1 YEAR WARRANTY

CE

OMEGA™

User's Guide

IF-001

IF-002

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IF-001/IF-002

USB/Modbus Smart Interface

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1 Notes, Cautions, and Warnings

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

Do not operate the equipment in flammable or explosive environments.

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

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 Omega Link Smart Interface Overview

The Omega Link IF-001 and IF-002 smart interfaces provide an easy way to configure, integrate, and monitor your Omega Link Smart Probes. The IF-001 and IF-002 are both fully compatible with SYNC configuration software, the Omega Link Cloud, the Omega Link family of hardware Gateways, and Omega Enterprise Gateway software. Omega Link Smart Interfaces provide both a simple command line interface, for quick configuration and monitoring, and Modbus RTU support, for integration with industrial networks. The command line interface allows interactive visualization of the connected Omega Link Smart Probe through accessible text strings using any terminal emulator.

The M12 8-pin female connector provides 3.3 V_{DC} power for external Omega Link Smart Probes with an integrated power monitor to protect against short circuits.

Operating Requirements: Windows OS 10 and above

The following LED status indicator table provides descriptions of the different Smart Interface behaviors.

Color	Status
Off	No Activity (no VBus present), waiting for next command
YELLOW	Waiting for USB enumeration, Pending Bootstrap mode
RED – 1-second flash rate	A short condition has been detected on the sensor power circuitry. Disconnect the device.
RED – ¼ second flash	A message to the device was not acknowledged.
GREEN	After power-up and USB enumeration, the GREEN LED remains on until the first transaction with the smart sensor device
GREEN Flash	The GREEN LED is turned on at the beginning of each transaction with the Smart Sensor and turned off at the end.

2.1 IF-001

The IF-001 provides an easy way to configure and monitor Omega Link Smart Probes using SYNC or other configuration tools. The IF-001 is a USB CDC / VCP device (serial interface), allowing it to connect to computers that do not have a native serial port. The USB 2.0 compliant device is compatible with Windows.

2.2 IF-002

The IF-002 allows Omega Link Smart Probes to connect to existing RS485 Modbus RTU serial networks. An M12 5-pin male connector provides a standard RS485 serial interface. The IF-002 can run off a wide range of power, from 5 to 36 V_{DC}, allowing broad compatibility while providing regulated power to Smart Probes.

3 Smart Interface Pin Layouts

3.1 IF-001: Smart Probe to USB

The IF-001 can connect direct to the Omega Link Smart Probe through an M12 8-pin female connector as shown in the example below. The connector supports the required I2C + INTR signal lines and the Smart Probe power signals. The shield connection is coupled to the Serial Connector.

Figure 1:Example SP-001 connected to an IF-001

The Smart Probe Discrete I/O signals are not internally connected. An ***M12.8-S-M-FM*** and ***M12.8-T-SPLIT*** are required to access the Discrete I/O Use the wiring diagram below to connect your Smart Probe and Discrete I/O accessories to the IF-001 cable.

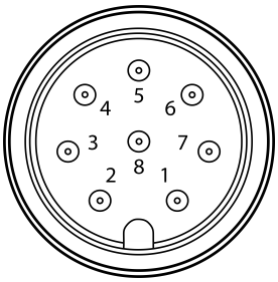


Figure 2: IF-001 front view of M12 8-Pin Connector

	Name	Function
Pin 1	N/A	No Connection
Pin 2	INTR	Interrupt Signal
Pin 3	SCL	SCL Signal
Pin 4	SDA	SDA Signal
Pin 5	Shield	Shield Ground
Pin 6	N/A	No Connection
Pin 7	GND	Power Return
Pin 8	VCC	Nominal 3.3 V_{DC} to Smart Probe

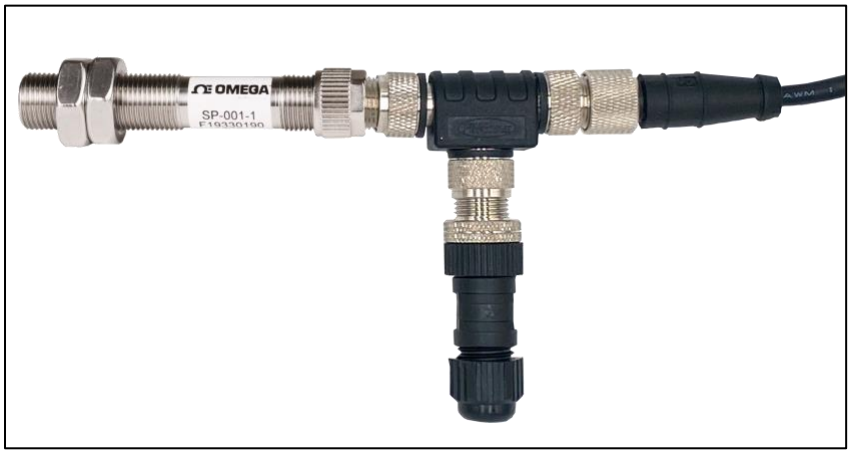


Figure 3: Example SP-001 connected to an M12.8-T-SPLIT, M12.8-S-M-FM, and IF-001

3.2 IF-002: Smart Probe to Modbus RTU

The IF-002 is used to connect to an existing Serial Modbus network through its M12 5-pin connector and directly to M12 Smart Probes through its M12 8-pin connector. The serial 5-pin connector provides the RS485 differential pair signal (A', B'), power input, and a shield signal. The device will accept external power in the range of 5 – 36 V_{DC} with reverse polarity and overcurrent protection up to 300 mA.

