SNAP IO4AB LEARNING CENTER USER'S GUIDE

Form 1798-090824—August 2009

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SNAP IO4AB Learning Center User's Guide
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Table of Contents

1: Welcome 1

Using this Guide 1

Documents and Online Help 2

Additional Resources for EtherNet/IP 2

Product Support 3

2: Setting Up the SNAP IO4AB Learning Center 5

What You Will Need 5

What's Included 6

Installing the SNAP-PAC-RCK8 Rack 7

Install the DIN-Rail Clips 7

Install the SNAP Rack Extrusion and the DIN-rail Clip Assembly 8

Install the SNAP Rack in the Rack Extrusion 8

Connecting the Power Supply 9

Installing the SNAP PAC Brain 10

Installing the SNAP I/O Modules 11

Removing a SNAP I/O Module 13

Connecting the SNAP Modules to the Wiring Harness 14

Connecting the Temperature Sensor 15

Connecting the Power Cable 16

Connecting the Remote SNAP I/O 16

Installing EtherNet/IP Configurator 17

Resetting the Brain 17

3: Lessons Using Implicit Messaging 19

Introduction 19

Contents 19

What You Will Need 20
Lesson 1: Establishing Communications 20
Configuring the Intelligent Remote I/O Unit 20
Adding the SNAP-PAC-EB1 20
Adding the Modules 23
Configuring the Points 25
Creating Assembly Instances 27
Saving and Downloading the Configuration 32
Configuring RSLogix 5000 and Running the Program 33
Setting Up Communications in RSLogix 5000 33
Viewing the Controller Tags 37
Using Ladder Logic to Turn on an Output from an Input and Show Temperature in Engineering Units 39
Downloading and Running the Program 42
Summary of Lesson 1 43
Lesson 2: Using Intelligent Discrete I/O Functions 43
Configuring the Additional Point and Assemblies 44
Using a Counter 49
Using a Watchdog 51
Using the Pulse Generator 54
Watching the Pulse in RSLogix 5000 57
Summary of Lesson 2 58
Lesson 3: Using Intelligent Analog I/O Functions 59
Configuring the I/O Unit 59
Configuring the Points on the SNAP-AIV Input Module 62
Configuring the Assemblies 63
Setting Up RSLogix 5000 68
Using Analog Output 72
Summary of Lesson 3 74
Lesson 4: Using Distributed PID Loop Control 74
Configuring the ICTD Temperature Probe 74
Configuring RSLogix 5000 79
Controlling the Setpoint 81
About PID Loops 83
Summary of Lesson 4 84
What's Next? 84

A: Supported Allen-Bradley Platforms 85

1: Welcome

Welcome to the *SNAP IO4AB Learning Center User's Guide*. Inside you'll find instructions on how set up your Learning Center as well as hands-on lessons for you to experience configuring and using implicit messaging via EtherNet/IP™ between an Allen-Bradley® Logix controller and Opto 22's intelligent remote SNAP PAC I/O™.

This guide assumes that you are already familiar with how to use Allen-Bradley's RSLogix 5000 software to configure Allen-Bradley devices.

Using this Guide

Chapter 1: Welcome (this chapter)—Provides information about this guide, where to find additional information, and how to reach Opto 22 Product Support.

Chapter 2: Setting Up the SNAP IO4AB Learning Center—Details what's included in the Learning Center, how to assemble it, and how to install the EtherNet/IP Configurator software.

Chapter 3: Lessons Using Implicit Messaging—Provides hands-on lessons for you to experience setting up implicit messaging between the Learning Center's I/O unit and your own Allen-Bradley controller.

Documents and Online Help

For more information on the hardware included in the SNAP IO4AB Learning Center and the EtherNet/IP protocol, see the following Opto 22 documentation.

For this information	See this guide	Form
Installing and using SNAP PAC brains	*SNAP PAC Brain User's Guide*	1690
Wiring, specifications, and installation information for SNAP Analog Input Modules	*SNAP Analog Input Modules Data Sheet*	1065
Wiring, specifications, and installation information for SNAP Analog Output Modules	*SNAP Analog Output Modules Data Sheet*	1066
Wiring, specifications, and installation information for SNAP Digital Input Modules	*SNAP Digital Input Modules Data Sheet*	0773
Wiring, specifications, and installation information for SNAP Digital Output Modules	*SNAP Digital Output Modules Data Sheet*	1144
Setting up EtherNet/IP messaging between an Allen-Bradley® Logix™ controller and Opto 22's SNAP I/O, using the EtherNet/IP commands that can be accessed when using remote Opto 22 I/O with an Allen-Bradley controller	*EtherNet/IP for SNAP PAC Protocol Guide*	1770

All documents are available on our website, www.opto22.com. The easiest way to find a document is to search on its form number.

Additional resources are also available on the Opto 22 Web site such as a demonstration video that shows how easy it is to configure and program an Allen-Bradley controller to talk to SNAP I/O. If you are viewing this document online and have an internet connection, click the image.

Additional Resources for EtherNet/IP

For an overview of CIP and EtherNet/IP technology, see http://www.odva.org/Portals/0/Library/Publications_Numbered/PUB00138R2_CIP_Adv_Tech_Series_EtherNetIP.pdf

For information on the network infrastructure for EtherNet/IP, see http://www.odva.org/Portals/0/Library/Publications_Numbered/PUB00035R0_Infrastructure_Guide.pdf

For a good starting point for Ethernet/IP research on the ODVA web site, see http://www.odva.org/default.aspx?tabid=67

Product Support

If you have any questions about using EtherNet/IP to communicate with Opto 22 devices, you can call, fax, or email Opto 22 Product Support. Product support is free.

Phone:	800-TEK-OPTO (835-6786) 951-695-3080 (Hours are Monday through Friday, 7 a.m. to 5 p.m. Pacific Time)
Fax:	951-695-3017
Email:	support@opto22.com
Opto 22 website:	www.opto22.com

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

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

- PC configuration (type of processor, speed, memory, and operating system)
- RSLogix 5000 version
- Allen-Bradley PLC model
- Specific error messages seen.

2: Setting Up the SNAP IO4AB Learning Center

This chapter describes what's included in the SNAP IO4AB Learning Center, how to assemble it, and how to install the EtherNet/IP Configurator software.

It includes the following topics:

"What You Will Need" on page 5 (below)

"What's Included" on page 6

"Installing the SNAP-PAC-RCK8 Rack" on page 7

"Installing EtherNet/IP Configurator" on page 17

What You Will Need

- A computer with at least the minimum processor required for your version of Microsoft Windows (1 GHz Pentium®-class or better recommended) and Ethernet capability
- VGA or higher resolution monitor
- Mouse or other pointing device
- Microsoft Windows Vista® Business (32-bit), Windows XP (with Service Pack 2) or Windows 2000® (with Service Pack 4) workstation operating system. Microsoft Windows server and 64-bit versions of Windows workstation operating systems are not supported.
- At least 1 GB RAM for Windows Vista, or at least 512 MB for Windows XP or Windows 2000
- RSLogix 5000, version V13 or later installed on your computer
- Three CAT-5 Ethernet cables
- Allen-Bradley controller that supports EtherNet/IP with an Ethernet port or an Ethernet adapter module connected to the network. The Allen-Bradley controller must support implicit messaging, also called *I/O messaging*. See "A: Supported Allen-Bradley Platforms" on page 85.
- IGMP enabled, managed industrial Ethernet switch. EtherNet/IP implicit messages are multicast, and a managed switch configured for IGMP Snooping filters these messages appropriately.

NOTE: If you use the Learning Center only as a learning tool (that is, not in an actual installation or as part of any other network), any switch (managed or unmanaged) will suffice.

What's Included

The SNAP IO4AB Learning Center includes the following items:

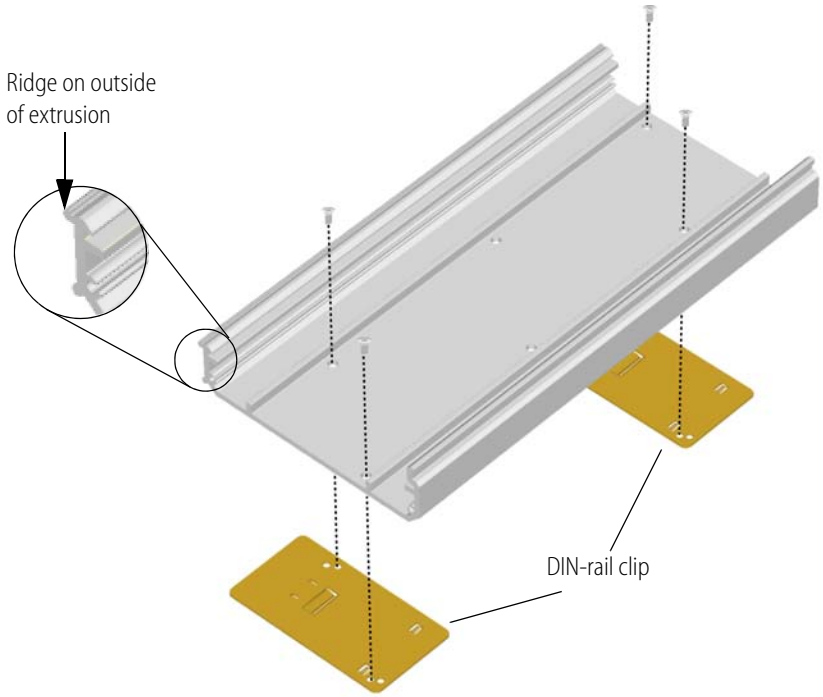
Component	Description	Graphic
SNAP-PAC-EB1	I/O and communications processor for your Allen-Bradley Logix systems	
SNAP-PAC-RCK8 Rack	Mounts up to eight SNAP digital, analog, and serial modules	
SNAP I/O Modules (5)	Includes the following five modules: • SNAP-IDC5D: Digital DC Input 2.5–28 VDC, 5 VDC Logic • SNAP-ODC5SRC: Digital DC Output 5–60 VDC Source, 5 VDC Logic • SNAP-AOV27: Analog Output Dual -10 to +10 VDC • SNAP-AICTD: Analog Input Dual ICTD Temperature • SNAP-AIV: Analog Input Dual ±10 or ±5 VDC	
Learning Center Load Panel	The load panel consists of: • Two toggle switches • Two momentary switches • One buzzer • Three LEDs • One meter • One potentiometer • Temperature sensor connection	
Temperature probe	The ICTD temperature probe on your Learning Center is actually a PID (Proportional Integral Derivative) Simulator, which has—in addition to the ICTD—a resistor that heats up the probe to simulate a real world process.	
Power cable	Input voltage range for the Learning Center is 120–300 VAC. A power cable is included based on your location (U.S., international, or UK). If you find that the cable you have is incorrect, please call Opto 22 at 800-321-6786 (toll-free in the U.S.) or 951-695-3000 to request the correct one. For more Product Support contact information, see "Product Support" on page 3.	
SNAP rack extrusion	For mounting the SNAP rack	
DIN-rail clips (2)	For mounting the rack assembly to the DIN-rail	
SNAP module tool	For removing a SNAP module	

Component	Description	Graphic
Phillips and flat blade screwdrivers	For assembling the SNAP IO4AB Learning Center	
Software installation CD	Contains EtherNet/IP Configurator software	

Installing the SNAP-PAC-RCK8 Rack

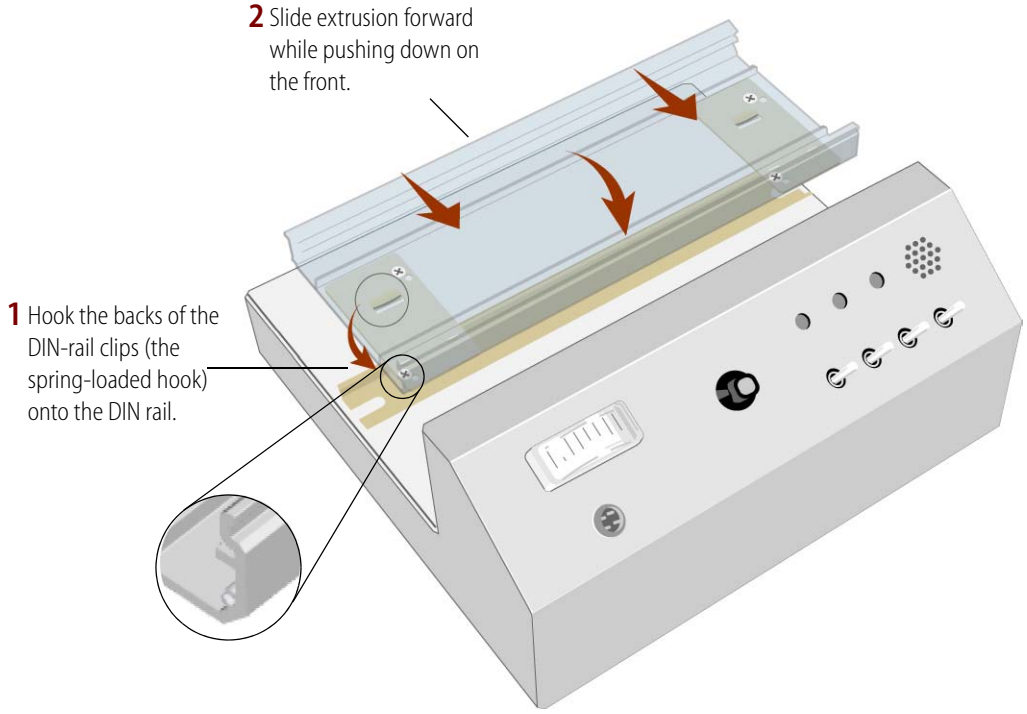
Install the DIN-Rail Clips

1. Align the DIN-rail clips, extrusion, and the mounting screws as shown in the following diagram, and then install the screws.



