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WARRANTY



Ω OMEGA™ **User's Guide**



IF-001



IF-002

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IF-001 / IF-002 **USB / RS485 Smart Interface**



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1. Layer N Smart Interface

The Layer N IF-001 and IF-002 smart interfaces provide an easy way to configure, integrate, and monitor your Layer N Smart Probes. The IF-001 and IF-002 are both fully compatible with SYNC configuration software, the Layer N Cloud, the Layer N family of hardware Gateways, and Omega Enterprise Gateway software.

Layer N 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 Layer N Smart Probe through accessible text strings using any terminal emulator.

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

1.1. IF-001

The IF-001 provides an easy way to configure and monitor Layer N 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 which do not have a native serial port. The USB 2.0 compliant device is compatible with Windows, macOS, and Linux.

Note SYNC is only available for Windows 8 or newer Operating Systems.

1.2. IF-002

The IF-002 allows Layer N Smart Probes to connect to existing RS485 Modbus RTU serial networks. A 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.

1.3. IF-001 Status Indicator

The LEDs indicate the current state of the IF-001

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 solid 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.

1.4. IF-002 Status Indicator

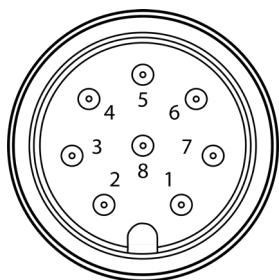
The LEDs indicate the current state of the IF-002.

Color	Status
Off	No power
YELLOW	Communications in progress. LED flashes RED on receipt of transmission of an I2C packet. The result is a yellow 'flash' during the I2C transactions.
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, the GREEN LED remains on solid while power is available to the device. It will go OFF during error reporting.

2. Wiring Diagrams

2.1. Smart Probe Connector

The IF-001 and IF-002 connects to the Layer N Smart Probe through an M12 8-pin female connector. The connector supports the required I2C + INTR signal lines and the Smart Probe power signals. The shield connection is coupled to the Serial Connector. The Smart Probe Digital Input / Output signals are not internally connected.

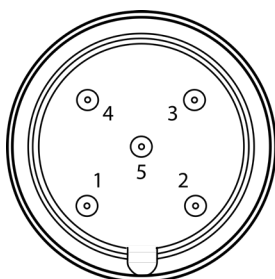


M12 8-Pin Connector

	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 3.0 V _{DC} to Smart Probe

2.2. Serial Connector (IF-002 Only)

The IF-002 is used to connect to an existing Serial Modbus network. The serial 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.



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

3. IF-001 and IF-002 Configurations

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	
Modbus Address	1
Address Range	0
Baudrate	115200
Parity	Even
Stopbits	1
Databits	8

3.1. 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 in the start of frame is interpreted as a Modbus RTU Modbus device address.

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

3.2. 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.

$$\text{Modbus Register} = ((\text{Smart Probe 12C Register}) / 2) + 0xf000$$

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 – 0xffff	Registers 0xec00 – 0xffff 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

3.3. Configuration Registers

The configuration registers are stored in non-volatile memory. Changes to the serial configuration and Modbus address take effect at the completion of 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	0xfee-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 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 based 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 YYYY.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

3.3.1. 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).

3.3.2. 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	

3.3.2.1. 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.

3.3.2.2. Verbose

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

3.3.2.3. Hex

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

3.3.2.4. Device Reset

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

3.3.2.5. 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.

3.3.2.6. Reset Stats

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

3.4. Serial Configuration Word (IF-002 Only)

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 acknowledgement 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	0	1 Stop	0	No Parity	0	9600
		1	8 Data Bits	1	2 Stop	1	Mark Parity	1	19,200
						2	Odd Parity	2	38,400
						3	Even Parity	3	115,200
15	14	13	12		11	10	9	8	
Reserved									

3.4.1. Configuration Updating

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.