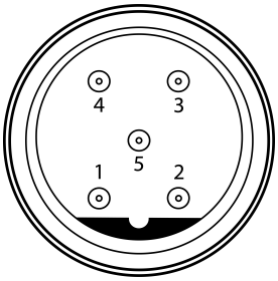


Figure 4: IF-002 front view of M12 5-Pin Connector

	Name	Function
Pin 1	VDD	5-36V_{DC}
Pin 2	A'	RS485 Data +
Pin 3	GND	Ground
Pin 4	B'	RS485 Data -
Pin 5	Shield	Shield Ground

Additionally, a 5-pin ***M12.5B-S-F-FM*** connector and a third-party ***USB to RS485 Serial Converter Cable*** are required to establish a connection from the IF-002 and the USB COM Port of your PC or Modbus device. Refer to the wiring diagram provided with your USB to RS485 to successfully connect the IF-002 wire leads of the USB to RS485 cable.

Figure 5: SP-001

Figure 6: IF-002 unit

Figure 7: M12.5B-S-F-FM

Figure 8: USB to RS485 Cable

An M12.8-S-M-FM and M12.8-T-SPLIT can be attached to the Smart Probe prior to connecting to the IF-002 to access the discrete I/O using the following wiring diagram. Refer to Figure 3 for a setup example.

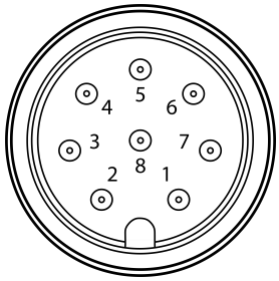


Figure 9: IF-002 front view of M12 8-pin connector

	Name	Function
Pin 1	N/A	No Connection
Pin 2	INTR	Interrupt Signal
Pin 3	SCL	SCL Signal
Pin 4	SDA	SDA Signal
Pin 5	Shield	Shield Ground
Pin 6	N/A	No Connection
Pin 7	GND	Power Return
Pin 8	VCC	Nominal 3.3 V_{DC} to Smart Probe

4 IF-001 and IF-002 Serial Communication

The serial communication parameters may be configured over the serial channel or SYNC configuration software. The factory default configuration conforms to the required Modbus RTU standard.

The IF-001 is a virtual COM port and will accept any serial port baud rate.

Refer to the table below for the default serial configuration of the IF-002:

Default Serial Configuration	
Modus Address	1
Address Range	0
Baudrate	115200
Parity	Even
Stopbits	1
Databits	8

4.1 Serial Packet Format

Communications to the IF-001 and IF-002 are based on serial data frames. For serial terminal sessions, the "transaction" ends on the receipt of a CR (0x0d) character. For Modbus RTU transactions, the entire transaction must adhere to the Modbus serial RTU time specifications.

The IF-002 uses the ***first byte*** of the transaction (the start-of-frame character) to determine the type of transaction. For the Command Line Interface, the first character denotes the operation to be performed as indicated in the following table:

Start of Frame Character	Hex	Interpretation
#	0x23	Command Line Interface comment line (ignored)
:	0x3a	Start of Frame for Modbus ASCII frame
?	0x3f	Command Line Interface 'Help' command – display command / current state summary
C	0x43	Command Line Interface 'Configure' command – configure Smart Probe device
O	0x4F	Command Line Interface 'Options' command – configuration options
R	0x52	Command Line Interface 'Read' command – read any Smart Probe register
T	0x54	Command Line Interface 'Trigger' command – trigger an event on Smart Probe device
V	0x56	Command Line Interface 'View' command – view Smart Probe data and status
W	0x57	Command Line Interface 'Write' command – Write any Smart Probe register
Any other character	Any other	Indicates register address for a Modbus RTU frame

Any other byte value appearing at the start of the frame is interpreted as a Modbus RTU Modbus device address.

Note: This requires excluding several Modbus addresses in the RTU mode, but in most cases, this will have no impact.

4.2 Modbus Register Mapping

The IF-001 and IF-002 accept RS485 Modbus RTU packets. The IF-001 / IF-002 maps the Modbus register addresses to internal configuration registers and to external I2C registers.

Modbus Register = ((Smart Probe 12C Register) / 2) + 0xf000

Modbus Register	Usage
0x0000 – 0xebff	Register address 0x0000 – 0xebff and addresses 0xf800 – 0xffff are not recognized and will result in an INVALID ADDRESS response
0xec00 – 0xefff	Registers 0xec00 – 0xefff are reserved for configuration of the IF-001 / IF-002
0xf000 – 0xf7ff	Registers 0xf000 – 0xf7ff are mapped to the external I2C device(s)
0xf800 – 0xf800	Invalid Address

4.3 Configuration Registers

The configuration registers are stored in non-volatile memory. Changes to the serial configuration and Modbus address take effect after the Modbus Transaction.

	MB Register	Type	Access	Description
Reserved	0xec00 – 0xefcf	u16	--	Reserved, return Invalid Address
I2C_Read Errors	0xefd0	u32	R	Number of Read errors
I2C_Write_Errors	0xefd2	u32	R	Number of Write errors
I2C_Read Retries	0xefd4	u32	R	Number of Read Retries
I2C_Write_Retries	0xefd6	u32	R	Number of Write Retries
I2C_Indirect_Retries	0xefd8	u32	R	Number of Read Retries
I2C_Read_Request	0xefda	u32	R	Number of read requests
I2C_Write_Request	0xefdc	u32	R	Number of write requests
Reserved	0xecda – 0xefe7	--	--	Reserved, return Invalid Address
DEVICE_ID	0xefe8-0xefeb	u8[8]	RW*	Read only, but used as part of Bootload access mechanism
FW_VERSION	0xefec-0xefed	u32	RW*	Read only, used as part of Bootload access mechanism. Formatted as MM.mm.bb.cc
HW_VERSION	0xefee-0xefef	u32	R	Formatted as MM.mm.bb.cc
DEVICE_TYPE	0xeff0	u16	R	0xff01 == IF-002
SYSTEM CONTROL	0xeff1	u16	R/W	<see below>
I2C_BASE_ADDRESS	0xeff2	u16	R/W	Defaults to 0x68. Sets the base address of I2C device(s).
I2C_SPEED	0xeff3	u16	R/W	I2C bus speed in kHz, ie 40 == 40 kbit/second
SERIAL_CONFIG	0xeff4	u16	R/W	See Serial Configuration Word
MODBUS_ADDRESS	0xeff5	u16	R/W	Defaults to 1. Sets the base address for Modbus transactions. Limited to 1 .. 247.
ADDRESS_RANGE	0xeff6	u16	R/W	Default to 0, limited to 0..7. Sets number of consecutive Modbus addresses accepted. Each Consecutive Modbus address maps to consecutive I2C device addresses.
MANUFACTURED_DATE	0xeff8	u16	R	Bit packed value with format YYYYY.MM.DD
USER_HOURS	0xeff9	u16	R/W	User settable counter, increments every 3600 seconds
OPERATING_TIME	0xeffa	u32	R	Total number of seconds of operation
GATEWAY_CONTROL	0xefff	u16	R	Reserved

