

SNAP SSI (SERIAL SYNCHRONOUS INTERFACE) MODULE USER'S GUIDE

Form 1931-160920—September 2016

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SNAP SSI (Serial Synchronous Interface) Module User's Guide
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1: Using the SSI Module

Introduction

The SNAP-SCM-SSI module provides two individually isolated serial synchronous interface (SSI) inputs for acquiring data from linear or rotary transducers used in motion control.

The module can decode both binary and Gray Code, and is software configurable to set clock speed, frame length, delay time between data samples, and other parameters.

SNAP SSI modules mount alongside analog, digital, and other serial modules on any SNAP PAC rack with a SNAP PAC brain (either EB or SB) or an R-series controller. The brain or controller processes the data from the module and can communicate the data to other parts of an Opto 22 SNAP PAC System™ or to another system (such as an OPC client or a Modbus® system).

SNAP PAC racks accommodate up to 4, 8, 12, or 16 I/O modules, with a maximum of 8 serial modules (including SSI modules) on any one rack. Because the SNAP-SCM-SSI module is mounted on these standard racks with other SNAP I/O modules, you can use the combination of analog, digital, and serial modules required by your application at the location where they are needed.

NOTE: SSI modules require a SNAP PAC brain (either EB or SB) or an R-series controller with firmware version 8.5c or newer. These modules do not work with legacy brains or controllers.

This guide assumes that you have some familiarity with Ethernet networking and the serial synchronous interface. Commercial resources are available for learning about these subjects. To learn about SNAP PAC brains and controllers or other SNAP I/O modules, visit the Opto 22 website at www.opto22.com.

This guide includes the following chapters:

Chapter 1: Using the SSI Module describes the module and how to install, configure, and read data from it.

Chapter 2: Specifications and Additional Information includes specs, dimensional diagrams, and handy tables to use when configuring the module.



For Help

If you have problems installing or using the SNAP-SCM-SSI and cannot find the help you need in this guide or on our website, contact Opto 22 Product Support.

Phone: 800-TEK-OPTO (800-835-6786
toll-free in the U.S. and Canada)
951-695-3080
Monday through Friday,
7 a.m. to 5 p.m. Pacific Time

NOTE: Email messages and phone calls to Opto 22 Product Support are grouped together and answered in the order received.

Fax: 951-695-3017

Email: support@opto22.com

Opto 22 website: www.opto22.com

When calling for technical support, be prepared to provide the following information about your system to the Product Support engineer:

- Detailed data sheet for the transducer you are using
- Software and version being used
- PC configuration (type of processor, speed, memory, and operating system)
- A complete description of your hardware and operating systems, including:
 - loader and firmware versions for the controller or brain, and device type
 - IP addresses and net masks for devices on the system
 - type of power supply
 - third-party devices installed (for example, barcode readers)
- Specific error messages seen

Installing the SSI Module

Requirements

You'll need the following to install the SNAP-SCM-SSI module:

- I/O unit consisting of a SNAP PAC rack, a SNAP PAC EB or SB brain or R-series controller with firmware R8.5c or newer, and (optionally) other I/O modules
- Manufacturer's data sheet for the transducer
- PAC Manager 9.0 or newer, installed on a PC on the same network segment as the I/O unit

Installing the Module on the Rack

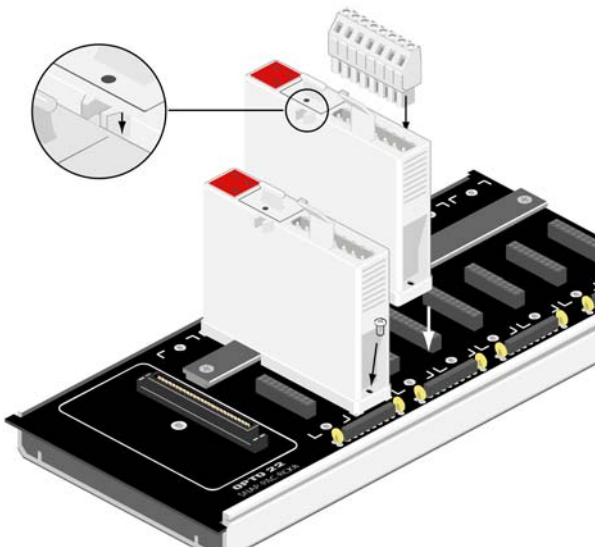
SNAP SSI modules can be installed in any position on an Opto 22 SNAP PAC mounting rack.