Install the SNAP Rack Extrusion and the DIN-rail Clip Assembly

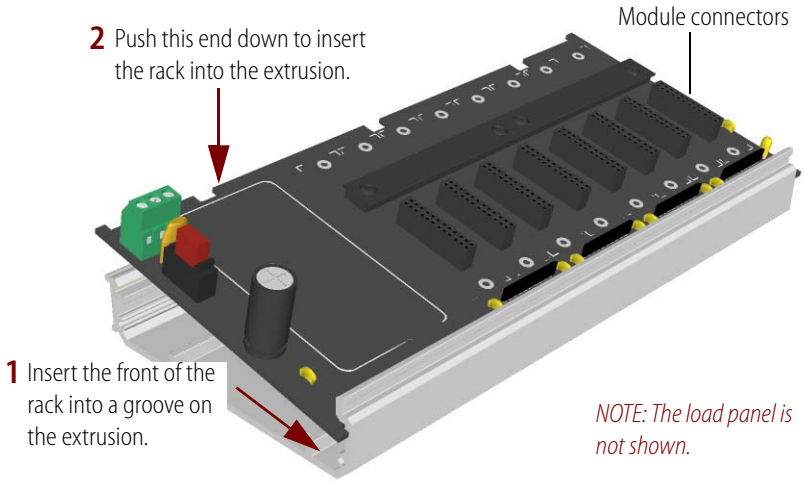
1. Align the extrusion so that the taller lip is closest to the Learning Center load panel and the lower edge is towards the back, as shown in the next illustration.
2. Hang the fixed end of each DIN-rail clip over the top edge of the DIN rail.
3. Position the extrusion and clip assembly flat against the DIN rail.
4. Apply pressure to the bottom of the extrusion and clip assembly to snap it into position on the Learning Center's DIN rail.



Install the SNAP Rack in the Rack Extrusion

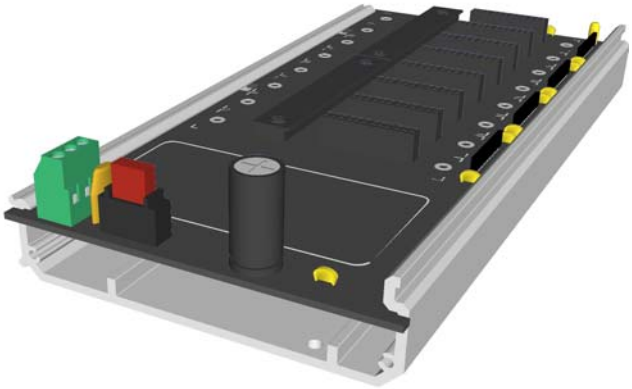
1. Orient the circuit board so that the module connectors are at the bottom and the circuit board release notches on the circuit board are at the top.
2. Align the bottom edge of the circuit board with the top groove in the extrusion above the DIN-rail clip release holes as shown in the illustration below.

3. Press the top of the circuit board against the extrusion and snap the board into the groove on the top side of the extrusion. (It's okay to push hard.)



NOTE: The load panel is not shown.

A correctly inserted rack appears as shown here:

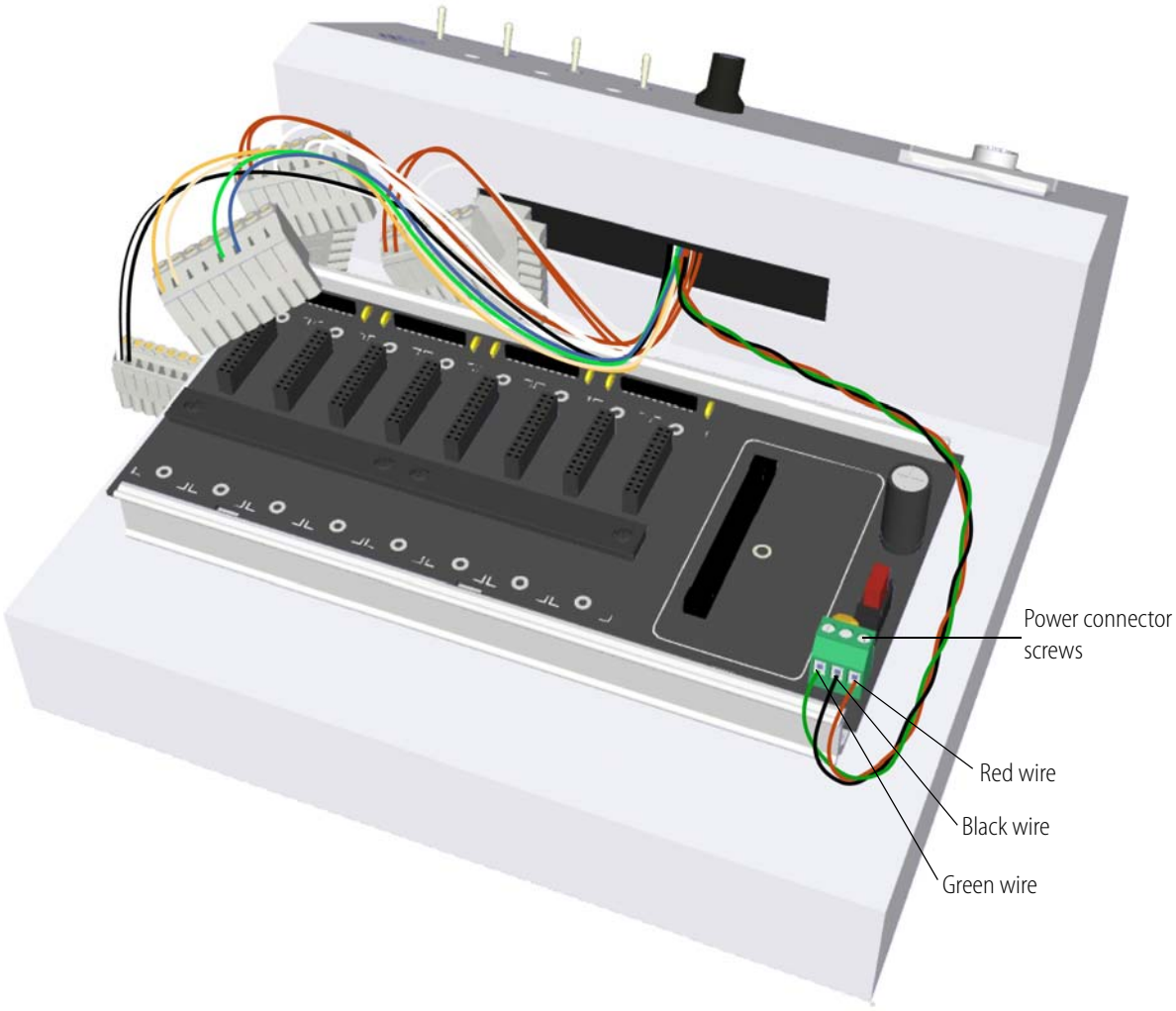


NOTE: The load panel is not shown.

Connecting the Power Supply

1. Locate the wire harness behind the load panel of the Learning Center.
2. Locate the red, black, and green wires that have bare leads at one end.
3. Connect the red wire to the +5V connection on the SNAP-PAC-RCK8 rack, and tighten its power connector screw. See the diagram below.
4. Connect the black wire to the -5V connection and tighten its screw.

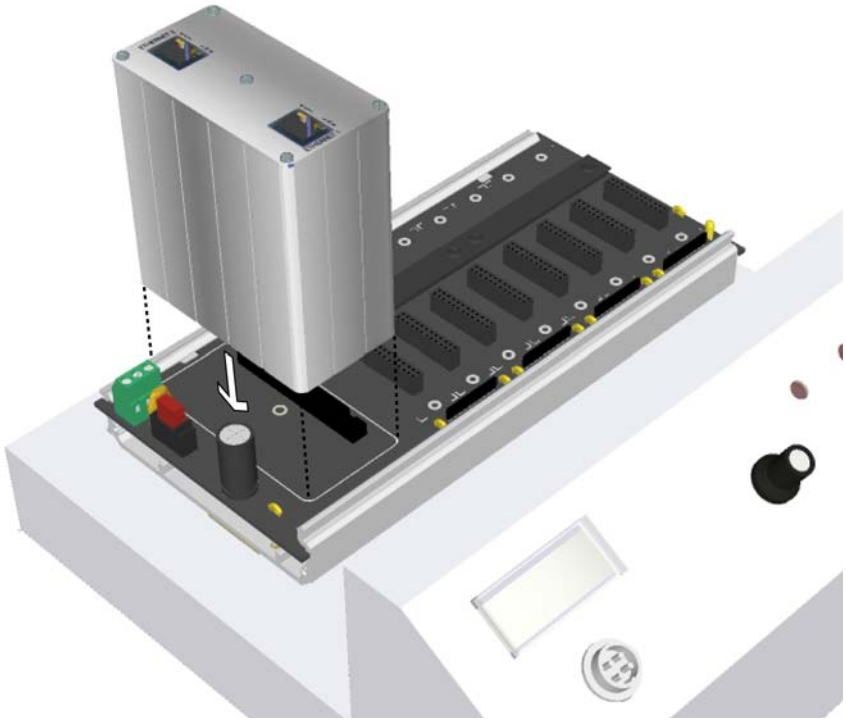
5. Connect the green wire to the ground connector and tighten its screw.



Installing the SNAP PAC Brain

1. Remove the SNAP PAC brain from its packaging.
2. Align the brain's connector with the mating connector on the SNAP rack as shown in the following illustration.
3. Seat the brain onto the connector.
4. Tighten the hold-down screw to secure the brain in position.

CAUTION: *Do not overtighten the hold-down screw. Doing so may damage the connector, the brain, or other components on the SNAP rack.*



Installing the SNAP I/O Modules

1. Remove the five SNAP I/O modules from their packaging.
2. Remove the screw terminal connectors from the tops of the modules and set them aside.

   You will not use the terminal connectors that came with the modules, as the Learning Center has already been wired for you.
3. Install the modules on the SNAP rack in the order shown in the table below.

SNAP Module	Position on SNAP Rack
SNAP-IDC5D	0
SNAP-ODC5SRC	1
SNAP-AOV-27	2
SNAP-AICTD	3
SNAP-AIV	4

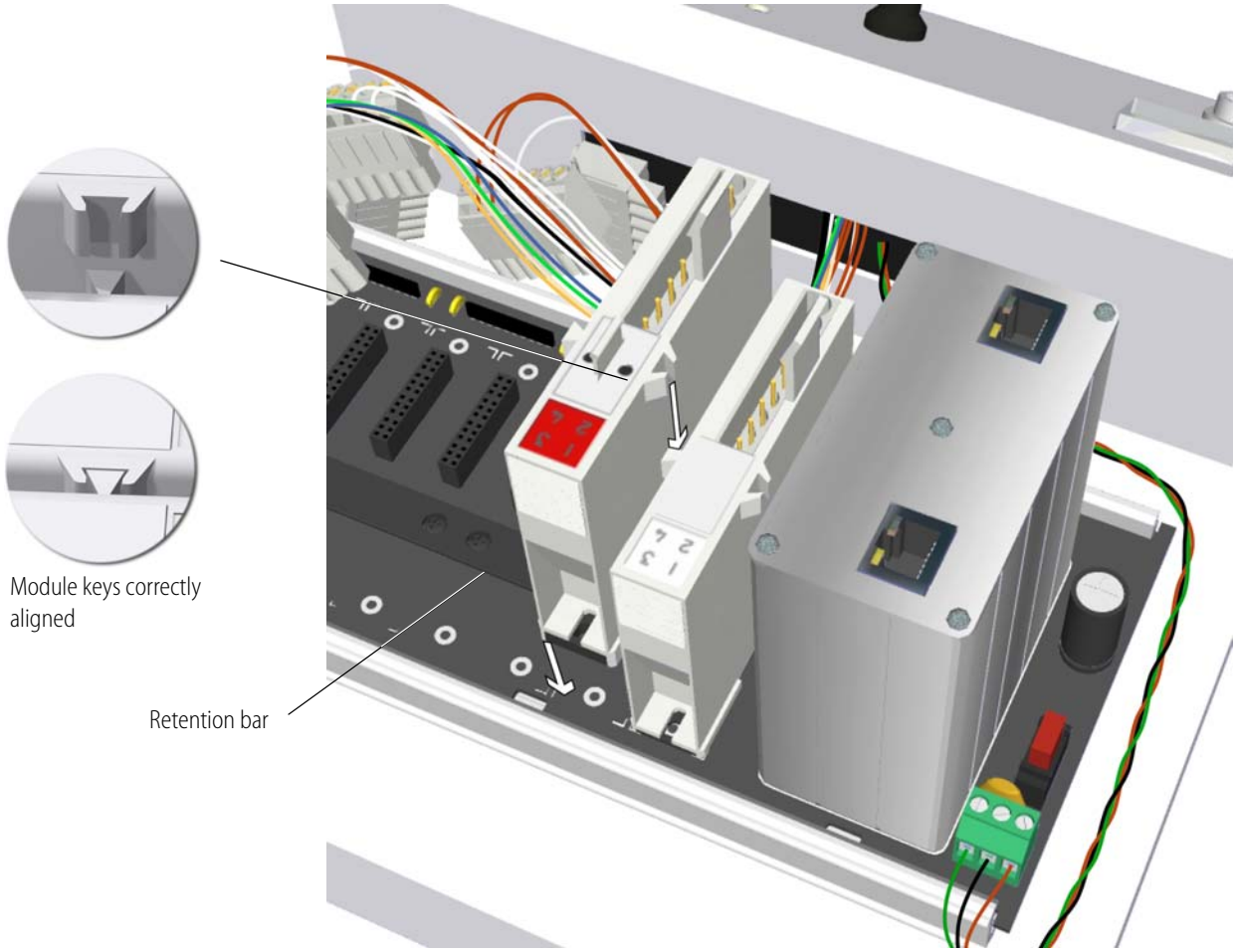
Module positions are labeled on the SNAP rack. Also, the module positions are in numerical order from left to right as you face the load panel.