4.3.1 I2C Status

Modbus registers 0xefd0 - 0xefd9 provide access to statistics indicating the number of I2C errors and retries. The ***Retry*** counts indicate the number of transactions that resulted in an NAK. When an NAK is detected, the IF-001 / IF-002 will automatically generate up to 3 retries. If an NAK is detected on the 3rd attempt the transaction is dropped, an error is reported and the Read or Write Error count is incremented. The Indirect Retry count is incremented if an NAK is generated when writing the Indirect register (0x0030).

4.3.2 System Control Register

7	6	5	4	3	2	1	0
	CLI	**HEX**	**VERBOSE**			**INTR MODE**	
	0 ON 1 OFF	0 ON 1 OFF	0 ON 1 OFF			**0 Ignore** 1 Process INTR 2 Send Notify 3	
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**
	Reserved		**Reset Stats**		**Device Reset**	**Factory Reset**	

4.3.2.1 INTR Mode

The INTR Mode determines how the Smart Probe INTR signal is handled. If it is set to PROCESS, the Command Line Interface activity is processed. If it is set to Notify, the device will send a NOTIFY command through the Command Line Interface. For Modbus applications, the INTR Mode should be set to IGNORE.

4.3.2.2 Verbose

The Verbose mode offers expanded information when in the Command Line Interface mode.

4.3.2.3 Hex

The Hex mode causes the data to be displayed as HEX values in the Command Line Interface mode.

4.3.2.4 Device Reset

Writing a 1 to the device reset bit will force the device to re-initialize using the current configuration information.

4.3.2.5 Factory Reset

Writing a 1 to the Factory Reset bit will force a factory reset and all configuration parameters will be returned to the initial factory default values.

4.3.2.6 Reset Stats

Writing a 1 to the reset stats bit will force the I2C Statistic counters to be reset to 0.

4.4 Serial Configuration (IF-002)

All serial line configuration is done through the serial channel using Modbus or Command Line Interface commands and the configuration information is retained in non-volatile memory. When accessed via Modbus, the serial configuration parameters are accessed at a Modbus register address which is outside of the range mapped to the Smart Sensor registers. When altering the communications parameters, any changes occur after the acknowledgment of the Modbus command.

The device serial configuration word is located at Modbus register address 0xeff4.

7	6	5	4	3	2	1	0
Reserved		**Data Width**	**Stop Bits**	**Parity**		**Baud Rate**	
		0 7 Stop Bits **1 8 Data Bits**	**0 1 Stop** 1 2 Stop	0 No Parity 1 Mark Parity 2 Odd Parity **3 Even Parity**		**0 9600** 1 19,200 2 38,400 **3 115,200**	
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**
Reserved							

4.4.1 Configuration Update

The IF-002 Modbus commands accept changes to the serial configuration (Baudrate, Parity, Stop Bits, Data Bits) but **does not apply them** until the next power cycle or a Device Reset trigger has been received. This allows all serial configuration parameters to be set using Modbus commands without having to change the host settings as each configuration setting change is made. All other configuration changes are applied immediately.

The sequence to change the communication parameters over the Modbus connection is:

Step 1: Change one or more parameters – each change is acknowledged using the current Serial settings

Step 2: Issue a Write command to the IF-002 System Control Register with the *Device Reset* bit set.

The command will be acknowledged using the current settings and then the serial channel will be reconfigured to reflect the new settings.

The Command Line Interface includes a Serial command that allows you to set the serial channel. These take **immediate effect**. In general, the terminal emulator must be reconfigured after the command to match the new configuration.

4.4.2 Serial Configuration Recovery

The IF-002 serial configuration may be reset to the factory default values by momentarily connecting the SCL (M12 8-Pin Pin 3) and SDA (M12 8-Pin Pin 4) signal lines together and cycling power. To reset the IF-002 to its factory default settings, follow these steps:

Step 1: Disconnect power from the IF-002 by disconnecting it from your Modbus Network.

Step 2: Unplug any smart probe connected to your IF-002.

Step 3: Short pins 3 and 4 on the 8-Pin connector on the IF-002.

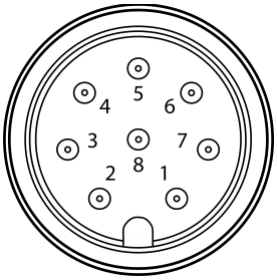


Figure 10: IF-002 front view of M12 8-pin connector

	Name	Function
Pin 1	N/A	No Connection
Pin 2	INTR	Interrupt Signal
Pin 3	SCL	SCL Signal
Pin 4	SDA	SDA Signal
Pin 5	Shield	Shield Ground
Pin 6	N/A	No Connection
Pin 7	GND	Power Return
Pin 8	VCC	Nominal 3.3 V_{DC} to Smart Probe

Step 4: Apply power to the IF-002 for 3 seconds from the 5-pin connector.

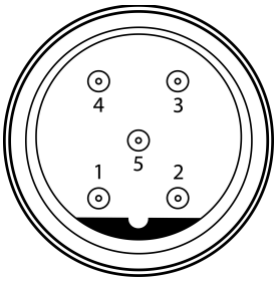


Figure 11: IF-002 front view of M12 5-Pin Connector

	Name	Function
Pin 1	VDD	5-36V_{DC}
Pin 2	A’	RS485 Data +
Pin 3	GND	Ground
Pin 4	B’	RS485 Data -
Pin 5	Shield	Shield Ground

Step 5: Reconnect your Omega Link Smart Probe and apply power.