NOTE: SNAP SSI modules draw more power than a standard SNAP analog or digital module. As a rule, the rack can handle a maximum of eight serial modules (including SSI modules), plus the processor and up to eight digital or analog modules. Power can usually be supplied by an Opto 22 SNAP-PS5 power supply; however, check total power requirements for the processor and all modules on the rack to make sure you have sufficient power.

1. Turn off power to the rack.

WARNING: Make sure power is off before continuing, or you will severely damage the module.

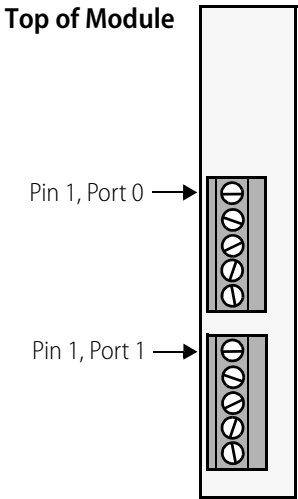
2. Position the module over the connector on the rack, aligning the slot in the module's base with the retention bar on the rack. If it is next to another module, make sure the male and female module keys are aligned, as shown at right.
3. Push straight down on the module to snap it into position.
4. Use two standard 4-40 x 1/4 truss-head Phillips holddown screws to secure both sides of each module.



CAUTION: Do not over-tighten screws. See "Specifications" on page 11.

To remove a module, see [page 14](#).

Wiring the SSI Module to Field Devices



Wire each port on the module to a transducer as shown.

Pin	Use
1	Clock +
2	Clock -
3	Data -
4	Data +
5	Excitation common

Use twisted-pair, 24-gauge shielded cable with an additional pair for common (three pairs total).

Configuring the SSI Module

To configure the SNAP-SCM-SSI, you'll need the following information on the transducer you're using with it. A detailed data sheet should contain most of this information, but you may need to contact the manufacturer for some of it:

- Data frame size
- Data frequency in kHz
- Idle time between frames (in microseconds)
- Data bit location in data frame
- Number of data bits
- Status bit location in data frame
- Status bit indication level
- Data encoding (binary or Gray)

Calculating Configuration Parameters for PAC Manager

Use the transducer manufacturer's data sheet to calculate or obtain the following parameters, which PAC Manager requires for configuring the SNAP-SCM-SSI module. You can complete the tables on [page 13](#) to make configuration easier (especially useful if you have more than one transducer type).

Data Frame Length—The total number of bits the SNAP-SCM-SSI should receive from the transducer. This number is larger than the number of data bits the transducer supports, because SSI-oriented transducers transmit the digital data within a frame that includes additional information, such as error indication bits.

Clock Divider—Each transducer's serial data is delivered at a specific clock frequency. Typically this value is specified in kHz, and it may be indicated as a range. The SSI module uses an internal 20,000 kHz (20 MHz) clock. Because this clock rate is too fast for most transducers, you set the divider parameter to slow down the data transfer rate between the transducer and the SSI module so that it falls within the transducer's specified range. Calculate the divider appropriate for your transfer speed as follows:

$$\text{Clock Divider} = 20,000 \text{ kHz} / (\text{Transducer Data Frequency})$$

If the result contains a fraction, round up to the next whole number. For example, if the result is 19.3, use 20 as the Clock Divider. If the result is 26.0, use 26.

IMPORTANT: The Clock Divider must not be less than 8. If it is less, select a slower frequency available on the transducer. The maximum data frequency input of the SSI module is 2,500 kHz.