To install each SNAP I/O module on the SNAP rack, follow these steps:

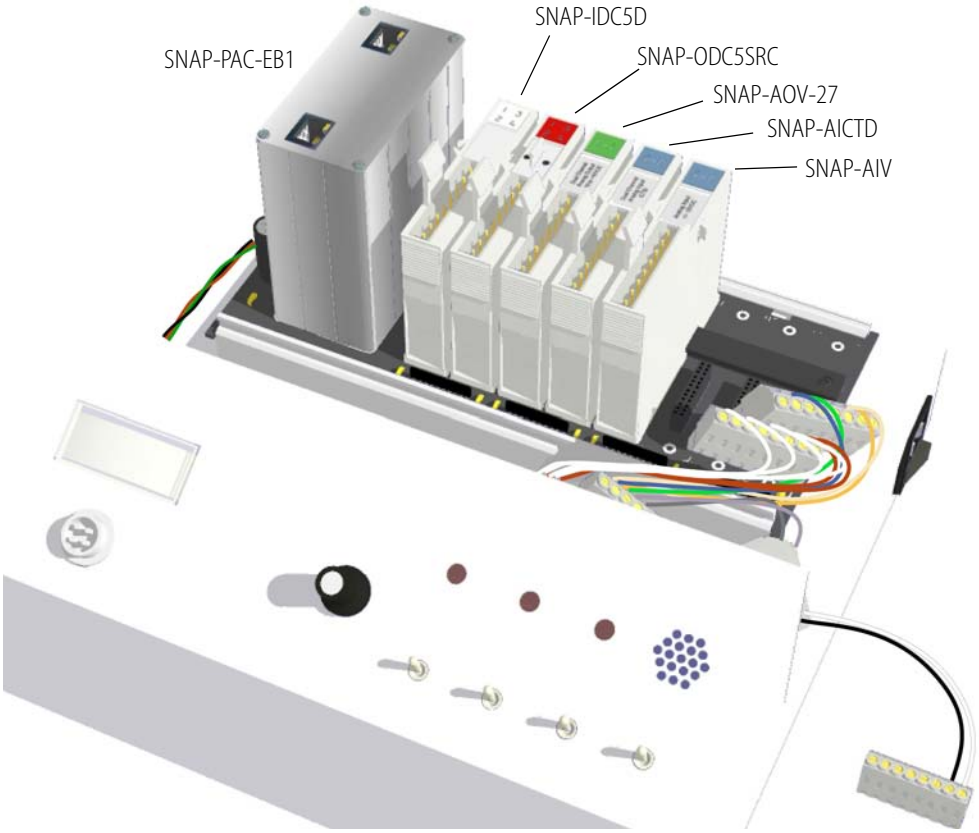
a. Position the module over the connector, aligning the small slot at the base of the module with the retention bar on the rack.

b. With the module correctly aligned over the connector, push straight down on the module to snap it into position.

When positioning modules next to each other, be sure to align the male and female module keys (shown in the detailed view in the illustration below) before snapping a module into position.



Your Learning Center should now resemble the illustration below. If a module is positioned incorrectly, remove it (see "Removing a SNAP I/O Module" on page 13), and then reinstall it.



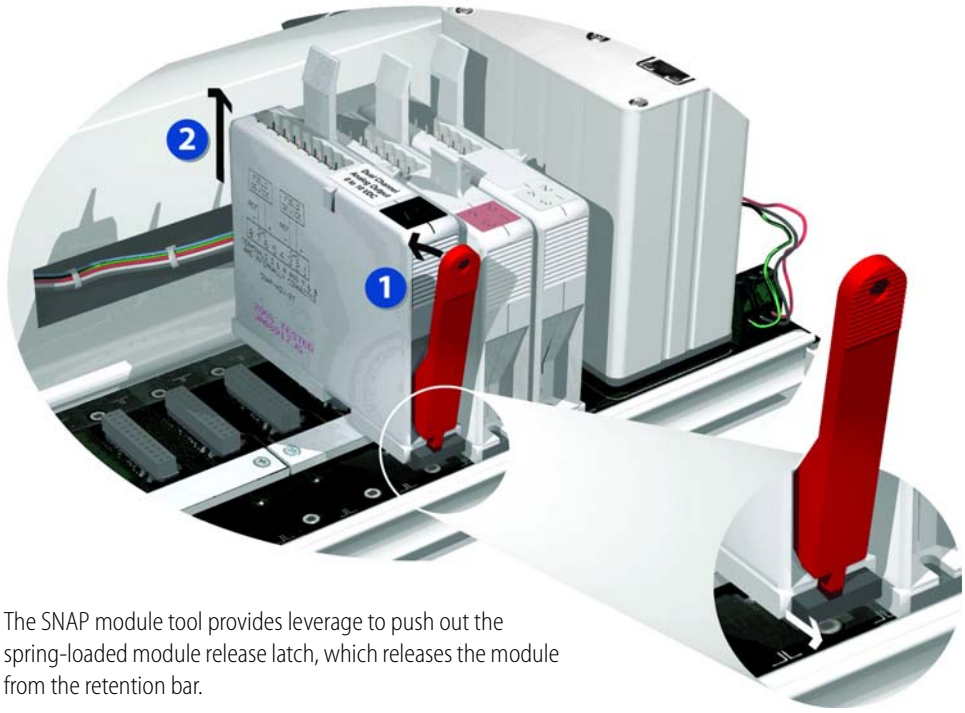
Removing a SNAP I/O Module

If you insert a module in the wrong location, you can remove it as follows:

1. Use the SNAP module tool shown in the next illustration to retract and hold the release latch at the base of the module.

   Note that the release latch is located on the end of the module facing the back of the Learning Center.

2. While holding open the release latch with the SNAP module tool, pull straight up on the module to remove it.

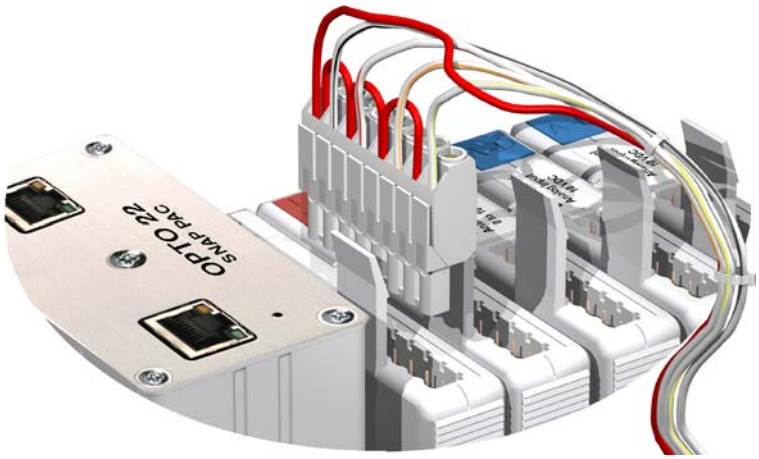


The SNAP module tool provides leverage to push out the spring-loaded module release latch, which releases the module from the retention bar.

Connecting the SNAP Modules to the Wiring Harness

Snap the screw terminal connectors on the Learning Center's wiring harness into the SNAP modules as follows:

1. Plug the first connector to branch off from the wiring harness (after the power wires) into the first module, the SNAP-IDC5D.



2. Plug subsequent connectors that branch off the wiring harness into the remaining modules. Note that the connectors are on different lengths of wire to help indicate which connector goes with each module. (The shortest wire corresponds to slot 0.)
3. Carefully double-check your connections by comparing them with the following list of SNAP modules and the corresponding wire.

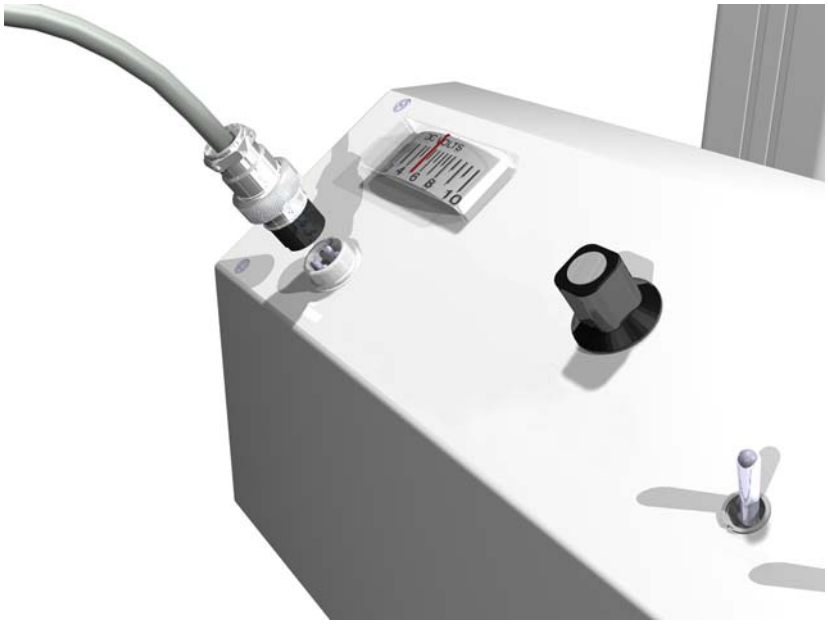
SNAP Module	Wire Colors for Corresponding Connector on Wiring Harness
SNAP-IDC5D	red, brown/white, red/white, orange/white, yellow/white
SNAP-ODC5SRC	red, red, green/white, blue/white, purple/white, gray/white
SNAP-AOV-27	orange, yellow, green, blue
SNAP-AICTD	gray, purple
SNAP-AIV	white, black

Connecting the Temperature Sensor

The temperature sensor is the cable approximately 3 feet (1 meter) in length with a black plastic tip at one end.

1. Plug the temperature sensor into the jack on the front left-hand side of the Learning Center load panel.

NOTE: The four small prongs in the plug must align with the holes in the jack.



2. Tighten the threaded collar.

Connecting the Power Cable

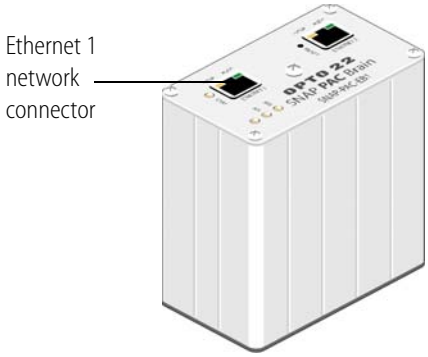
To connect the power cable to the SNAP IO4AB Learning Center, plug the cable into the power cord connector located on the right side of the Learning Center base.

NOTE: Don't turn on the Learning Center until instructed to do so in the next chapter.

Connecting the Remote SNAP I/O

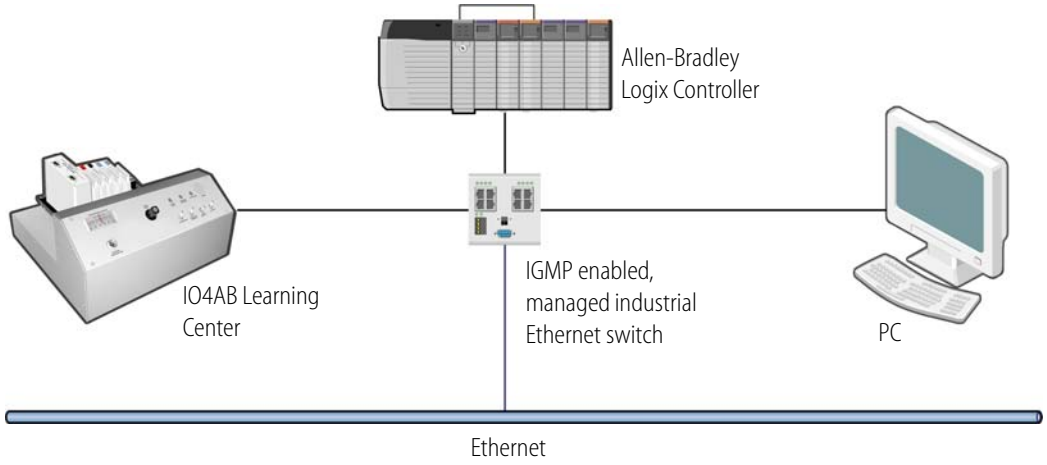
Connect the assembled Learning Center, an Allen-Bradley Logix PLC, and a personal computer, to an Ethernet network (see note) as illustrated below.

Plug one end of a CAT-5 Ethernet cable into the managed switch and the other end into the Ethernet 1 network connector on the EB1 brain.



NOTE: The Ethernet 2 network connector will not work in this application.

The IP addresses of the SNAP-IO4ABLC, Allen-Bradley Logix PLC, and computer should be on the same subnet. You will set up the IP address on the SNAP-IO4ABLC in "Lesson 1: Establishing Communications" on page 20.



This setup requires some networking expertise. We recommend that first you consult with your network administrator.

Installing EtherNet/IP Configurator

On the PC, insert the CD that came with the Learning Center in your CD-ROM drive. The installation wizard should start automatically. If it doesn't, use Windows Explorer to navigate to your CD-ROM drive and then double-click setup.exe. Follow directions to install the software.

If you have trouble installing the software, contact Opto 22 Product Support. See "Product Support" on page 3.

Resetting the Brain

If the Learning Center has been used previously, you may want to reset the brain.

1. Carefully insert a straightened paperclip or stiff wire into the small hole labeled RESET.
2. Press and hold down the RESET button as described below.

To perform this kind of reset...	...do this	Result
Simple restart	Press and hold the RESET button for less than 1 sec. until the STAT LED turns off, and then immediately release the button. OR Turn off power to the brain and then turn it on again. OR Use PAC Manager to send the brain the "Restart from Powerup" command.	• The brain restarts. • Any files in RAM are erased. If files have been stored to flash memory, they will not be erased.
Restore factory default settings	Press and hold the RESET button for 1 or 2 seconds until the STAT LED turns solid green, and then immediately release the button. Don't hold it down too long.	• The brain restarts. • Files in RAM and flash memory are erased. • IP address is reset to 0.0.0.0 and subnet mask to 255.255.255.0.

CAUTION: *Do not hold down the RESET button too long. If you hold it down longer than five seconds, the brain will enter hardware test mode, which is indicated by the STAT LED blinking orange, rapidly and continuously. Hardware test mode erases all files in RAM and flash memory and resets the IP address. If your brain restarts in hardware test mode, cycle power; the result will be the same as restoring factory default settings (see table above).*

If you hold down the RESET button less than five seconds but longer than the time needed to restore the default settings, the brain will restart in failsafe bootloader mode, which is indicated by the STAT LED

blinking green 7 times quickly. This is a diagnostic mode that you don't need to access unless you are troubleshooting a problem with Opto 22 Product Support. If your brain restarts in failsafe bootloader mode, cycle power; the result will be same as the simple restart described above.

3: Lessons Using Implicit Messaging

Introduction

The hands-on lessons in this chapter allow you to experience setting up implicit messaging between the Learning Center's I/O unit and your own Allen-Bradley controller.