5 Command Line Interface

Note: The following Command Line Interface section can be applied to both the IF-001 and the IF-002.

The command line interpreter allows human-readable commands to be sent to the smart sensor device through a terminal emulator which are widely available and may be easily installed on a PC or Linux systems. The COM channel enumerated by the device must be selected and must be configured to match the serial configuration parameters. (Refer to Appendix A).

5.1 Help Command

The Help command uses the '?' character and will display a brief summary of the available commands and options. It is useful to determine if the IF-001 / IF-002 is successfully communicating and does not require a smart probe device to be connected.

```
?
 IF-002, Version 1.11.0.0

O(ptions)  <V/v(erbose)> <H/h(ex)/D(ecimal)> <I(gnore) | P(rocess) | N(otify) INTR handling>
        <A/a(ddr for I2C) =?> <S(peed) =?> <M(odbus Addr) =?> <R(ange) = ?>
R(ead)    <@><#n></d><{Add}> Reg [Len <format> ...]
W(rite)   <@><#n></d><{Add}> Reg [data <format>...]
V(iew)    <@><#n></d><{Add}> <I(nfo) | D(ata) | L(og) | N(ext)
T(rigger)  <@><#n></d><{Add}> <R(eset) | F(actory reset) | P(ower reset) | C(lear log) | S(ample) | L(og)
S(erial)   <B(audrate) = 9600 | 19200 | 38400 | 115200> <P(arity) = E(ven) | O(dd) | M(ark) | N(one)>
        <S(top) = 1 | 2> <D(ata) = 7 | 8> <R(eset)>
C(onfig)   <@><#n></d><{Add}><R(ate) | I(nterrupt) | D(evice) | S(ensor nn) | O(utput nn)

   @ - Continuous/no delay, #n - number cycles, /d - delay time, <..> - are optional
   formats: I/i(nteger), L/l(ong), F/f(loat).precision, S/s(string)
Verbose, Hex, internal INTR use,  I2C Addr: 0x68 @ 50 kbp,  Modbus Addr: 0x01, Modbus Range: 0x00
```

5.1.1 Alternate Address {Add}

The I^2C address used to access the Smart Sensor device defaults to 0x68, unless overwritten by the Options command. The address may be further overwritten in each command by enclosing the address in { } bracket.

5.1.2 Numeric Formats

Data may be entered or displayed as hexadecimal, decimal or float values. The standard output shows data in decimal or hex format depending on the Verbose H/h/D mode setting, which may be overwritten using formatting characters. The following formatting characters are accepted:

Data Type	Suffix	Example (Assume Hex Option Selected)
Byte	<none, default>	R 0x68 -> display single byte value
16-bit integers	i	R 0x68 20 2 i -> result displayed as 0x1234
32-bit integers	l (lower case 'L')	R 0x68 20 2 l -> result displayed as 0x12345678
Floats	f.n (n == precision)	R 0x68 0x3c 4 f.3 → result displayed as 12.345, precision is optional and defaults to 1 digit.
Strings	S/s	R 0xe0 s → result displays the user-defined device name located at 0xe0 W 0xe0 "My Name" → will write a new device name to the string. Be cautious not to exceed the maximum string lengths.

5.1.2.1 Invalid Commands

Since the first character of the serial record is used to determine the Command Line Interface command and all other characters are treated as Modbus Start of Frame (':') or address values, no interpretation is made of characters other than those shown in the Help summary and no error reporting will be generated.

5.1.3 Command Repetition @, #, /

The Read, Write, View, Configure and Trigger commands may be set up to repeat a specific number of times with an optional repetition rate. Repeated commands are terminated if an error occurs or any keyboard entry is made.

- The '**@**' symbol causes the command to be repeated indefinitely, at the fastest possible rate. If the @ symbol is specified, the # and / may not be used.
- The '**#**' symbol, followed by a numeric value, causes the command to be repeated the specified number of times.
- The '**/**' symbol, followed by a numeric value, allows specifying a delay in seconds between each command repetition when using the '#' option.
  If no repetition information is provided the command will be executed once.

5.2 Read Command

The Read command accepts the repetition information, the starting register number, the number of elements to be read and the format of the data. The starting register location ***must*** be provided while all other fields are optional. If the number of elements is omitted, it is assumed to be one. If the data format is omitted, it is assumed to be BYTES. There may be multiple elements and related format information contained within a read. Commas or spaces may be used to separate the individual values.

R(ead) <repetition options> register [<number> <format <.precision>> …]

The simplest form is ***R 0x????,*** where ***0x????*** represents a value between 0x0000 and 0x0fff. The command will return a single byte from the specified location. A more complex example would be ***Read 0x38 1l 4f.2*** to read the current time, and the 4 sensor readings. The Time information is stored in register 0x38 as a 32-bit long value and is then immediately followed by the four sensor results stored as floating-point values at locations 0x003c .. 0x004b.

```
// Location 0x3c represents the sensor readings, stored as floating point values.
// Read a single byte from the start of the sensor values (default count is 1, type byte)
R 0x3c
[Dev: 0x68 Reg: 0x3c Cnt: 0x01 ->  0x41 ]
// Read 2 bytes (the format defaults to BYTE)
R 0x3c 2
[Dev: 0x68 Reg: 0x3c Cnt: 0x02 ->  0x41,  0xb7 ]
// Read 3 'long ' (4 byte) values, representing 12 (0x0c) bytes
R 0x3c 3l
[Dev: 0x68 Reg: 0x3c Cnt: 0x0c ->  0x41b73333,  0x42483d71,  0x447605c3 ]
// Read 3 'float' ( 4 byte ) values, representing 12 ( 0x0c ) bytes, default precision is 2
R 0x3c 3f
[Dev: 0x68 Reg: 0x3c Cnt: 0x0c ->  22.8,  50.1,  984.0 ]
// Read 3 float values and display with 4 digit precision
R 0x3c 3f.4
[Dev: 0x68 Reg: 0x3c Cnt: 0x0c ->  22.8899,  50.1899,  984.1099 ]
O v d
verbose, Decimal mode, Ignore INTR,  I2C Addr: 0x68 @ 50 kbp,  Modbus Addr: 0x01
Read 0x38 1l 4f.2
 0000367195  23.22,  28.27,  1013.40,  0.00
```

5.3 View Command

The View command accepts an option that specifies what is to be displayed. If no option is provided the command assumes the **V**iew Information option.