Data Delay (in Clock Cycles)—The number of clock cycles the transducer requires between the last clock of one data frame and the first clock of the next. Manufacturers may describe this parameter in units of time (μs). If so, calculate the data delay as follows:

$$\text{Data Delay} = \text{Idle Time between frames in } \mu\text{s} / (0.05 \mu\text{s} * \text{Clock divider})$$

Or presented another way:

$$\text{Idle Time between data frames in } \mu\text{s} = \text{Data Delay} * (0.05 \mu\text{s} * \text{Clock divider})$$

For example, if the Clock Divider = 32 and the Data Delay = 64, then:

Idle Time between data frames in μs = $64 * (0.05 \mu\text{s} * 32)$

Idle Time between data frames in μs = 102.4 microseconds

If the result of the data delay calculation is fractional, round up to the next whole number. In this example, if the result is 63.2, use 64 as the Data Delay. If the result is 63.0, use 63.

Most Significant Data Bit Offset—Transducer manufacturers place the first data bit (MSB) in the data frame in various positions. This parameter tells the SNAP-SCM-SSI where to look for the first data bit. The offset should be available from the manufacturer. Note that the SNAP-SCM-SSI's bits start at zero, not one. Other manufacturers may start counting with bit 1. If so, adjust bit positions accordingly.

Data Bits in the Data Frame—This value indicates how many bits of the data frame are used to report the transducer's position. The SNAP-SCM-SSI module supports a maximum of 24 data bits. Sensors with resolution higher than 24 bits can be used, but only 24 bits of data, starting with the MSB, will be read. For example, if an encoder with 27 bits of data is connected to the module, the 24 most significant bits (MSB) will be read, and the 3 least significant bits (LSB) will be ignored (truncated).

Error Bit Offset and Level—Most SSI-interfaced positional transducers have a status or error status indication. This error indicates when the transducer reading is questionable, thus generating an error state. Manufacturers also choose the status bit state (high or low) to indicate a questionable reading. The SNAP-SCM-SSI module needs to know where this bit is located within the data frame and which level of this bit (high or low) indicates a faulty reading. Only one error bit can be monitored. If the error bit is in an error state, the module will read -8388608. If your encoder has no error bit, use a value of -1 for Error Bit Offset in the Data Frame.

Data Encoding—The SNAP-SCM-SSI module accepts either binary or Gray encoded data.

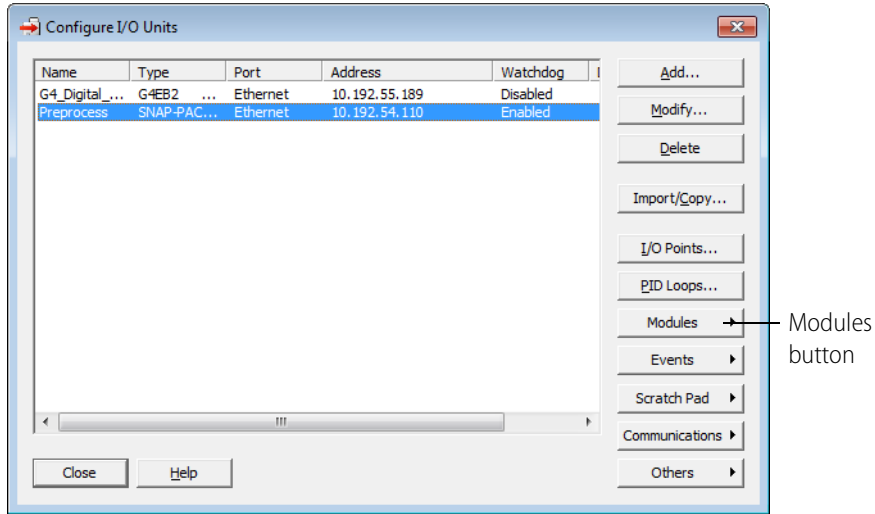
Configuring the I/O Unit with PAC Manager

You use PAC Manager, a free configuration utility, to configure the SNAP-SCM-SSI on the I/O unit. PAC Manager 9.0 or newer is required.