Also known as *I/O messages*, *implicit* messages don't contain requests or responses. They simply contain real-time I/O data. Both the Allen-Bradley PLC and the Learning Center must be configured to agree on the content and format of the I/O data prior to establishing an implicit connection. (For more in implicit messaging, see form 1770, the *EtherNet/IP for SNAP PAC Protocol Guide*.)

In the following lessons you will use EtherNet/IP Configurator to specify the I/O data format on the EB1 brain by configuring assembly object data attributes. Using Allen-Bradley's RSLogix 5000 software, you will configure the Allen-Bradley controller to create a connection to the appropriate assembly instance on the SNAP PAC device and experience some of the advantages of distributed intelligence.

Contents

- "Lesson 1: Establishing Communications" on page 20—using EtherNet/IP Configurator to set up communications between the intelligent remote I/O and RSLogix 5000 and download a configuration
- "Lesson 2: Using Intelligent Discrete I/O Functions" on page 43—using the intelligence of the remote SNAP I/O for counting, pulsing for a direct output, and for setting up a communication watchdog
- "Lesson 3: Using Intelligent Analog I/O Functions" on page 59—using the SNAP-AOV-27 output module and the SNAP-AIV input module to read scaled analog inputs and write a clamp value to an analog output
- "Lesson 4: Using Distributed PID Loop Control" on page 74—configuring and running a distributed PID loop in the Opto 22 intelligent remote I/O
- "What's Next?" on page 84—where to find information to set up your own system

What You Will Need

- SNAP IO4AB Learning Center, fully assembled. See "2: Setting Up the SNAP IO4AB Learning Center" on page 5.
- EtherNet/IP Configurator installed on your computer (see page 17)
- RSLogix 5000, version V13 or later installed on your computer
- A network consisting of the Learning Center, your computer, and an Allen-Bradley controller that supports EtherNet/IP with an Ethernet port or an Ethernet adapter module. The Allen-Bradley controller must support implicit messaging, also called *I/O messaging*. See "A: Supported Allen-Bradley Platforms" on page 85. See also the network diagram on page 16.
- R8.3a or newer firmware

Lesson 1: Establishing Communications

In this lesson you will use EtherNet/IP Configurator to configure the intelligent remote I/O (page 20) and RSLogix 5000 to set up communications with the PLC and run the program (page 33).

At the end of this lesson you will be able to toggle the Limit Switch on the Learning Center and see the corresponding bit in RSLogix 5000 change state. This demonstrates data being exchanged between the SNAP IO4AB Learning Center and the Allen-Bradley controller.

Configuring the Intelligent Remote I/O Unit

Configuring the intelligent remote I/O unit includes the following activities:

"Adding the SNAP-PAC-EB1" (below)

"Adding the Modules" on page 23

"Configuring the Points" on page 25

"Creating Assembly Instances" on page 27

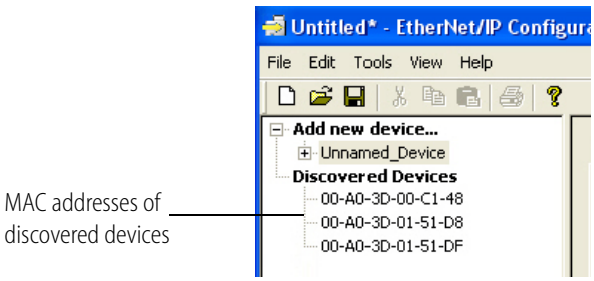
"Saving and Downloading the Configuration" on page 32

Adding the SNAP-PAC-EB1

To add the SNAP-PAC-EB1 to the configuration (and also the network), you will allow EtherNet/IP Configurator to discover the device. Then you will give the discovered device a name, a valid IP address, and a subnet mask.

1. Open EtherNet/IP Configurator by selecting
   Start→All Programs→Opto 22→EtherNet-IP→EtherNet-IP Configurator
2. With the SNAP-PAC-EB1 connected to the network, turn on the Learning Center. The power switch is next to the power cord connection.

When installed and first turned on, the SNAP-PAC-EB1 sends out a BootP broadcast, requesting an IP address. EtherNet/IP Configurator discovers each Opto 22 device on your network that is broadcasting a BootP request and lists the devices in the device tree.

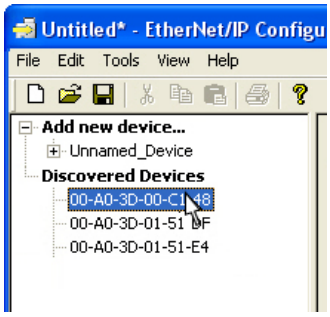


The discovered device is identified by a unique hardware Media Access Control (MAC) address, which is displayed in the device list.

The MAC address is also written on a label attached to the side of the EB1's housing. (An Opto 22 device's MAC address begins with 00.a0.3d.) If no units are listed under Discovered Devices, turn off your Learning Center and then turn it on again.

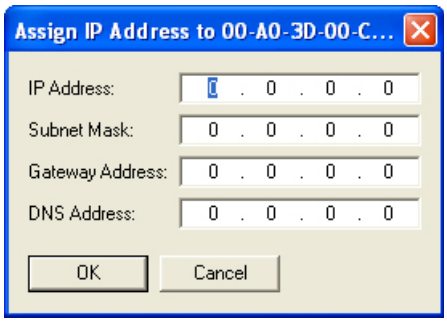
NOTE: If the EB1 is not new, you can reset the device using the reset button to start the BootP request. For more information on resetting the SNAP-PAC-EB1, see "Resetting the Brain" on page 17.

3. When the MAC address of the discovered device appears under Discovered Devices, double-click the MAC address.



CAUTION: *EtherNet/IP Configurator lists ALL Opto 22 devices sending BootP or DHCP broadcasts. Assign IP addresses only to the ones you know are yours!*

The Assign IP Address dialog box appears.



4. Enter the IP Address and the Subnet Mask for the EB1. Leave the Gateway Address and the DNS address all zeros (0.0.0.0).

   NOTE: Make sure the EB1 is on the same subnet as the computer and the PLC.

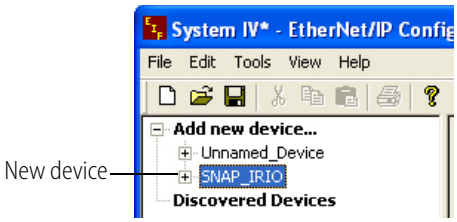
   WARNING! *Each device on your network, including computers, routers, controllers, brains, and so on, must have a unique IP address. Failure to assign unique IP addresses may cause catastrophic network or hardware failures. If you don't know which IP addresses are safe to use, check with your system administrator.*

5. When the IP Address and Subnet Mask fields are correct, click OK.

   The Name This Device dialog box appears with the Device Type, IP Address and Port filled in automatically.

6. Fill in the rest of the dialog box as follows:
   - **Device Name**: SNAP_IRIO
   - **Temperature**: Fahrenheit
   - **Watchdog**: No
7. Click OK.

The EB1 appears in the device tree.

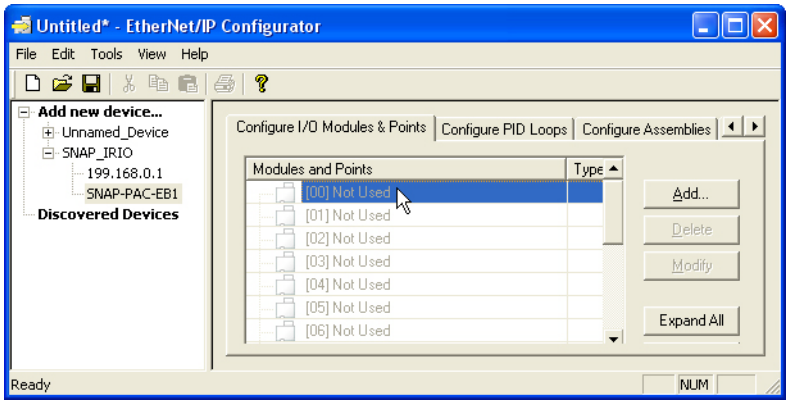


Adding the Modules

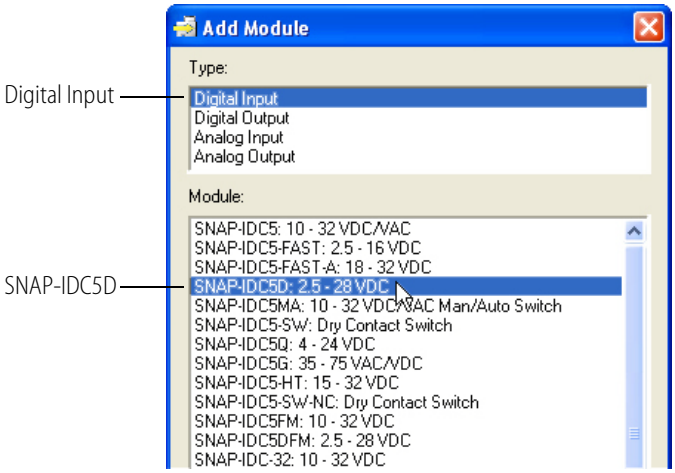
In this activity you will use EtherNet/IP Configurator to add and configure three of the five SNAP I/O modules you already installed in the Learning Center. You must do this in order to configure the modules' points in the next activity.

Position	Type	Module
00	Digital Input	SNAP-IDC5D
01	Digital Output	SNAP-ODC5SRC
03	Analog Input	SNAP-AICTD

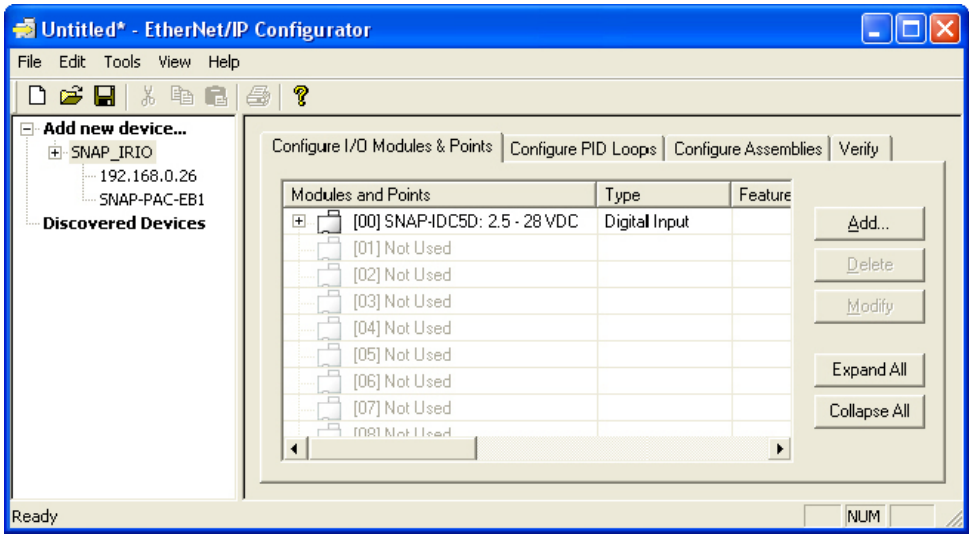
1. In the Configure I/O Modules & Points tab, double-click module 00.



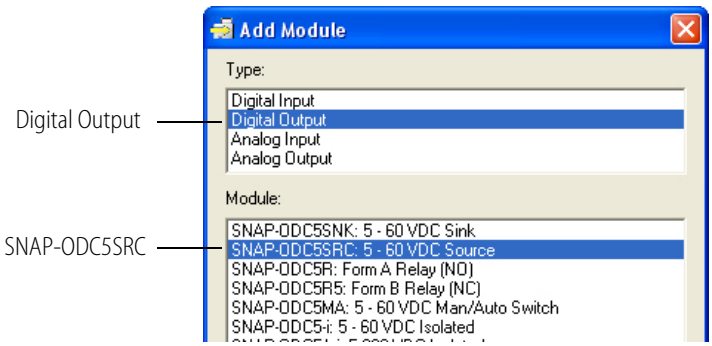
2. In the Add Module dialog box, under Type, select Digital Input, and under Module, select SNAP-IDC5D.



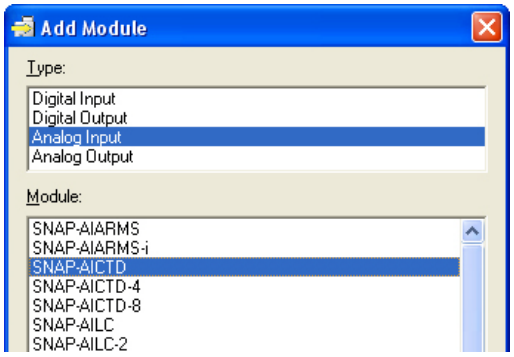
3. Click OK.



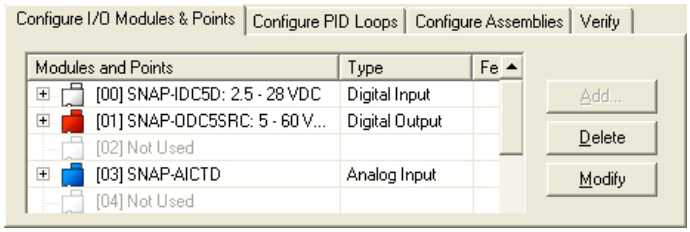
4. In the same manner, add a SNAP-ODC5SRC digital output module at position 01.



5. Finally, add a SNAP-AICTD analog input module in position 03 (not 02).



When finished, the module configuration will look like this:



Notice that the module icons are color-coded by type: white for digital input, red for digital output, blue for analog input.

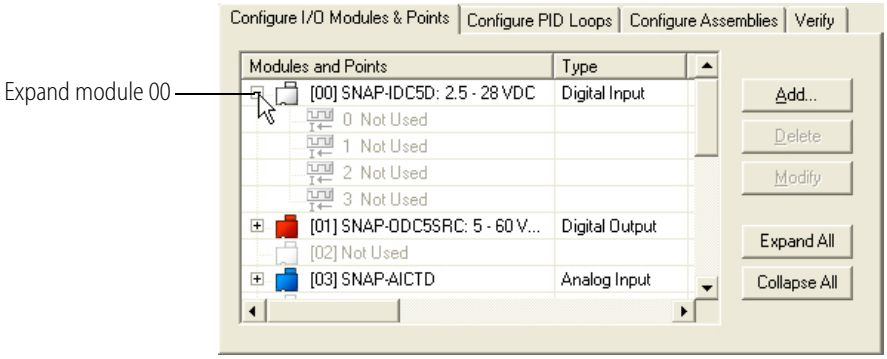
In the next activity you will add points to the modules.