V(iew) <repetition options> <I(nformation) | (D(ata) | L(og) | N(ext)>

Information Group	Attributes (registers)	Usage
I(nformation)	Device Name (0xe0), Device ID (0x00) Number of Sensors (0x00) Number of Outputs (0x00)	Provides summary of the device status and health used to take the measurements.
D(ata)	Current Time, Sensor Readings, Sensor Units	Provides summary of current time, reading values and units of measure.
L(og)	Extract Start, Extract End, Number Records	Provides information on information contained in Log file
N(ext)	Extract Time Extract Data	Extracts and displays the next log file record

View Information
Device: Device Name, ID: 00000001
Type: BTH-SP, Version: 1.25.4.0
Manufactured: 2017/08/25, Operating Hours: 11-13:33:48
Calibrated: 2017/08/25, Calibration Hours: 11-13:33:48
Oper Volt: 3.3 Vdc,Oper Temp: 21 oC, Fault Code: 0
Sensors: 3, Outputs: 2
View L
Start Time: 11-13:06:41, End Time: 11-13:33:59, Records Available: 820
V Data
11-13:34:03 21.0 .C 28.0 %RH 1017.0 mbar
V N
11-13:34:01 21.0 .C 28.0 %RH 1017.0 mbar

5.4 Trigger Command

The Trigger command allows users to initiate an action on the smart sensor. The Trigger commands makes use of the options provided by the Trigger register at register location 0x26. If no option is provided, a Trigger Log sequence will be performed, forcing a reading to be taken and saved to the event memory.

T(rigger) <repletion options> <R(eset) | F(actory reset) | P(ower reset) | C(lear) | S(ample) | L(og)>

Action	Trigger Register, Value	Usage
R(eset)	Trigger Register = Trigger Value 0x0004	Reset device forcing re-enumeration of sensor mix
F(actory reset)	Trigger Register = Trigger Value 0x0005	Forces a factory reset which clears all user set up and logged information
P(ower reset)	Trigger Register = Trigger Value 0x0006	Performs a user reset that is treated as a power on reset which includes logging the event in the event log.
C(lear)	Trigger Register = Trigger Value 0x0003	Clears the event log
S(ample)	Trigger Register = Trigger Value 0x0100	Forces a sampling of the sensor data. The data ***is not*** written to the event log. The display will show the current values.
L(og)	Trigger Register (0x26), Trigger Value 0x0300	Forces a sampling of the sensor data and the information ***is*** saved to the event log. The display will show the current values.

5.5 Serial Command

The Serial command allows setting specific operating characteristics of the Serial interface. If no option is provided the current settings for the selected characteristics are provided.

S(erial) <**B**(audrate) = 9600 | 19200 | 38400 | 115200> <**P**(arity) = E(ven) | O(dd) | M(ark) | N(one)>
<**S**(top) = 0 | 1> <**D**(ata) = 7 | 8> <**R**(eset)>
S
Baudrate = 115200, Parity = Even, Data = 8, Stop = 1

Multiple options may be set on the same command line in any order. The updated configuration will be shown using the current serial configuration and then all changes are applied at once.

Serial BR=38400, Stop = 1, Data=7 Parity = Odd
Baudrate = 38400, Parity = Odd, Data = 7, Stop = 1
<changes are applied, terminal configuration must be changed to match new configuration>

Characteristic	Options	Usage
Baudrate)	9600, 19200, 38400, 115200	Serial Baudrate = 38400
Parity	Even, Odd, Mark, None	S P=None
Stop	1, 2	S S=2
Data	7, 8	Serial Databits = 8
Reset	--	Resets serial configuration to 115200, Even, 8, 1

5.6 Configure Command

The Configure command sets specific operating characteristics of the device. If an option is not provided, the current settings for the selected characteristic are provided. If no characteristic is provided, a summary of the Configure command is provided.

C(onfig) <repetition options> <R(ate) | D(evice) | S(ensors) | O(utputs)> < option >

Characteristic	Attributes (registers)	Usage
R(ate)	Event 1 Time Base	C R Displays current Rate C R = xx Sets the Event 1 sample time, which is the default timer, used to trigger reading and logging activity.
D(evice)	IO_DEVICE_NAME IO_LIST_SELECT	C D Displays the I/O mix available on the device with an indication of how to select different configurations. C D = nn Allows selecting device configuration from available options shown in the C D command.
S(ensors)		C S Displays the list of all available sensors on the device and available configuration options. C S n Displays the configuration options available on sensor 'n'. C S n = x Allows selecting a sensor configuration option from available options shown in the C S n command
O(utputs)	0x??	C O Displays the list of all available outputs on the device and available configuration options. C O n Displays the configuration options available on output 'n'. C O n = x Allows selecting a output configuration option from available options shown in the C O n command

5.6.1 Configure Device

The Configure Device command displays a list of different device configurations as shown below. In this example, there are 2 configurations available (0 to 1) and currently option #6 is selected.