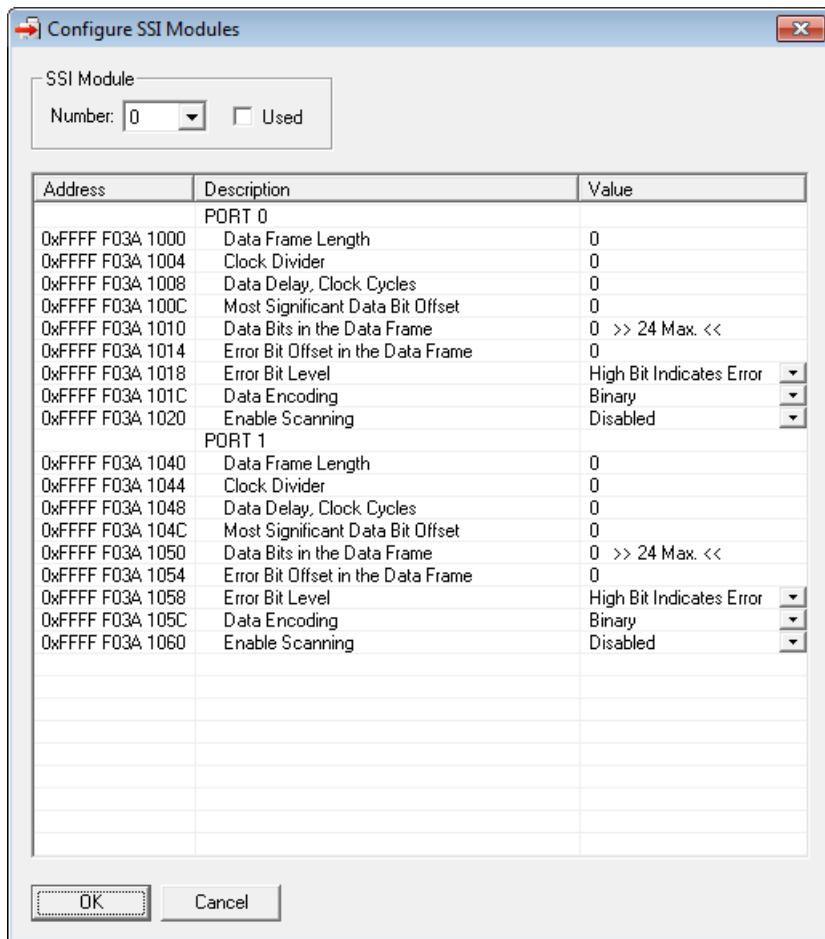
PAC Manager comes on a CD with every SNAP PAC brain and controller and is also available for download from the Support section of our website, www.opto22.com. For information about using PAC Manager, see the *PAC Manager User's Guide*, form #1704.

1. Turn on the I/O unit.
2. If PAC Manager isn't open, choose Start > Programs > Opto 22 > PAC Project > PAC Manager.
3. In PAC Manager, open the configuration file for the I/O unit the module is on, or configure a new I/O unit. (You can also configure the module in PAC Manager's Inspect window.)
4. Right-click the name of the I/O unit and choose Configure from the popup menu.

The Configure I/O Units dialog box opens (see the next page).



5. Make sure the correct I/O unit is highlighted. Click the Modules button and choose SSI Modules from the pop-up menu.



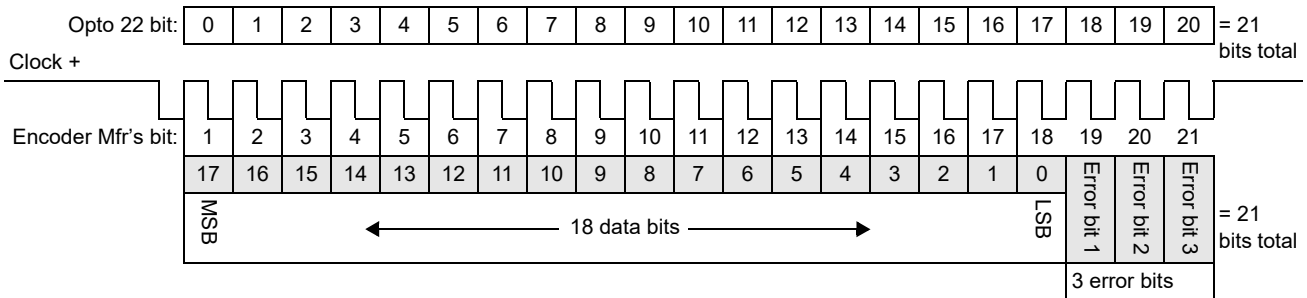
6. In the Number field at top, choose the SSI module's position from the drop-down list. Click to put a check mark in the Used box.