Configuring the Points

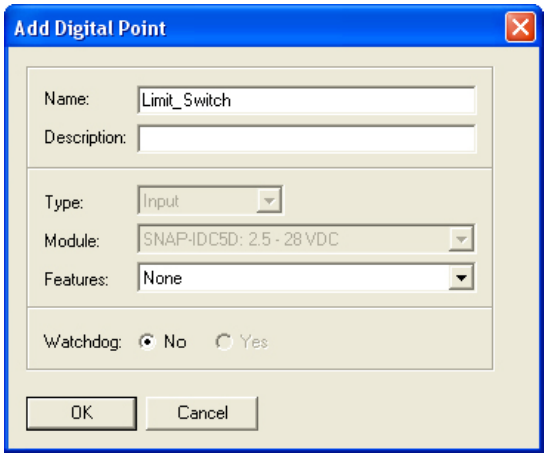
In order to tell the PLC which points to connect to, you will configure the points on the EB1 brain as shown in the following table:

Position	Module	Point	Name
00	SNAP-IDC5D	2	Limit Switch
01	SNAP-ODC5SRC	1	Solenoid
03	SNAP-AICTD	0	Process Temperature

1. On the Configure I/O Modules & Points tab in EtherNet/IP Configurator, expand module 00.

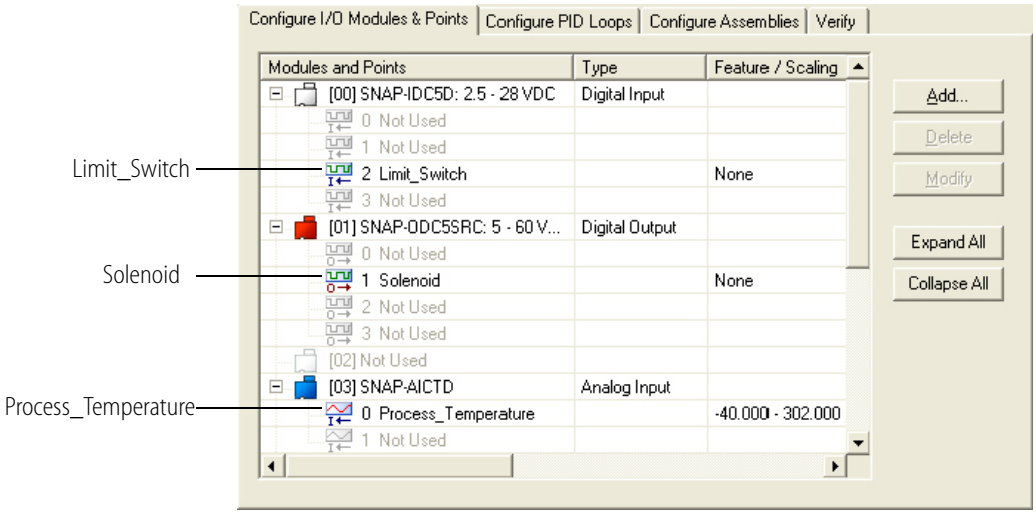


2. Double-click point 2 to open the Add Digital Point dialog box.
3. Name the point Limit_Switch, and then click OK.



4. Expand module 01, and then double-click point 1.
5. Name the point Solenoid, and then click OK.
6. Finally, expand module 3, double-click point 0, and add a new point called Process_Temperature.

When you have finished adding the points for this lesson, the configured modules and points should look like this:



Creating Assembly Instances

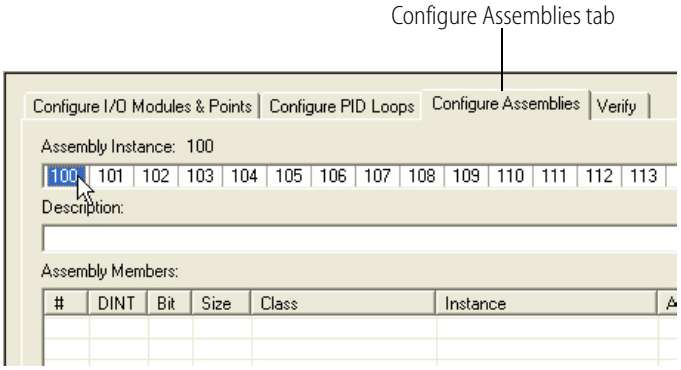
In this section you will create the input assembly instance (page 27) and output assembly instance (page 30).

Creating the Input Assembly Instance

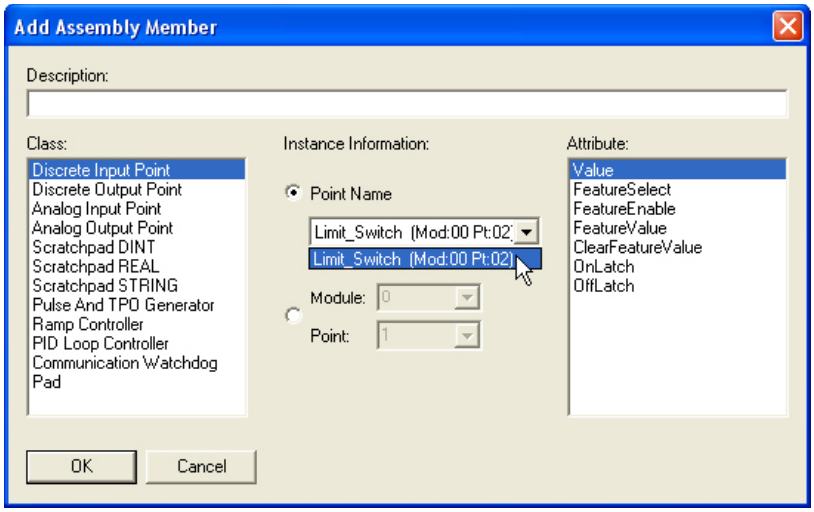
The input assembly instance allows the Allen-Bradley controller to read data from the intelligent remote I/O unit. You will create input instance 100 that has the following members:

#	DINT	Bit	Size	Class	Instance	Attribute
0	0	0	1	Discrete Input Point	Limit_Switch Mod:00 Pt:02	Value
1	0	1	31	Pad		
2	1	0	32	Analog Input Point	Process_Temperature Mod:03 Pt:00	rValue

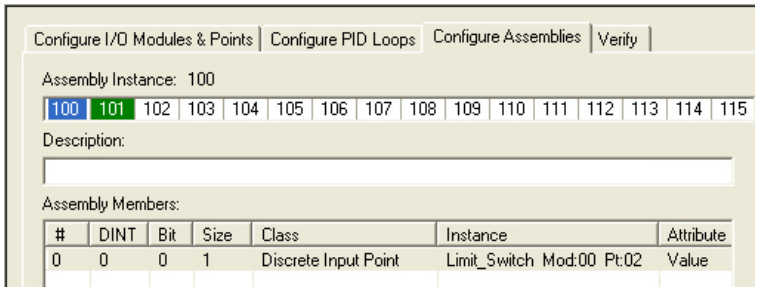
1. In EtherNet/IP Configurator, click the Configure Assemblies tab, and then click assembly instance 100.



2. Click Add to open the Add Assembly Member dialog box.
3. Under Class, select Discrete Input Point.
4. Select Point Name, and then click the down arrow and select Limit Switch.
5. Under Attribute, select Value.



6. Click OK.

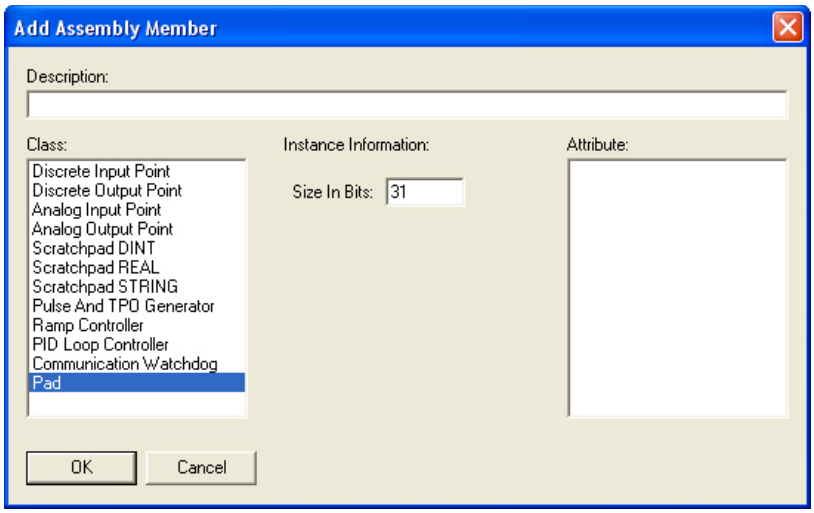


The assembly instance needs to have 32-bit words defined. Each of these 32-bit words is called a DINT (Double precision Integer Type).

So far you have defined only one of the 32 bits. So now you will pad the word with an additional 31 bits.

7. Click the Add button to open the Add Assembly Member dialog box.

8. Select Pad, set the Size in Bits field to a size of 31, and then click OK.

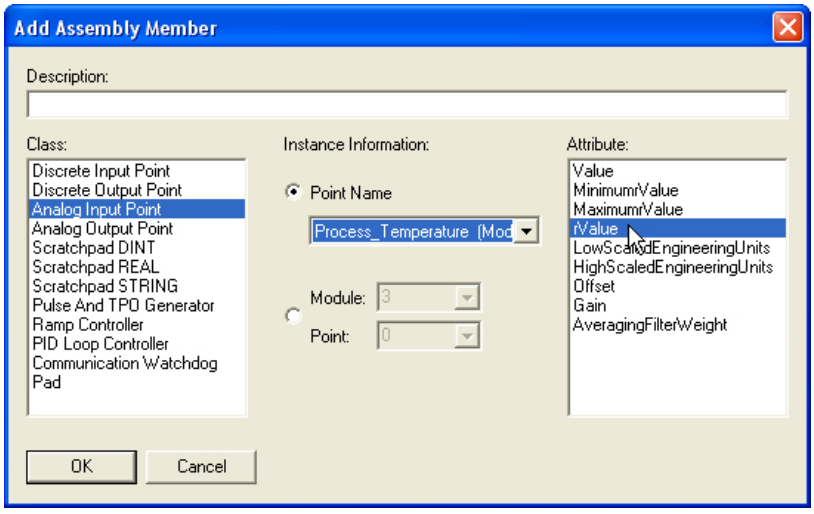


Now the total number of bits is 32.

9. Add another assembly member with the following characteristics:

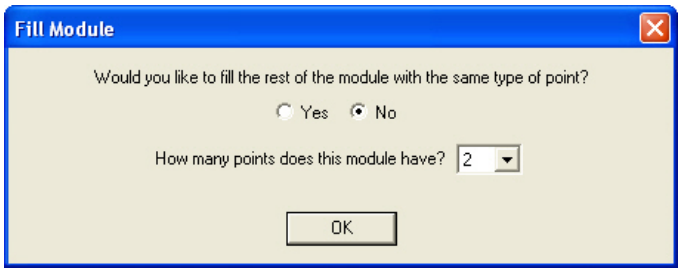
- **Class**: Analog Input Point
- **Point Name**: Process Temperature
- **Attribute**: rValue

NOTE: An rValue is a floating point number that is used to display scaled engineering units. A Value on the other hand is an integer used for displaying raw counts.



10. Click OK.

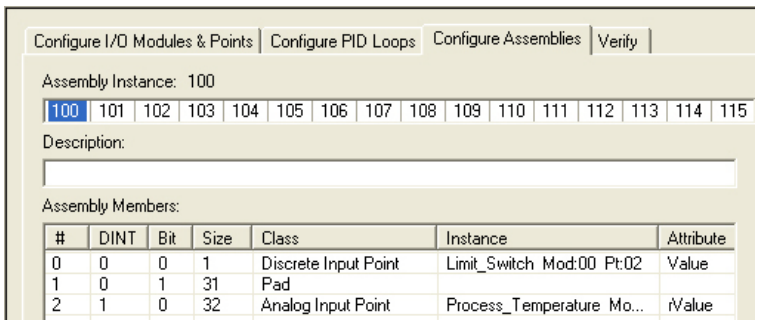
The Fill Module dialog box allows you to configure the other points the other points on the module the same way. But in this case you don't want to do that.



11. Select No, and then click OK.

An rValue is 32 bits, so there is no need for a pad.

This completes assembly instance 100. You have created an input assembly instance that has two 32-bit DINTs as follows:



Next you will create another assembly instance to send data to a discrete output module.