To change the device configuration, enter C D = n, where n is one of the displayed options. The device will be reconfigured, a 'Reset' will be generated to force the new input selections to be enumerated and a revised list will be displayed.

```
C D
SP-003-1 Options
    T / OUT (option: 0)
    H / OUT (option: 1)
    T,H / OUT (option: 2)
    B / OUT (option: 3)
    T,B / OUT (option: 4)
    H,B / OUT (option: 5)
 >> T,H,B / OUT (option: 6)

C D = 1
SP-003-1 Options
    T / OUT (option: 0)
    H / OUT (option: 1)
    T,H / OUT (option: 2)
    B / OUT (option: 3)
 >> T,B / OUT (option: 4)
    H,B / OUT (option: 5)
    T,H,B / OUT (option: 6)
```

5.6.2 Configure Sensors and Outputs

When configuring sensors and outputs, multiple **Sensor** or **Output Types** may be presented. If any of the 'options' related to the Sensor or Output Type are selected the device will be reset to ensure re-enumeration of the selected type ***and the remaining options (CLK A, RST etc.) may change.***

C S

Sensor Type (0) Options
- DIN (option: 0)
- >> RATE (option: 1)
- WIDTH (option: 2)
- DUTY (option: 3)
- DELAY (option: 4)
- CNT (option: 5)
- U/D_CNT (option: 6)

PLS
- NO/PU (option: 7)
- >> NC/PU (option: 8)
- NO/PD (option: 9)
- NC/PD (option: 10)

RST
- NO/PU (option: 11)
- NC/PU (option: 12)
- >> NO/PD (option: 13)
- NC/PD (option: 14)

ENB
- NO/PU (option: 15)
- NC/PU (option: 16)
- >> NO/PD (option: 17)
- NC/PD (option: 18)

Sensor (1) Options

DIO

DIO_0 Active
- Disable (option: 0)
- HIGH (option: 1)
- >> LOW (option: 2)

DIO_1 Active
- Disable (option: 3)
- HIGH (option: 4)
- >> LOW (option: 5)

C S 0 = 6

Sensor Type (0) Options
- DIN (option: 0)
- RATE (option: 1)
- WIDTH (option: 2)
- DUTY (option: 3)
- DELAY (option: 4)
- CNT (option: 5)
- >> U/D_CNT (option: 6)

PLS
- NO/PU (option: 7)
- NC/PU (option: 8)
- NO/PD (option: 9)
- NC/PD (option: 10)

RST
- NO/PU (option: 11)
- NC/PU (option: 12)
- >> NO/PD (option: 13)
- NC/PD (option: 14)

DIR
- NO/PU (option: 15)
- NC/PU (option: 16)
- >> NO/PD (option: 17)
- NC/PD (option: 18)

In addition to selectable options, sensors may also contain **Sensor Parameters**, whose floating-point values are maintained in a fixed memory space allocated for each sensor. Sensor Parameters are displayed showing the corresponding allocated space. The corresponding Sensor Parameter may be read or written using the Read and Write commands.

V i
Device: Device_19302C0C, ID: 0x010119302c0cda4d
Type: SP-013-1, Version: 0.1.4.0
Core Version: 3.31.1.0, H/W Version: 1.0.0.0

Manufactured: 2019/07/08, Operating Hours: 0-02:00:25
Calibrated: 2019/07/08, Calibration Hours: 0-02:00:25
Oper Volt: 3.3 Vdc,Oper Temp: 25 oC, Fault Code: 0x0000
Sensors: 2, Outputs: 2, Sample Rate: 1
C D
SP-013-1 Options
DIGITAL/OUT (option: 0)
>> DIGITAL, DIN/OUT (option: 1)
C S 0
Sensor Type (0) Options
DIN (option: 0)
RATE (option: 1)
WIDTH (option: 2)
DUTY (option: 3)
DELAY (option: 4)
CNT (option: 5)
>> U/D_CNT (option: 6)
PLS
NO/PU (option: 7)
NC/PU (option: 8)
NO/PD (option: 9)
NC/PD (option: 10)
RST
NO/PU (option: 11)
NC/PU (option: 12
>> NO/PD (option: 13)
NC/PD (option: 14)
DIR
NO/PU (option: 15)
NC/PU (option: 16)
>> NO/PD (option: 17)
NC/PD (option: 18)

R 0x08c0 1 f
[Dev: 0x68 Reg: 0x8c0 Cnt: 0x04 -> NAN]
C O 0
Output (0) Options
>> ON/OFF (option: 0)
PWM (option: 1)
Active
HIGH (option: 2)
>> LOW (option: 3)
C O 0 = 6
Output (0) Options
>> ON/OFF (option: 0)
PWM (option: 1)
Active
HIGH (option: 2)
>> LOW (option: 3)

5.7 Option Command

The Option command allows configuring the IF-001 / IF-002 device to use default values to simplify the user interface by providing extended formatting options. Changes to the Options settings are retained in the internal Flash memory.

O(ptions) <V/v(erbose)> <H/h(ex)/D(ecimal)> <I(gnore) | P(rocess) | N(otify) INTR handling>
<A/a(ddr for I2C) =?> <S(peed) =?> <M(odbus Addr) =?>

Characters shown in parenthesis (..) are optional. To Enable an option, specify the name with an upper-case character. Multiple options may be specified in the same command line in any order. To disable the option, specify the name with a lower-case character.

Action	Usage
V(erbose)	Turn on Verbose mode
v(erbose)	Turn off Verbose mode
H(ex)	Data values are output in hexadecimal Upper case ie: 0x1AC7
h(ex)	Data values are output in hexadecimal Lower case ie: 0x1ac7
D(ecimal)	Data values are output in decimal format ie: 6855
I(nterrupt)	Ignore (and disable) the Smart Sensor device INTR device interrupt
P(rocess)	Process the Smart Sensor INTR device interrupt
N(otify)	Notify via notification message on interrupt occurrence
A(ddress) = nnn	Set the address to be used when accessing the smart sensor device
a(ddress)	Set the default I^2C address (0x68)
S(peed) = nnn	Set the I2C bus clock speed to be used
M(odbusAddr) = nnn	Set the Modbus address to be used

The serial port settings can be changed using the command line interface. To set the Modbus Address on your IF-001 / IF-002, use the following command:

O(ptions) **M**(odbusAddr) = X

Note: For Modbus RTU operation the Modbus Address must be unique, Databits must equal 8, and Stopbits must be set to 1.

