COUNTER	CNT	UP/DOWN COUNTER

8.5.1.2 Digital Data Type/Format

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

8.5.1.2.1 Data Type

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

8.5.1.2.2 Factory Calibrate

No Factory calibration is used on the SS-015.

8.5.1.2.3 Writeable

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

8.5.1.2.4 Smart Sensor

This bit is cleared.

8.5.1.3 Digital Configuration Register

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

8.5.1.3.1 Sensor Range / Type

Range / Type		Measurement Type	Units of Measure	Signals		
				DIO2	DIO1 **	DIO0
0x00	DIN	0x18	DIN	INPUT 2	INPUT 1	INPUT 0
0x01	RATE	0x19	Hz	RESET	ENABLE	PLS
0x02	PULSE WIDTH	0x1a	msec	RESET	ENABLE	PLS
0x03	DUTY CYCLE	0x1b	&	RESET	ENABLE	PLS
0x04	DELAY	0x1c	msec	RESET	PLS B	PLS A
0x05	COUNTER	0x1d	CNT	RESET	ENABLE	PLS
0x06	U/D COUNTER	0x1e	CNT	RESET	DIR	PLS

** When configured for Mixed-mode operation (Digital pulse + Process) the DIN1 signal is used for the Process input signal. The Pulse Delay and Up/Down counter functions are not available.

8.5.1.3.2 Lock

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

8.5.1.3.3 Apply Scaling

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

Result = (Raw Reading * Gain) + Offset

8.5.1.3.4 Assigned

The Assigned bit will always read as 0.

8.5.1.3.5 Available

The Available bit will always read as 0.

8.5.2 Digital Device Byte

For digital I/0 types, the Device Configuration field determines the signal types for each of the channel bits.

CHANNEL 0										
SIG 2 (ENABLE)				SIG 1 (RESET)			SIG 0 (PULSE)			
7	**6**	**5**	**Description**	**4**	**3**	**Description**	**2**	**1**	**0**	**Description**
0	0	0	N.0. SINK (DRY)	0	0	N.0. SINK (DRY)	0	0	0	N.0. SINK (DRY)
0	0	1	N.C. SINK (DRY)	0	1	N.C. SINK (DRY)	0	0	1	N.C. SINK (DRY)
0	1	0	N.O. SOURCE (WET)	1	0	N.O. SOURCE (WET)	0	1	0	N.O. SOURCE (WET)
0	1	1	N.C. SOURCE (WET)	1	1	N.C. SOURCE (WET)	0	1	1	N.C. SOURCE (WET)
							1	0	0	COMPARATOR (100 mV)
							1	0	1	COMPARATOR (500 mV)
							1	1	0	COMPARATOR (1.0 V)
							1	1	1	COMPARATOR (2.0 V)

8.5.3 Digital Sensor Parameters

There are no Digital Sensor Parameters.

8.5.4 Digital IPSO Definition

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

Offset	Name	Value	Description
0x08a8	Sensor Type	<table>	Value / Description: 3318 Frequency; 33005 Pulse Width; 33006 Pulse Delay; 33015 Duty Cycle; 33002 Counter; 33003 Up/down Counter
0x08aa	Precision	0	Provides reading of xxx
0x08ac	Sensor Trigger	??	See Below
0x08b0	Min Measured	??	Minimum reading since the last reset
0x08b4	Max Measured	??	Maximum reading since the last reset
0x08b8	Min Range	-8388607	Minimum reading
0x08bc	Max Range	+8388607	Maximum reading

8.5.4.1 Digital Precision

The measured digital value provides +/- 1.0 resolution.

8.5.4.2 *Digital Sensor Trigger Function*

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

Digital 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 Digital inputs and all configuration bits should be written as 0.

8.6 Process Input

The Process Input interface provides single-ended voltage and current loop inputs. The Sensor Configuration and Sensor Device fields may be written to provide control of the overall function of the channel and the signal types used.

8.6.1 Process Descriptor

Offset	Name	Value	Description
0x00	Measurement Type	0x??	Analog Voltage and Current – set by Sensor Type field in Configuration byte.
0x01	Data Type/Format	0x06	Float,
0x02	Configuration	0x4?	Determines Process input type/range
0x03	Sensor Device	0x??	Determines AIO signal types
0x04..0x08	UOMR	"??"	Units of measure

8.6.1.1 *Process Measurement Types*

The Process interface provides a measurement dependent on the input range/type selected. The units of measure may be changed by the user.

Sensor Type	SI Derived Units	Measurement
0x11	mV	Process Voltage (0 - 1.0 V, 0 – 2.0 V)
0x13	mA	Process Current (0-24 mA current loop, common return)

8.6.1.2 *Process Input Data Type/Format*

Process Input Data Type/Format							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Smart Sensor	Writeable	Factory Calibrate	Reserved	Data Type			
0	0	?	0	0x06 = Float			

8.6.1.2.1 *Data Type*

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

8.6.1.2.2 *Factory Calibrate*

Factory calibration is available for the SS-015 process inputs. Clearing this bit will disable the factory calibration values.

8.6.1.2.3 *Writeable*

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

8.6.1.3 *Process Input Configuration*

Process Input Configuration							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Available	Channel	Scaling	Lock	Sensor Range / Type			
0	0*	?	?	(See Below)			

8.6.1.3.1 *Sensor Range / Type*

Sensor Range/Type	Sensor Input Type (Range)	Measurement Type	
0x01	0-24 mA	0x13	Current (mA)
0x03	0-1.0 Vdc	0x11	Millivolts (mV)
0x09	0-2.0 Vdc	0x11	Millivolts (mV)

8.6.1.3.2 *Lock*

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

8.6.1.3.3 *Apply Scaling*

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

Result = (Raw Reading * Gain) + Offset

8.6.1.3.4 *Assigned*

The Assigned bit will always read as 0.

8.6.1.3.5 *Available*

The Available bit will always read as 0.

8.6.2 Process Device Byte

The Sensor Device field determines the signal types for each of the channel bits.

Process Device Byte									
	A	**(Analog Input)**							
7	**6**		**5**	**4**	**3**	**2**	**1**	**0**	**Description**
1	X		0	0	0	0	0	0	Single Ended

8.6.3 Process Sensor Parameters

There are no Process Sensor Parameters.

8.6.4 Process IPSO Definition

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

Offset	Name	Value	Description
0x08a8	Sensor Type	3317	Current (mA)
		3316	Voltage (mv)
0x08aa	Precision	0-24mA	1 – display as xx.x
		0-1000 mV	-1 – display as xxx0.0
		0-2000 mV	-1 – display as xxx0.0
0x08ac	Sensor Trigger	??	Write any value to force a reset of min/max
0x08b0	Min Measured	??	Minimum reading since the last reset
0x08b4	Max Measured	??	Maximum reading since the last reset
0x08b8	Min Range		
0x08bc	Max Range		

Range	Minimum	Maximum
0-24 mA	0	24 mA
0 – 1 Vdc	0	1000 mV
0 – 2 Vdc	0	2000 mV

8.6.4.1 Process Precision

The measured mA value is rounded to provide +/- 0.1 mA resolution.
The measured mV value is rounded to provide +/- 10 mV resolution.

8.6.4.2 Process Sensor Trigger Function

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

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 Process inputs and all configuration bits should be written as 0.

WARRANTY/DISCLAIMER

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

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

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

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

RETURN REQUESTS/INQUIRIES

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

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

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

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

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

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

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

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