Creating the Output Assembly Instance

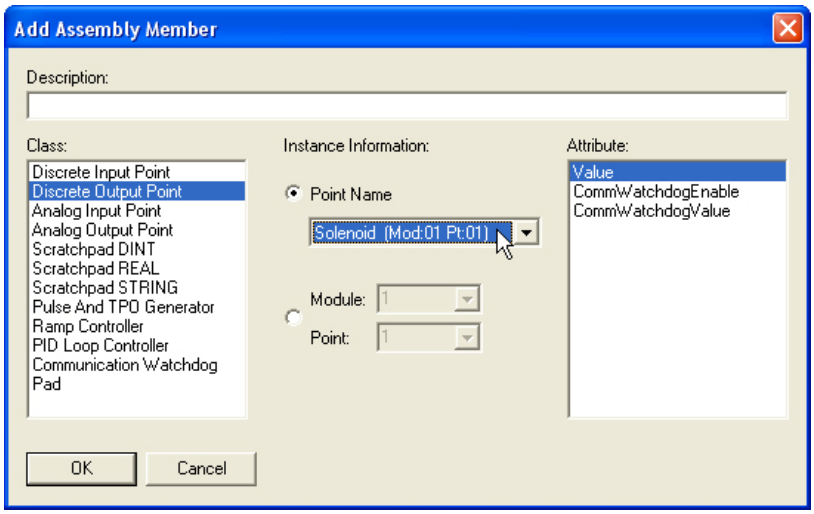
The output assembly allows the Allen-Bradley controller to write data to the intelligent remote I/O unit. You will create output instance 101 that has the following members:

#	DINT	Bit	Size	Class	Instance	Attribute
0	0	0	1	Discrete Output Point	Solenoid Mod:01 Pt:01	Value
1	0	1	31	Pad		

1. Select assembly instance 101.

2. Add an assembly member with the following characteristics:

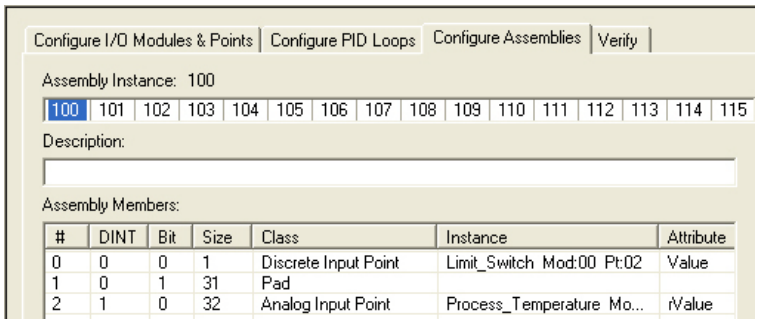
- **Class**: Discrete Input Point
- **Point Name**: Solenoid
- **Attribute**: Value



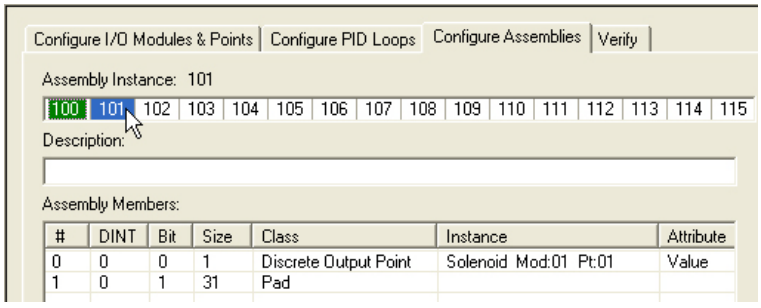
3. Click OK, and then add a 31-bit pad, just as you did in step 7 on page 28.

In addition to input assembly 100, you have now completed output assembly 101.

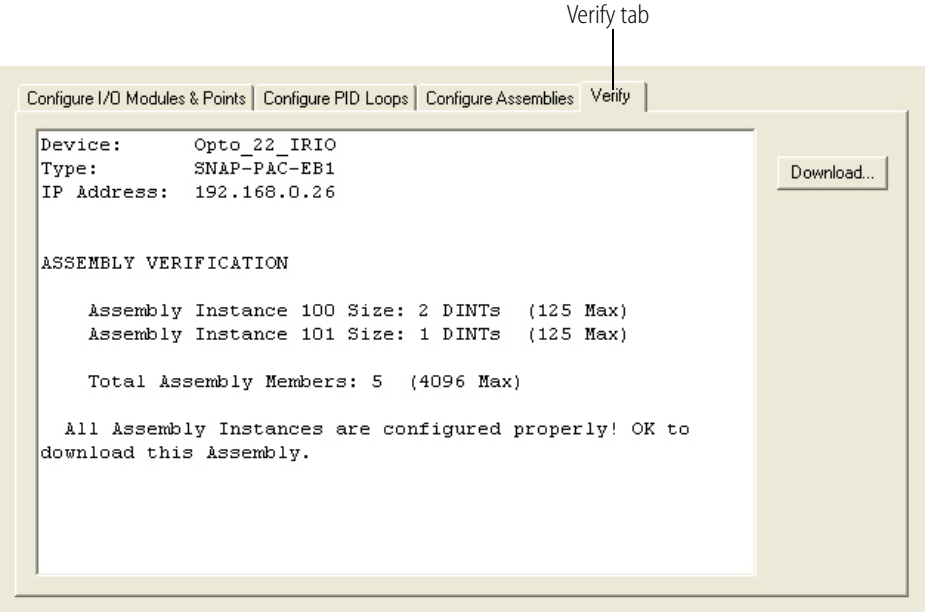
Input Assembly 100:



Output Assembly 101:



4. To check the configuration, click the Verify tab.



The information on this tab indicates any errors and whether or not the assembly is configured properly for download. It is helpful to check for errors in this report before you download the configuration to the device. For a complete report, select Tools→Assembly Configuration Report.

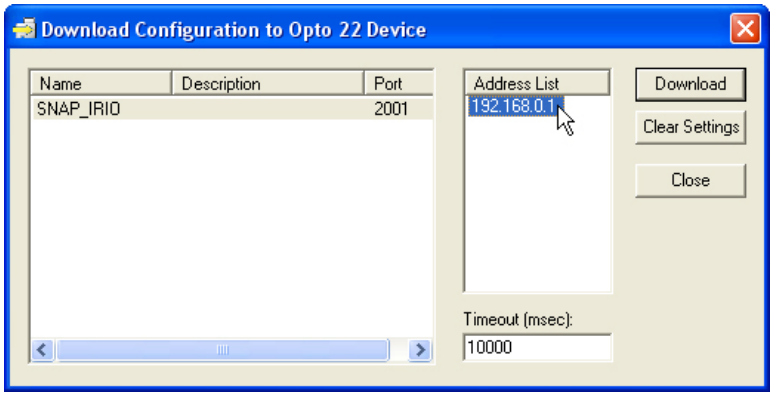
Now that you have configured the modules, points, and assembly instances for the intelligent remote I/O unit, it is time to save and download the configuration to the Opto 22 brain.

Saving and Downloading the Configuration

Up until now, the configuration only exists on your PC. The configuration includes all of the module, point, and assembly instructions you have entered in EtherNet/IP Configurator up to this point. By saving the configuration, you will create a file on your PC that contains all of the configuration information. This will allow you to open the configuration at a later time and modify it as necessary either for use either with this brain or with another one. By downloading the configuration to the brain, you can then configure the PLC to access the points you configured on the brain.

1. To save the configuration, choose File→Save, browse to an appropriate directory, name the file SNAP_IRIO, and then click Save.
2. Click the Verify tab and then click the Download button. (Or you can choose Tools→Download Configuration to Opto 22 Device.)

3. In the Download Configuration dialog box, select the brain's IP address, and then click Download.



4. When the configuration has been downloaded successfully, click Close.

This completes the setup of the Opto 22 remote I/O for lesson 1.

Configuring RSLogix 5000 and Running the Program

Now you are ready to use RSLogix 5000 to set up communications, view the controller tags, and then enter some ladder logic to demonstrate turning on the Solenoid from the Limit Switch.

This section includes the following activities:

"Setting Up Communications in RSLogix 5000" on page 33

"Viewing the Controller Tags" on page 37

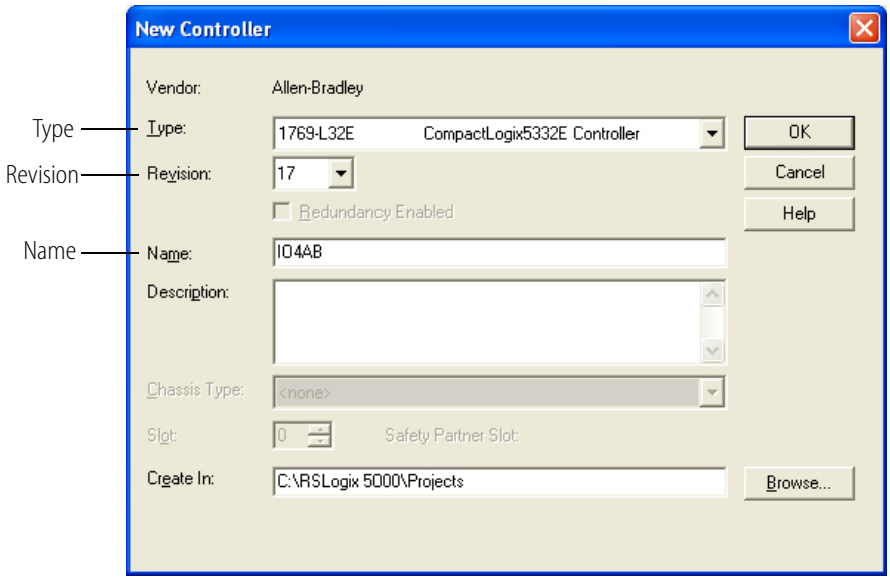
"Using Ladder Logic to Turn on an Output from an Input and Show Temperature in Engineering Units" on page 39

"Downloading and Running the Program" on page 42

Setting Up Communications in RSLogix 5000

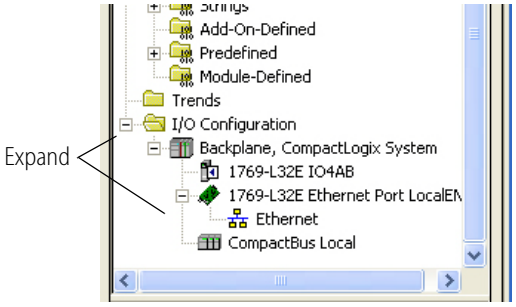
In this activity you will use RSLogix 5000 software to configure an Ethernet-enabled Allen-Bradley controller to be able to communicate with the intelligent remote I/O via a Ethernet module using the assembly instances you created using the EtherNet/IP Configurator.

1. Open RSLogix 5000.
2. Select File→New.
3. Enter or select the following information:
   - **Type**: *Your controller's type*
   - **Revision**: *RSLogix 5000 revision number*
   - **Name**: IO4AB



4. Browse to the folder you want to use, and then click OK.
5. Make sure the Path is set correctly for your controller.

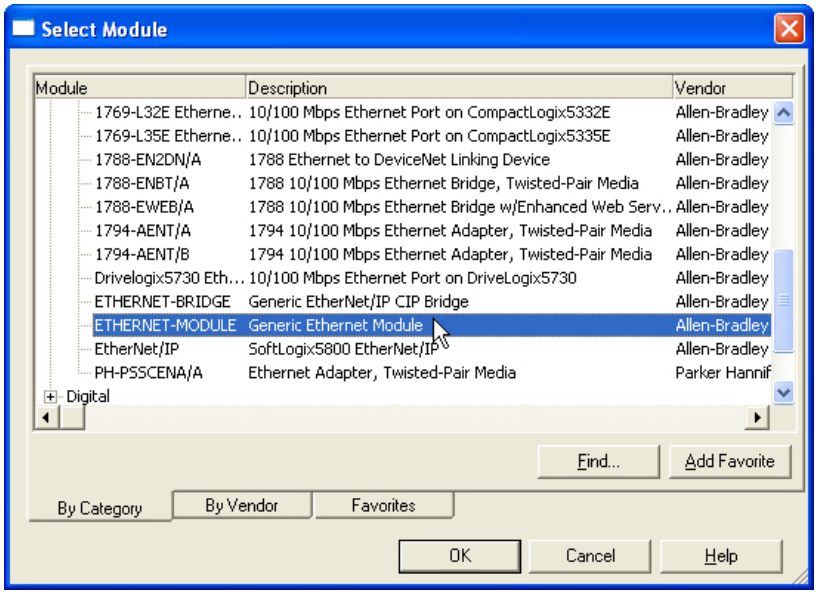
6. In the project tree display, expand I/O Configuration, Backplane, and 1769-L32E Ethernet Port LocalENB.



7. Right-click on Ethernet and select New Module.

   This module will be used to add the Opto 22 intelligent remote I/O unit.
8. In the Select Module dialog box, expand Communications in the tree display.

9. Scroll down to select Generic Ethernet Module, and then click OK to open the New Module dialog box.

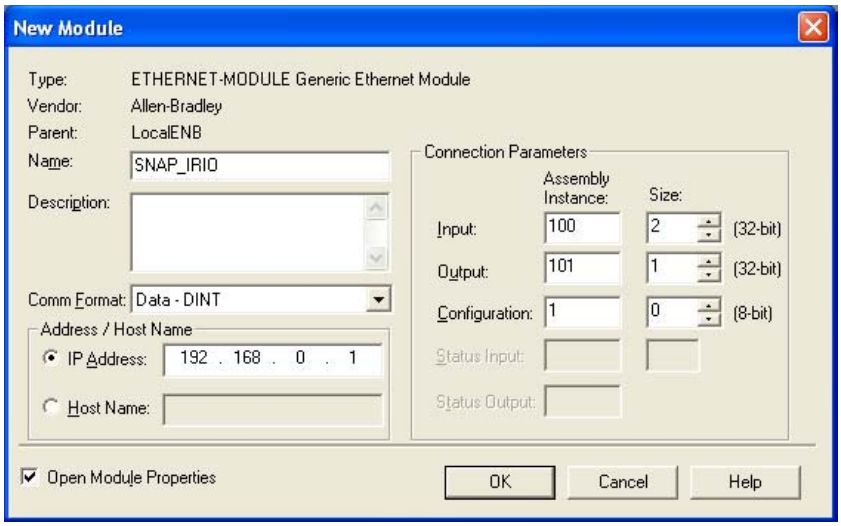


10. Enter or select the following information:

- **Name**: SNAP_IRIO
- **Comm Format**: Data - DINT
- **IP Address**: *IP address of the EB1 brain*
- **Input Assembly Instance**: 100; Size: 2 (There are two 32-bit DINTs in the input assembly instance you created.)
- **Output Assembly Instance**: 101; Size: 1 (There is only one 32-bit DINT in the output assembly.)
- **Configuration**: 1; Size: 0 (Configuration is not used. However, you must enter these values when not using this setting.)

NOTE: The Input Instance is an RSLogix 5000 READ assembly, and the Output Instance is an RSLogix 5000 WRITE assembly. The Configuration values are not used, but they must be entered.

The completed dialog box looks like this:

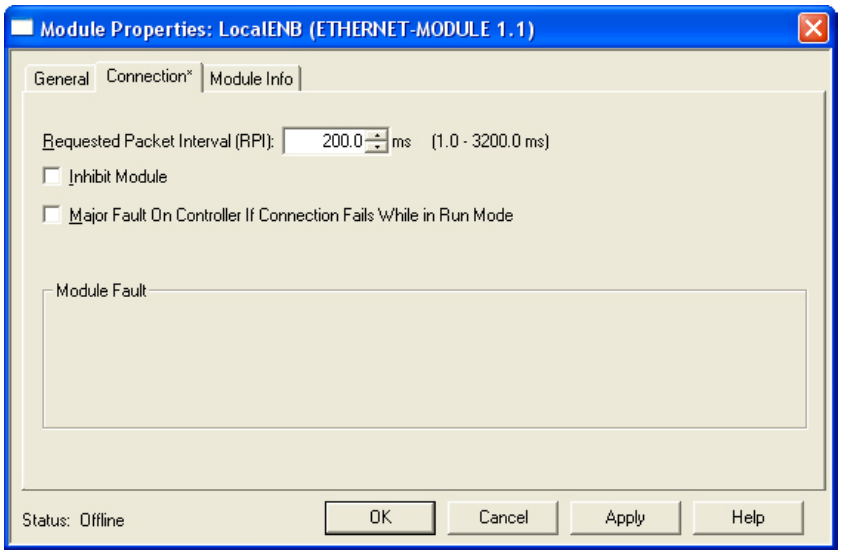


11. Click OK.

The Module Properties dialog box opens.