Serial commands should be entered in the same line and can be separated by a comma. Use the following table and example to set your serial configuration:

Serial	Configuration Options
B(audrate)	9600 | 19200 | 38400 | 115200
P(arity)	Even | Odd | Mark | None
D(atabits)	7 | 8
S(top)	1 | 2

To Set the Serial Configuration options on your IF-001 / IF-002, use the following command:

S(erial) **B**(audrate) = X, **P**(arity) =X, **D**(atabits) = X, **S**(top) = X

To reset the IF-001 / IF-002 serial configuration to default, type the following command:

S R

Multiple Options may be combined into a single command line.

Example:

Option V h	Set to verbose mode, lower case hexadecimal output

The response from the Option command is a summary of the current settings. Entering the O command with no parameters returns the current settings.

Option
Verbose, Hex, Ignore INTR, I2C Addr: 0x68 @ 50 kbp, Modbus Addr: 0x01

5.7.1 Verbose Mode

The Verbose mode adds formatting characters to command responses. Commas are inserted between each field and each record is enclosed in [ ] brackets.

5.8 Hex / hex / Decimal Option

The Hex / hex and Decimal option determines how numeric data is displayed if not specifically designated as a *float* or *string* value. When entering data, a '0x' indicates a hex value.

Option Verbose
Verbose, Hex mode, i(ignore INTR), I2C Address: 0x68 @ 50 kbp, Modbus Address: 0x01
// Read current sensor readings, display as 4 floats
R 0x3c 4f
[Dev: 104 Reg: 060 Cnt: 016 -> 23.1, 50.1, 984.0, 0.0]
// Force failure by disconnecting device
R 0x3c 4f
[Dev: 104 Reg: 060 E_NAK (009)
O v
verbose, Decimal mode, n(INTR ignored), I2C Address: 0x68 @ 50 kbp, Modbus Address: 0x01
R 0x3c 4f
23.1, 49.8, 983.9, 0.0
R 0x3c 4f
E NAK (009)

5.9 INTR Processing

Smart sensor devices use I²C in a request / response configuration, where the IF-001 / IF-002 is always the 'master' that initiates requests to the attached smart sensor device. If the attached device wishes to initiate a transaction, a separate active low interrupt signal (INTR) is provided.

5.9.1 Ignore INTR

If the IF-001 / IF-002 is configured to ignore the INTR signal (I) the corresponding hardware interrupt signal is disabled. No changes are made to the attached device.

5.9.2 Process INTR

Note: The processing of the INTR signal generates data whenever an interrupt is generated by the device. This behavior is not compatible with Modbus RTU and the I(nterrupt) processing mode MUST be set to Ignore if Modbus is to be used.

If the IF-001 / IF-002 is configured to process the INTR signal (P) the attached device is preconfigured, enabling the interrupts indicated below and the hardware interrupt is enabled. A handler is enabled to process the INTR signals. Upon receipt of an interrupt from the smart sensor device, the IF-001 / IF-002 adaptor will perform the following actions based on the INTERRUPT STATUS bits register read from the device.

Interrupt Status Bits	Enabled	Handler Action
SENSOR CHANGE	Y	Executes a 'View Info' command
POWER CHANGE	Y	Executes a 'View Info' command
HEALTH CHANGE	Y	Executes a 'View Info' command
EVENT 0	N	Display 'EVENT 0 INTERRUPT'
EVENT 1	N	Display 'EVENT 1 INTERRUPT'
DATA READY	Y	Executes a 'View Data' command (precede with '!')
FUNCTION BLOCK	N	Display 'FUNCTION BLOCK INTERRUPT'
LOG DATA READY	N	Executes a 'View Log' command

O P
Verbose, Hex mode, Process INTR, I2C Addr: 0x68 @ 50 kbp, Modbus Addr: 0x01

! 10-19:48:47 23.0 .C 16.0 %RH 1014.0 mbar
! 10-19:48:53 23.0 .C 16.0 %RH 1014.0 mbar

If the INTR is configured to notify (N), an alternate handler is loaded which will generate a Notify message consisting of the Interrupt Status read from the device. No change is made to the INTERRUPT CONTROL register.

O N
Verbose, Hex mode, Notify on INTR, I2C Addr: 0x68 @ 50 kbp, Modbus Addr: 0x01

N 0x68 0x02 0x0020
N 0x68 0x02 0x0020
N 0x68 0x02 0x0020

The Notify information consists of the device address (0x68), Register Index (0x?? = Interrupt Status), number of bytes (0x02), and the value.

Writing to the integer INTERRUPT CONTROL register at location 0x16 allows changing the enabled interrupts.

5.9.3 I2C Address

The IF-001 / IF-002 defaults to using I^2C address 0x68. The default may be overwritten by setting the Address = ??. If a lower case '**a**' is entered it resets the address back to the default 0x68 value.

5.9.4 Bus Speed

The I^2C bus speed defaults to 40 kb/second, suitable for up to 5-meter cable lengths. This may be changed from values 20 to 100 kbits/second. Note that changing this value will have a minimal impact on overall performance.

5.9.5 Modbus Address

The IF-001 / IF-002 defaults to Modbus address 0x01, which may be overwritten with the M(odbus) option.

6 Appendix A: Smart Sensor Register Summary

The following is a summary of commonly used smart sensor registers.