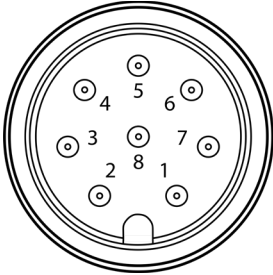
3.4.2. Serial Configuration Recovery

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:

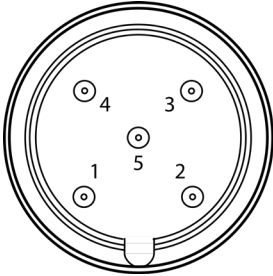
Step 1: Disconnect power from the IF-002 by disconnecting it from your Modbus Network.

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.



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



Step 6: Reconnect your Layer N Smart Probe and apply power.

4. 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).

4.1. 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(erbos)e> <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(ripper) <@><#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: l/i(nteger), L/l(ong), F/f(float).precision, S/s(string)
Verbose, Hex, internal INTR use, I2C Addr: 0x68 @ 50 kbp, Modbus Addr: 0x01, Modbus Range: 0x00
```

4.1.1. Alternate Address {Add}

The I²C 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.

4.1.2. 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.

4.1.2.1. 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.

4.1.3. Command Repetition @, #n, /d

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.

4.2. 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 1/ 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 1/ 4f.2
0000367195 23.22, 28.27, 1013.40, 0.00
```

4.3. Write Command

The Write command accepts the repetition information, the starting register address to receive the data, and the data values. Multiple data elements may be written from a single command and the data values will be interpreted according to the formatting suffixes or minimum size required to represent the value. Floating point values are indicated by including a decimal point in the value. Strings are represented by using double quotes (“...”). Commas or spaces may be used to separate the individual values.

W(rite) <repetition options> register [<number> <format>> ...]

W 0x80 123.4
 [Dev: 0x68 Reg: 0x80 Cnt: 0x04]
R 0x80 1f
 [Dev: 0x68 Reg: 0x80 Cnt: 0x04 -> 123.4]
W 0xe0 "Device Name"
 [Dev: 0x68 Reg: 0xe0 Cnt: 0x0c]
R 0xe0 20s
 [Dev: 0x68 Reg: 0xe0 Cnt: 0x14 -> "Device Name"]

4.4. View Command

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

4.5. Trigger Command

The Trigger command allows initiating 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(riigger) <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 <i>is not</i> 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 <i>is</i> saved to the event log. The display will show the current values.

4.6. 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 characteristic 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

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

4.7.1. Configuring Devices

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.

```
CD
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)

CD = 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)
```

4.7.2. Configuring 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)

4.8. 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 ² C 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:

<i>Option Vh</i>	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
```

4.8.1. Verbose Mode

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

4.8.2. 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)
```

4.8.3. 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.

4.8.3.1. 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.

4.8.3.2. Process INTR

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

OP

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.

ON

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.

Note

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.

4.8.4. I²C Address

The IF-001 / IF-002 defaults to using I²C 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.

4.8.5. Bus Speed

The I²C 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.

4.8.6. Modbus Address

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

5. 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 YYYYYYMMMMDDDDDD
Calibration Date	u16	0x012a	0xf095	Bit formatted as, year offset by 2000 YYYYYYMMMMDDDDDD
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

6. 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

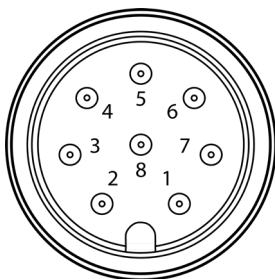
- Operating Temperature:** -40 to 85°C (-40 to 185°F)
- Rating:** IP67 when mated

Mechanical

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

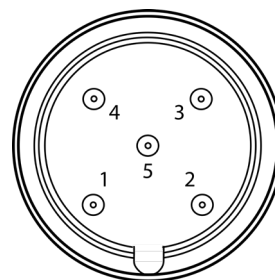
General

- Agency Approvals:** CE, EMC 2014/30/EU, LVD 2014/35/EU
- Compatibility:** Compatible with OEG, SYNC configuration software, and Modbus networks



M12 8-Pin Connector

Pin	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 3.0 V _{DC} to Smart Probe



M12 5-Pin Connector (IF-002 Only)

Pin	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

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2. Model and serial number of the product, and
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