7. For Port 0, use the values you calculated in the previous section to configure all parameters, either by entering the value or by choosing it from the dropdown list. Under Enable Scanning, choose Enabled.
Based upon the values you enter, PAC Manager shows the actual data frequency in kHz and the data delay in microseconds (μ s). Since the SSI module accepts a maximum of 24 data bits, if you enter a value higher than this, it is reduced to 24.
8. Repeat for Port 1.
9. When you have finished entering parameters for both ports, repeat from [step 6](#) for additional SSI modules.
10. When all SSI modules are configured, click OK.
11. Save the configuration file. When you have completed configuring the I/O unit, follow steps in the *PAC Manager User's Guide* to load the configuration file to the I/O unit and save to flash memory.

Configuration Example

In this example our transducer has the following specifications:

Example: SSI data format encoder



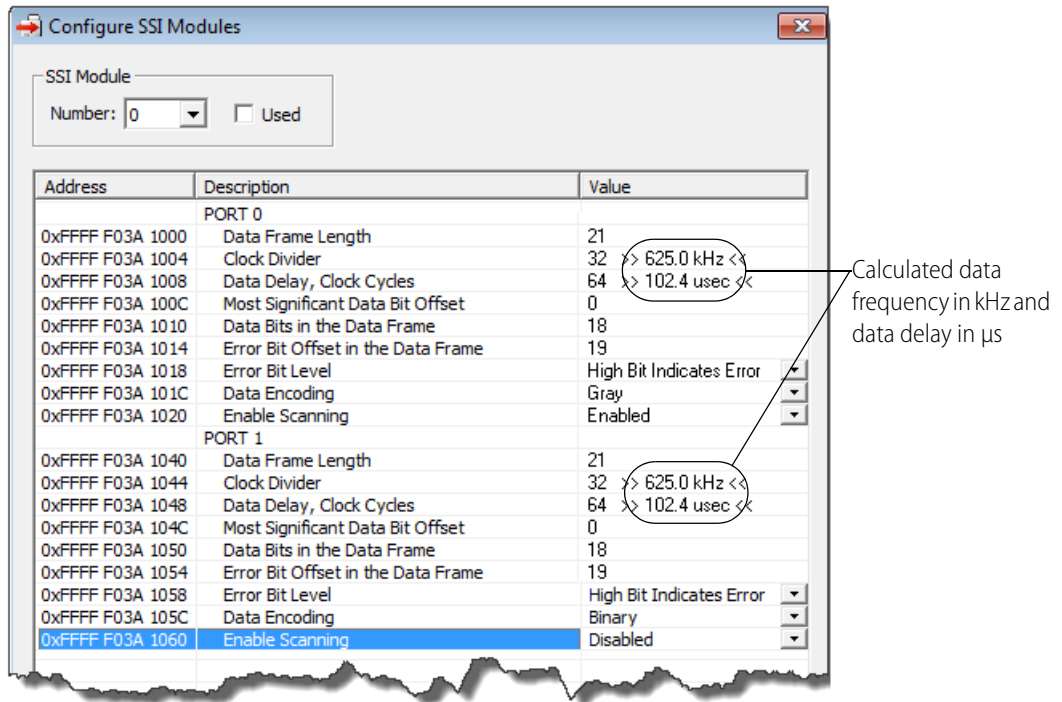
From this data we calculate the following parameters:

Module Position on Rack (0–15):		5
Configuration Parameter	Port 0 value	Port 1 value
Data Frame Length		21
Clock Divider		32
Data Delay in Clock Cycles		64
Most Significant Data Bit Offset		0
Data Bits in the Data Frame		18
Error Bit Offset in the Data Frame ^{1, 2}		19
Error Bit Level		High is Error
Data Encoding		Gray

1. Error bit 2. Only one error bit can be monitored. In this example, for error bit 1, error bit offset = 18; for error bit 3, error bit offset = 20.