12. Set the RPI (Requested Packet Interval) to 200.0 ms.

The RPI is the scan time of the remote I/O unit.



13. Click OK.

The Opto 22 remote I/O has now been configured and added to the RSLogix 5000 software as a generic Ethernet module.

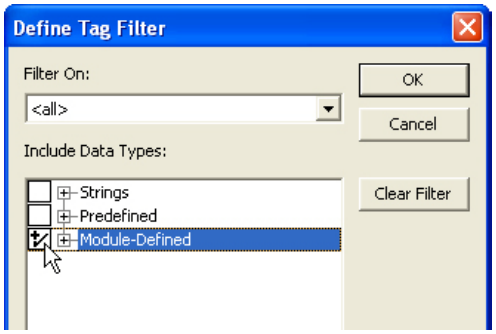
14. Select File→Save to save the configuration.

This completes the configuration of RSLogix 5000 for lesson 1. Next you will save, download, and run the program, and take a look at the data.

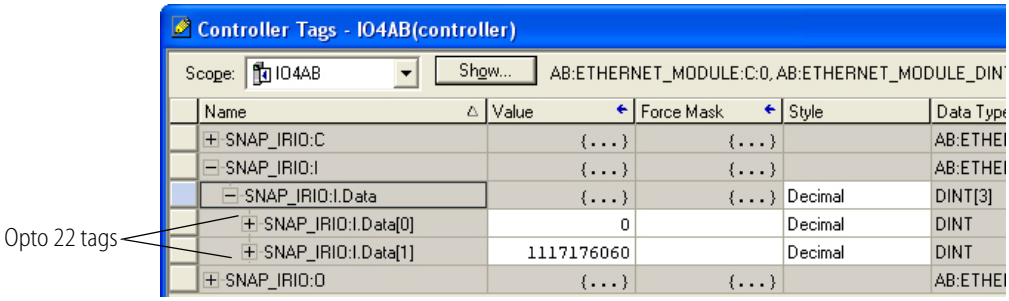
Viewing the Controller Tags

In this activity you will view the controller tags and see how RSLogix 5000 responds to input from the intelligent remote I/O when you toggle a point using on the Learning Center.

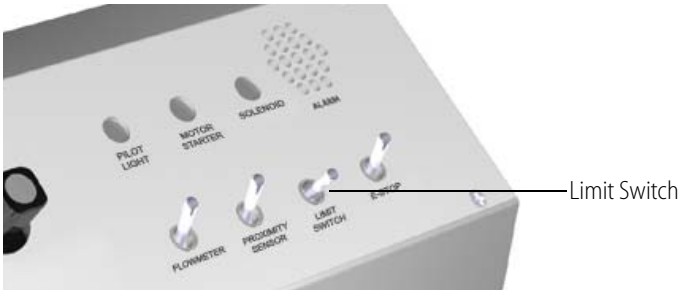
1. Select Communications→Download to download the RSLogix 5000 program to the controller, and then click Download in the next dialog box that appears.
2. Select Communications→Run Mode.
3. In the next dialog box that appears, click Yes.
4. Under the controller name in the tree display, double-click Controller Tags, and then click the Show button.
5. In the Define Tag Filter dialog box, make sure that Module-Defined is selected.



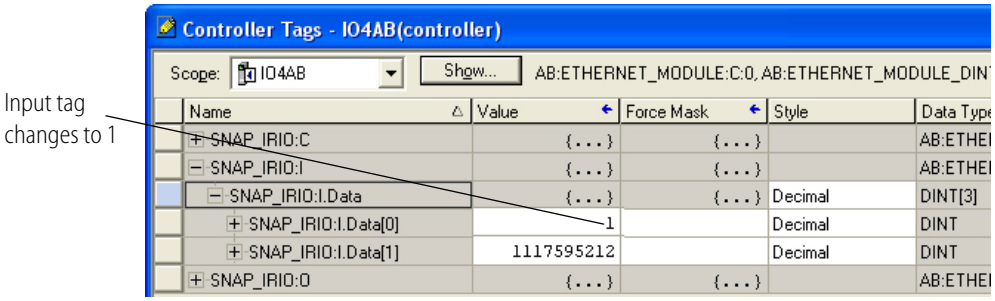
6. Click OK.
7. In the Controller Tags window, expand SNAP_IRIO:I until you see the Opto 22 input tags.



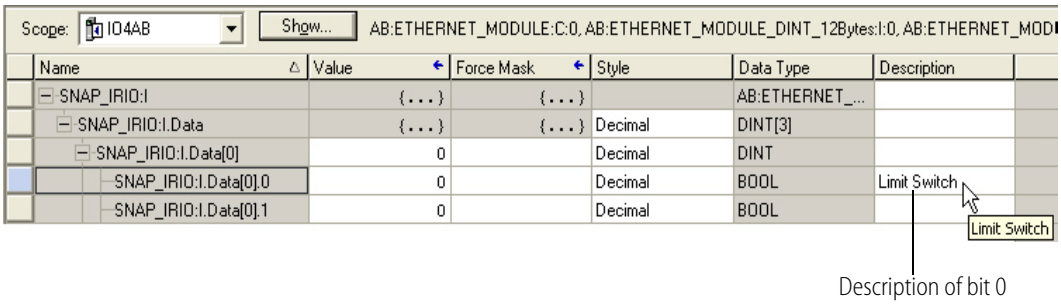
8. On the Learning Center, move the Limit Switch to the on position (down) to toggle the input point.



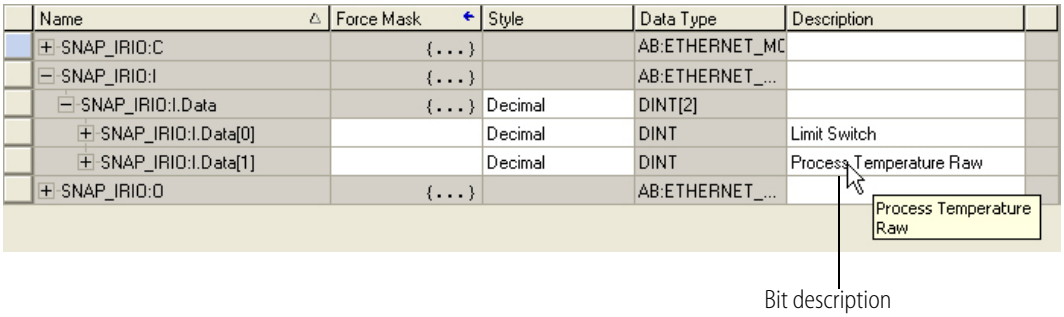
In RXLogix the value of the Opto 22 input tag changes from 0 to 1, which demonstrates that RSLogix 5000 is responding to input from the Opto I/O.



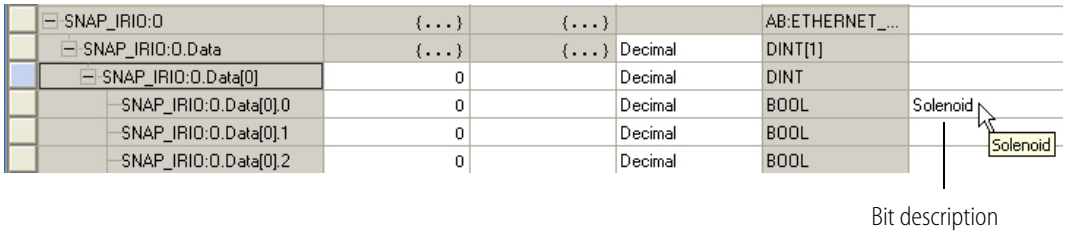
9. Stop the controller by selecting Communications→Program Mode.
10. Select Communications→Go Offline.
11. Expand SNAP_IRIO:I.Data[0] so that the 32 bits are displayed.
12. For bit 0, enter Limit Switch in the Description field.



13. Collapse SNAP_IRIO:I.Data[0].
14. In the Description field for SNAP_IRIO:I.Data[1], enter Process Temperature Raw.



15. Expand SNAP_IRIO:O, and then in the Description field for SNAP_IRIO:OData[0].0, enter Solenoid.

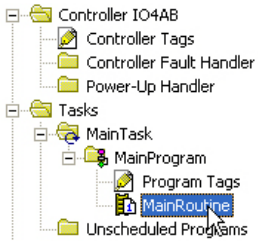


Using Ladder Logic to Turn on an Output from an Input and Show Temperature in Engineering Units

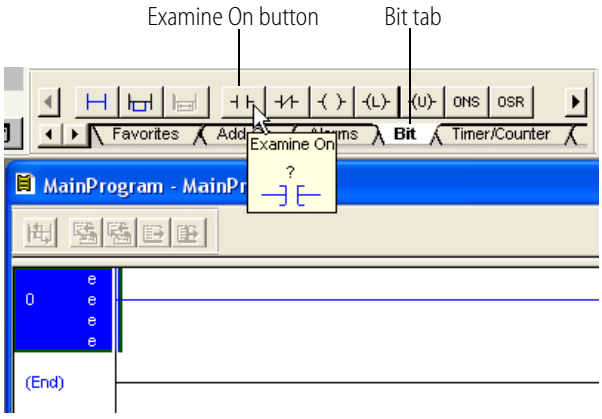
Next you will create two lines of ladder logic, which will show the following things:

- How the ladder is set up in RSLogix 5000 to control the digital output point named Solenoid
- The temperature in Engineering Units (using a REAL tag). Values in Engineering Units are available in the intelligent remote I/O

1. In the tree display, expand Tasks until you see an icon for MainProgram, and then double-click MainRoutine to open the program.

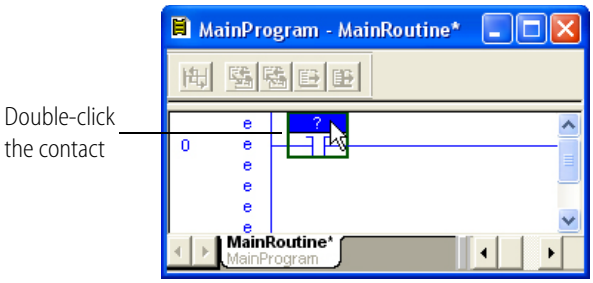


2. Click the Bit tab, and then add a normally open contact by clicking the Examine On button.

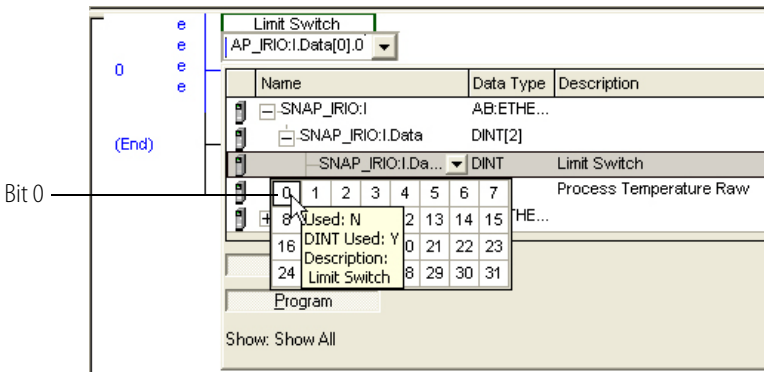


NOTE: This is the XIC instruction.

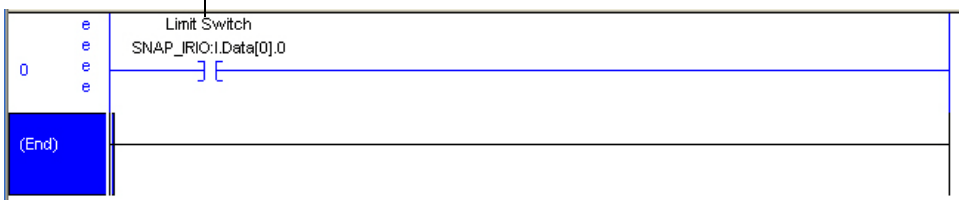
3. Double-click the contact, and then click the down arrow that appears.



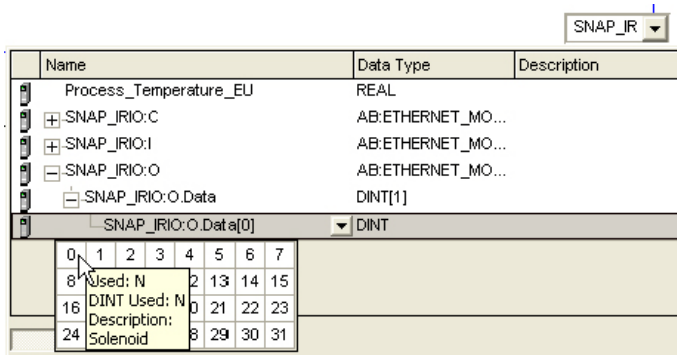
4. Assign the normally open contact to the Limit Switch by selecting bit 0 of the SNAP_IRIO:I.Data[0] DINT.



Normally open contact added



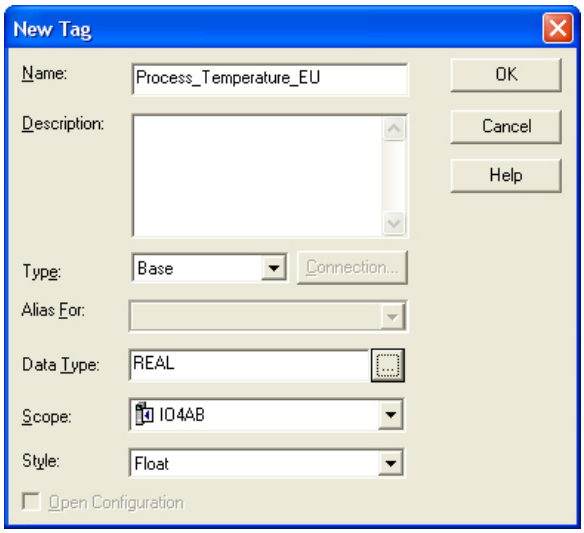
5. On the Bit tab again, click the Output Energize button to add an output coil.
6. Assign the output coil to the Solenoid by selecting bit 0 of the SNAP_IRIO:O.Data[0] DINT.