Name	Type	SS Register	Modbus Register	Usage / Comments
DEVICE_ID	u32	0x0000	0xf000	Unique identifier for this device
F/W Version	u32	0x0004	0xf002	Formatted as Major.Minor.Bug.Build
Hardware Version	u32	0x0008	0xf004	Formatted as Major.Minor.Bug.Build
Device I/O List selection	u8	0x000c	0xf006	Selects Mix of Sensor / Outputs
User Operating Hours	u16	0x000e	0xf007	User settable (Hours)
Event 1 Timer Base	u16	0x0010	0xf008	Used to set internal sampling rate
Event 2 Timer Base	u16	0x0012	0xf008	Aux timer for application specific use
System Control	u16	0x0014	0xf009	Determines how device behaves
Interrupt Control	u16	0x0018	0xf00c	Determines what generated INTR signal
Number Sensors	u8	0x001a	0xf00d	Number of enumerated sensors
Number Outputs	u8	0x001b		Number of enumerated outputs
Operating Temperature	u8	0x001c	0xf00e	Operating temperature of device
Operating Voltage	u8	0x001d		Operating voltage of device
Fault Process	u8	0x001e	0xf00f	Where last fault was detected
Fault Code	u8	0x001f		Type of last fault
Event 1 Timer	u16	0x0020	0xf010	Time remaining on Event Timer 1
Event 2 Timer	u16	0x0022	0xf011	Time remaining on Event Timer 2
System Status	u16	0x0024	0xf012	Overall system status / health
Trigger Request	u16	0x0026	0xf013	Initiates action on device
Extract Start Time	u32	0x0028	0xf014	Used for searching Event Log
Extract End Time	u32	0x002c	0xf016	Used for searching Event Log
Number of Records	u16	0x0036	0xf01b	Number of records found
Current Time	u32	0x0038	0xf01c	Current time (offset for 2000)
Sensor Readings (4)	float	0x003c	0xf01e	Four values (consecutive Address)
Log Record Time	u32	0x004c	0xf026	Current time (offset for 2000)
Extracted Values (4)	float / u32[4]	0x0050	0xf028	Four values (consecutive Address). May be float or u32 values based on record type
Sensor Range/Type (4)	u8	0x0062	0xf031	Determine overall sensor type/range. The values are offset by 0x08 (0x04 Modbus)
Sensor Device (4)	u8	0x0063		Determine overall specific signal configurations. The values are offset by 0x08 (0x04 Modbus)
Sensor Units (4)	u8[4]	0x0064	0xf032	4 byte string describing units of measure. The values are offset by 0x08 (0x04 Modbus)
User Parameters (16)	float	0x0080	0xf040	Application specific user registers (setpoints etc.)

Sensor (16)	float	0x0080	0xf040	Application specific user registers (setpoints etc.)
User Parameters (16)	float	0x0080	0xf040	Application specific user registers (setpoints etc.)
Sensor Offset (4)	float	0x00c0	0xf060	Offset value for V = R * Gain + Offset applied to Sensor 0, 4 values
Sensor Gain (4)	float	0x00c4	0xf062	Gain value for V = R * Gain + Offset applied to Sensor 0, 4 values
Device Name	u8[16]	0x00e0	0xf070	16 character user assigned device name
Output Values (4)	float	0x00f0	0xf078	4 values represent output values
Manufactured Date	u16	0x0128	0xf094	Bit formatted as, year offset by 2000 YYYYYYYMMMMDDDDD
Calibration Date	u16	0x012a	0xf095	Bit formatted as, year offset by 2000 YYYYYYYMMMMDDDDD
Operating Time	u32	0x012c	0xf096	Seconds since manufactured
Time since Calibration	u32	0x012c	0xf096	Seconds since calibrated
Output Range/Type (4)	u8	0x0134	0xf09a	Determine overall Output type/range. The values are offset by 0x02 (0x01 Modbus)
Output Device (4)	u8[4]	0x0135		Determine overall specific signal configurations. The values are offset by 0x02 (0x01 Modbus)
Sensor Names	u8[8]	0xe00	0xf700	4 X sensor name string
Output Names	u8[8]	0xe20	0xf710	4 X output name string
Parameter Names	u8[8]	0xe40	0xf720	16 X parameter name string
Function Block Names	u8[8]	0xec0	0xf760	32 X parameter name string
FB Parameter Names	u8[8]	0xfc0	0xf7e0	4 X Function Block parameter names

7 Appendix B: Specifications

RS485 Serial Port

Baudrate: 9600, 19200, 34800, 115200
Parity: Even, Odd, None
Data Bits: 7, 8
Stop Bits: 1, 2
Protocol: Modbus RTU or Command Line Interpreter

Input Power

Voltage: 5 V_{DC} – 36 V_{DC}

Output to Smart Probe

100 mA max @ 3.0V ±5%

Environmental

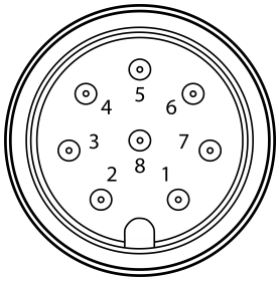
Operating Temperature: -40 to 85°C (-40 to 185°F)
Rating: IP67 when mated

Mechanical

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

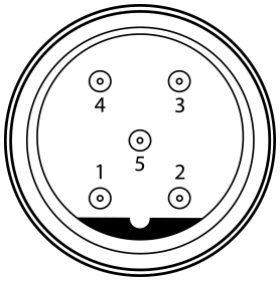
General

Agency Approvals: CE
Compatibility: Windows OS 10 and above. Compatible with OEG, SYNC configuration software, and Modbus networks



M12 8-Pin Female Connector Front View

	Name	Function
Pin 1	N/A	No Connection
Pin 2	INTR	Interrupt Signal
Pin 3	SCL	SCL Signal
Pin 4	SDA	SDA Signal
Pin 5	Shield	Shield Ground
Pin 6	N/A	No Connection
Pin 7	GND	Power Return
Pin 8	VCC	Nominal 3.3 V_{DC} to Smart Probe



M12 5-Pin Connector (IF-002 Only)

	Name	Function
Pin 1	VDD	5-36V_{DC}
Pin 2	A'	RS485 Data +
Pin 3	GND	Ground
Pin 4	B'	RS485 Data -
Pin 5	Shield	Shield Ground

8 Appendix C: Texas Instrument License Statement

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- Benchtop/Laboratory Meters
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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
- Flexible Heaters
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- Refractometers
- Pumps & Tubing
- Air, Soil & Water Monitors
- Industrial Water & Wastewater Treatment
- pH, Conductivity & Dissolved Oxygen Instruments

M5757/0223