2. If your encoder has no error bit, use a value of -1.

When we've entered the values and enabled scanning, the PAC Manager configuration window looks like the following:



Reading Data from the I/O Unit

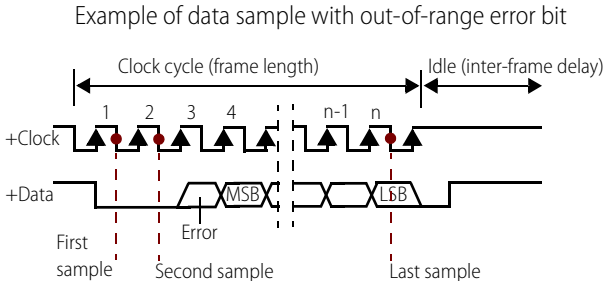
You can read data from the SSI module as counts and as scaled units. Both values are in an IEEE 754 32-bit floating point format. (For details about this format, see the *PAC Manager User's Guide*.)

You can see the data in PAC Manager for testing purposes. You can use the data in a PAC Control strategy or in a custom program you've written using the OptoMMP protocol. A Modbus/TCP client can also read and use the data.

NOTE: If the error bit is in an error state, the module will read -8388608.

How the SNAP-SCM-SSI Samples Data

The SSI module outputs a high clock signal during idle, and it samples SSI data on falling edges of the clock, starting after the first rising edge. The following diagram shows details.



Control Considerations

Both counts and scaled unit data from the SSI module are in an IEEE 754 32-bit floating point format. The scaled units represent a proportional value of measurement. The value is normalized to a 24-bit transducer, even though the actual transducer may have different bits of resolution.

In our example, the transducer we’re using has 21 bits of data resolution. The maximum reading can be calculated by this formula:

$$\text{Maximum Reading} = \frac{1}{(2^{(24 - \text{Bits of Data Resolution})})}$$


In our transducer example from [page 7](#), the maximum reading value is:

$$0.125 = \frac{1}{(2^{(24 - 21)})}$$

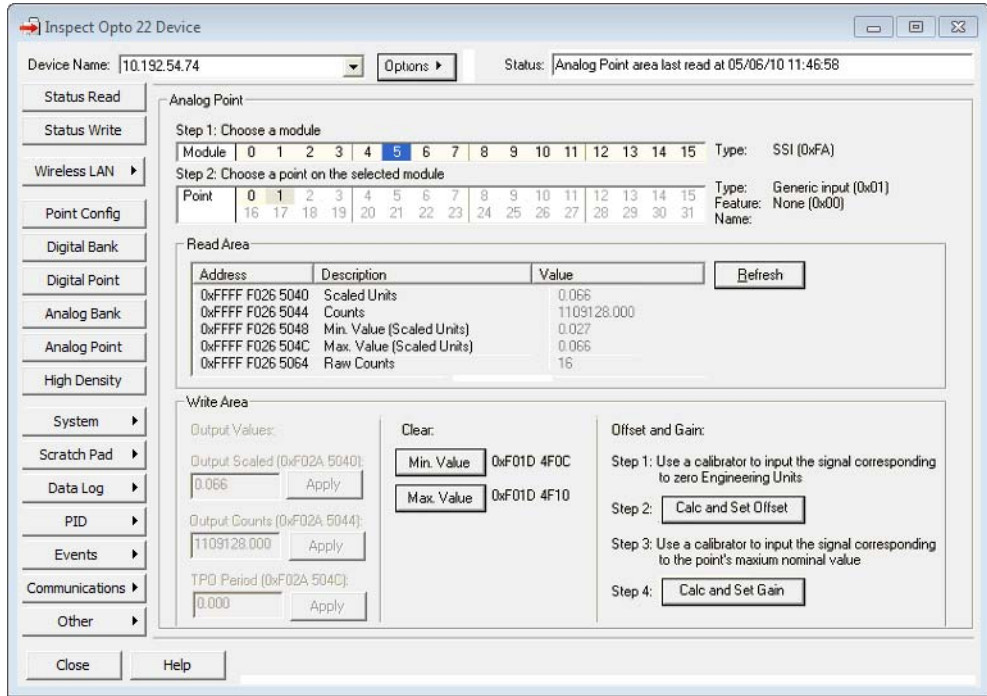
When the transducer exceeds the limit of measurement, a value of zero is reported (whether off-scale high or off-scale low). Due to this limitation, the probe should be installed in such a way that the measured displacement never reaches an off-scale value. If an off-scale value is reported, the control or monitoring system should consider it a fault.

Reading Data in PAC Manager

Once the module parameters are configured, the I/O unit immediately begins reporting data from the transducer. You can see the data in PAC Manager’s Inspect window.

1. If PAC Manager isn’t open, choose Start > Programs > Opto 22 > PAC Project > PAC Manager.
2. Click the Inspect button  or choose Inspect from the Tools menu.
3. In the Device Name field, type the IP address or name of the I/O unit.
4. Click Analog Point. This is where SSI module values are displayed. Choose the module position and point (port) 0 or 1.

Our example was port 1 on module position 5, so we chose module 5 and point 1 in the Inspect window. Here’s how the data looks (see next page).



Both the counts and scaled units are displayed. Both values appear in an IEEE 754 32-bit floating point format (for more information, see the *PAC Manager User's Guide*).

Reading Data in PAC Control or OptoMMP Protocol

If you are reading data from the module using PAC Control or the OptoMMP protocol, you will use memory map addresses.

For either PAC Control or the OptoMMP protocol, you can use PAC Manager's Inspect window to determine the memory map address. In our example above, for the SSI module installed in position 5, port 1, you can see that reading a float at address F0265040 would retrieve the Scaled Units value.

PAC Control does not have specific commands for these modules, and the SNAP-SCM-SSI is not a module type you can select in the PAC Control debugger. Use the I/O Unit—Memory Map command “Read Number from I/O Unit Memory Map” in PAC Control.

Reading Data using Modbus/TCP

The data presented by the SNAP-SCM-SSI is available to a Modbus/TCP client. When accessing the I/O unit's Modbus/TCP server, use these equations to determine the holding register location:

$$\text{First Holding Register} = 1 + 2 * ((4 * [\text{Module Number}]) + [\text{Port Number}])$$

$$\text{Second Holding Register} = 2 + 2 * ((4 * [\text{Module Number}]) + [\text{Port Number}])$$

In our example, where the SNAP-SCM-SSI is installed in module position 5 and using port 1, here are the completed equations:

$$\text{First Holding Register} = 1 + 2 * ((4 * 5) + 1) = 43$$

$$\text{Second Holding Register} = 2 + 2 * ((4 * 5) + 1) = 44$$

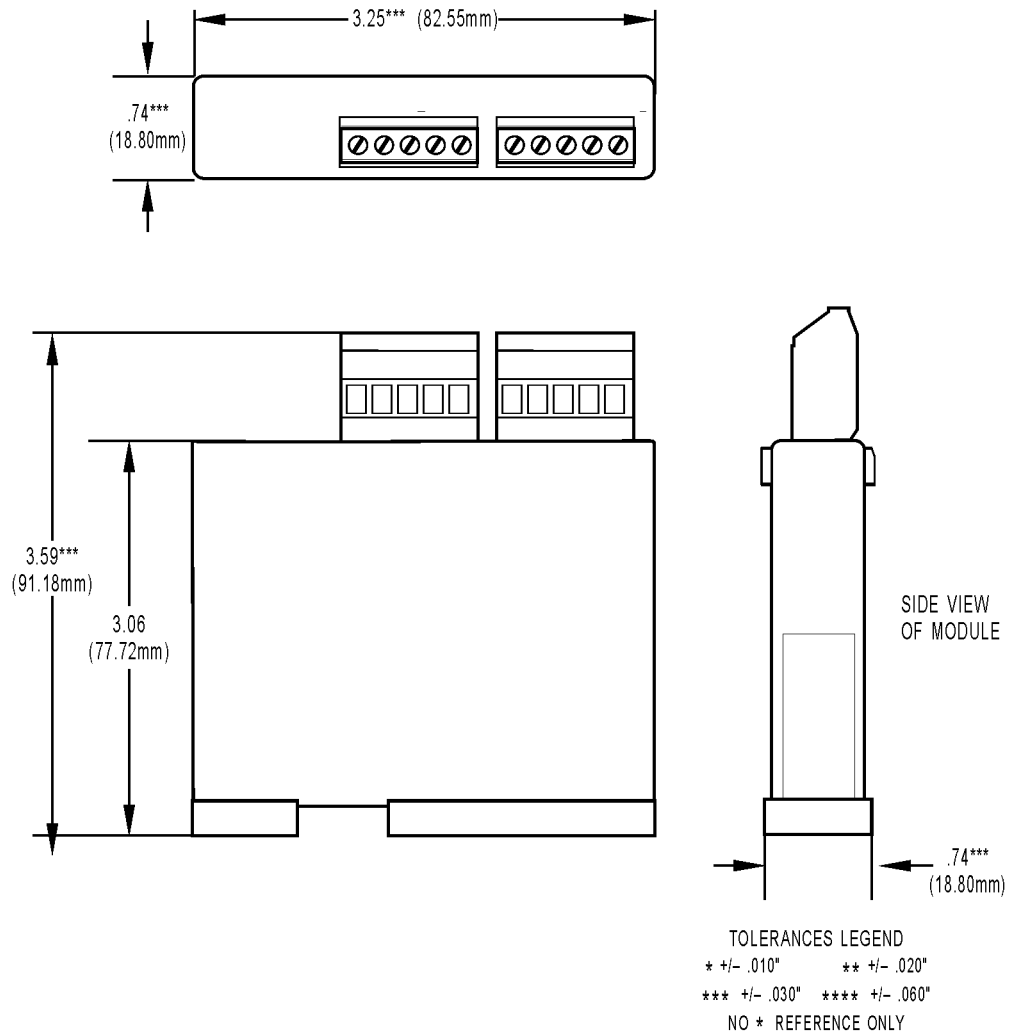
Note that holding registers are 4X, so in the Modbus/TCP client, you would read the holding register pair 40043 and 40044 as a swapped 32-bit float number.

2: Specifications and Additional Information

Specifications

Maximum SSI clock frequency	2.5 MHz
Channel-to-channel isolation	1500 VAC
Logic supply voltage	5.0 VDC
Logic supply current	200 mA DC
Compatible I/O processors	SNAP PAC R-series controllers and SNAP PAC EB or SB brains with firmware 8.5c or newer
Number of ports per module	2
Max. number of modules per rack	8
Max. data resolution	24 bits
Maximum cable length	500 feet at 200kHz using twisted-pair, 24-gauge shielded cable with an additional pair for common (three pairs total)
Operating temperature	-20 to 60 °C
Storage temperature	-30 to 85 °C
Torque, hold-down screws	4 in-lb (0.45 N-m)
Torque, connector screws	5.26 in-lb (0.6 N-m)
Agency approvals	CE, RoHS, DFARS
Warranty	30 months from date of manufacture

Dimensional Diagram



Configuration Tables

Use these tables to note configuration values you calculate and obtain from the transducer manufacturer's data sheet (see "Calculating Configuration Parameters for PAC Manager" on page 4).

Module Position on Rack (0–15): _____		
Configuration Parameter	Port 0 value	Port 1 value
Data Frame Length		
Clock Divider		
Data Delay in Clock Cycles		
Most Significant Data Bit Offset		
Data Bits in the Data Frame		
Error Bit Offset in the Data Frame ^{1, 2}		
Error Bit Level		
Data Encoding		

1. First error bit. Only one error bit can be monitored.
2. If your encoder has no error bit, use a value of -1.

Module Position on Rack (0–15): _____		
Configuration Parameter	Port 0 value	Port 1 value
Data Frame Length		
Clock Divider		
Data Delay in Clock Cycles		
Most Significant Data Bit Offset		
Data Bits in the Data Frame		
Error Bit Offset in the Data Frame ^{1, 2}		
Error Bit Level		
Data Encoding		

1. First error bit. Only one error bit can be monitored.
2. If your encoder has no error bit, use a value of -1.

Removing a SNAP I/O Module

To remove a SNAP I/O module, use the tool that came with the module.

1. Turn off power to the rack.

WARNING: Make sure power is off before continuing, or you will severely damage the module.

2. Remove the module's hold-down screws.
3. Holding the SNAP module tool as shown in the illustration at right, insert it into the notch at the base of the module.

NOTE: If you are facing the rack with the processor on the left side, the notch is on the back of the module, where the module meets the rack.

4. Squeeze the module tool against the module to open the release latch, and pull straight up on the module to remove it.