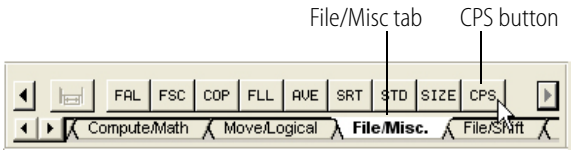
So far you have set up the Limit Switch to trigger the Solenoid light on the Learning Center.

Next you're going to take advantage of the values in Engineering Units available for temperature in the remote intelligent I/O. Recall that the data was brought in as a DINT.

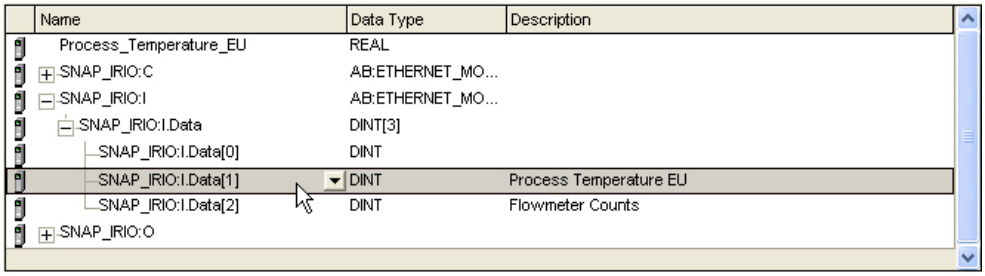
7. To create a controller tag, right-click Controller Tags in the tree display and select Add New Tag.
8. In the New Tag dialog box, name the tag Process_Temperature_EU and select REAL as the Data Type.



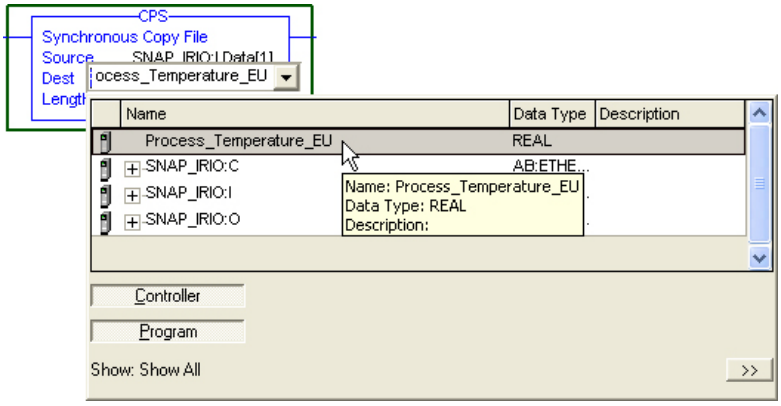
9. Click OK.
10. Add a new rung to the MainRoutine.
11. Click the File/Misc tab.
12. Scroll the commands until you find CPS, and then click it.



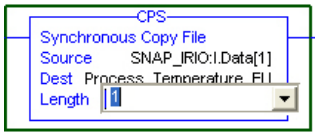
13. In the CPS instruction that appears, double-click Source.
14. Click the down arrow, expand SNAP_IRIO:I, and then select SNAP_IRIO:I.Data[1].



15. Double-click Dest, and then click the down arrow and select the new Variable, Process_Temperature_EU, as the destination.



16. Double-click Length and enter 1.



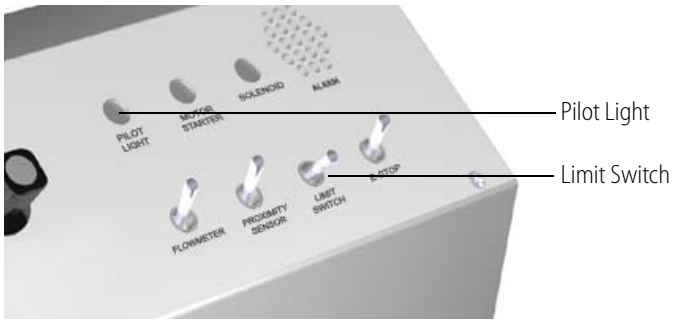
Downloading and Running the Program

1. Select Communications→Download to download the RSLogix 5000 program to the controller.

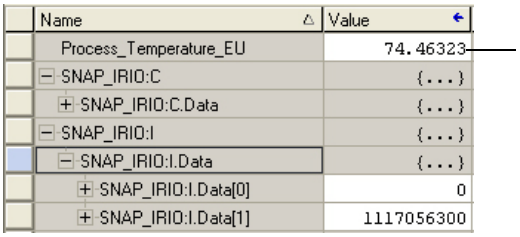
2. Click Download in the next two dialog boxes that appear.

3. Select Communications→Run Mode, and then click Yes in the next dialog box.

4. Toggle the Limit Switch on the Learning Center and watch the Pilot Light come on.



5. Notice in RSLogix 5000 that the value for the Process_Temperature_EU is shown in Engineering Units (degrees F).



6. Hold the Learning Center's temperature probe between your fingers for a only a second or two and watch the value change.

Summary of Lesson 1

In lesson 1 you used Ethernet/IP Configurator to configure the modules and points for the SNAP-PAC-EB1 brain, and you created input and output assemblies to enable communication with an Allen-Bradley PLC.

Then you viewed the controller tags in RSLogix 5000 and saw how it responds to input from the intelligent remote I/O when you toggle a point using a switch on the Learning Center.

In RSLogix you created two lines of ladder logic in order to control a digital output point and to view the temperature in Engineering Units.

You have just experienced how you can easily set up communications between the Allen-Bradley PLC and the SNAP I/O, read and write to digital I/O points, and take advantage of the values in Engineering Units of an analog value available in intelligent remote I/O.

Lesson 2: Using Intelligent Discrete I/O Functions

In the first activity of this lesson you will continue to configure the assemblies, modules, and points. And in subsequent activities you will use the remote I/O unit's intelligence for counting, responding to a watchdog timeout, and pulsing to a direct output.

"Using a Counter" on page 49 demonstrates using a discrete input point as a counter. The discrete input point is configured and run in the I/O. Also, note that no ladder function block is needed in RSLogix 5000 to perform counting. High-speed counting (up to 20 Khz) is built into certain SNAP digital input modules and the SNAP-PAC-EB1 brain, so there is no need for a special HSC (High-Speed Counting) module.

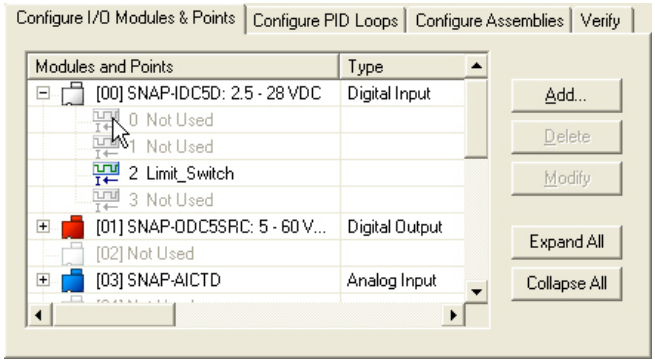
In the "Using a Watchdog" activity on page 51 you will see how an Opto 22 watchdog allows you to configure the *fail state* of a discrete output point (or the *fail value* for analog output signals).

In "Using the Pulse Generator" on page 54 you will use EtherNet/IP Configurator to configure the pulse characteristics for a point. Then in RSLogix you'll watch the pulse you created on the SNAP PAC EB1.

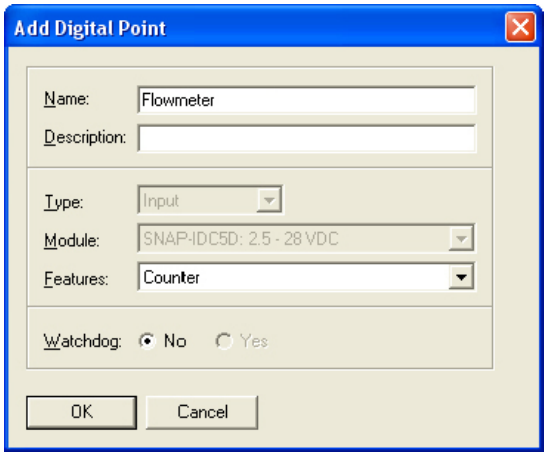
Configuring the Additional Point and Assemblies

In this activity you'll use EtherNet/IP Configurator to add additional points and modify the existing assembly instances.

1. In EtherNet/IP Configurator, select File→Open and open the SNAP_IRIO.otg, the configuration you created in lesson 1.
2. In the Configure I/O Modules & Points tab, expand module 0 and then double-click point 0.



3. In the Add Digital Point dialog box, complete the fields as follows:
   - **Name**: Flowmeter
   - **Features**: Counter

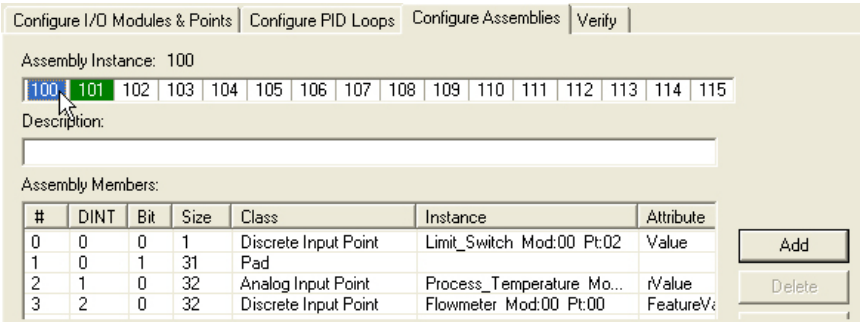


For future reference, there are several other built-in intelligence features you can configure with this digital input module. These include:

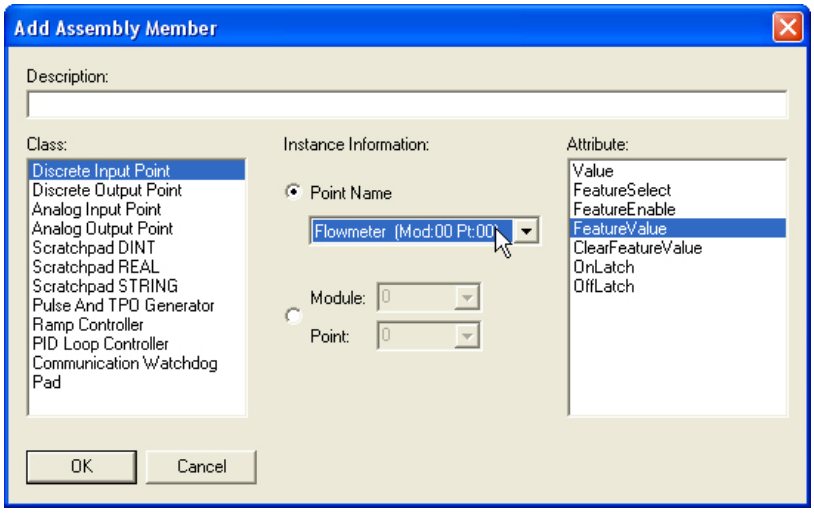
- on-pulse and off-pulse
- frequency
- period
- on-time and off-time totalizer

4. Click OK.

5. Click the Configure Assemblies tab, and then click input assembly instance 100.



6. Click Add.
7. In the Add Assembly Member dialog box, complete the fields as follows:
   - **Class**: Discrete Input Point
   - **Point Name**: Flowmeter
   - **Attribute**: Feature Value

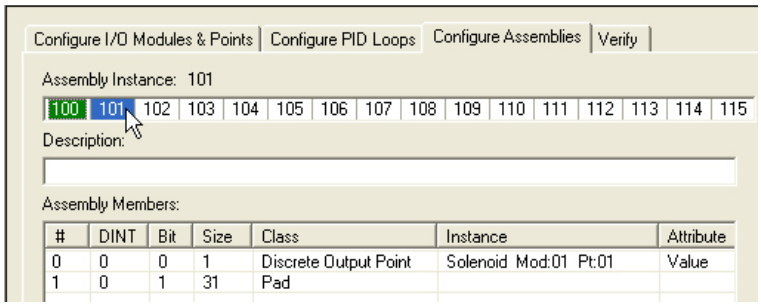


This Feature Value is for counter you just configured in the I/O Configuration tab. Note that the I/O's built-in intelligence can also give you the attributes OnLatch and OffLatch, which require no configuration.

8. Click OK.

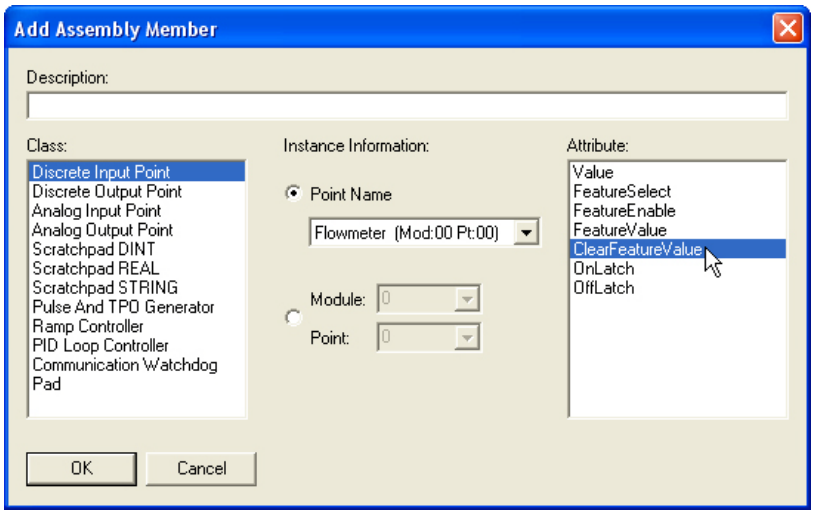
The Feature Value is 32 bits, so you don't need to add a pad to align the data.

9. Click output assembly instance 101.



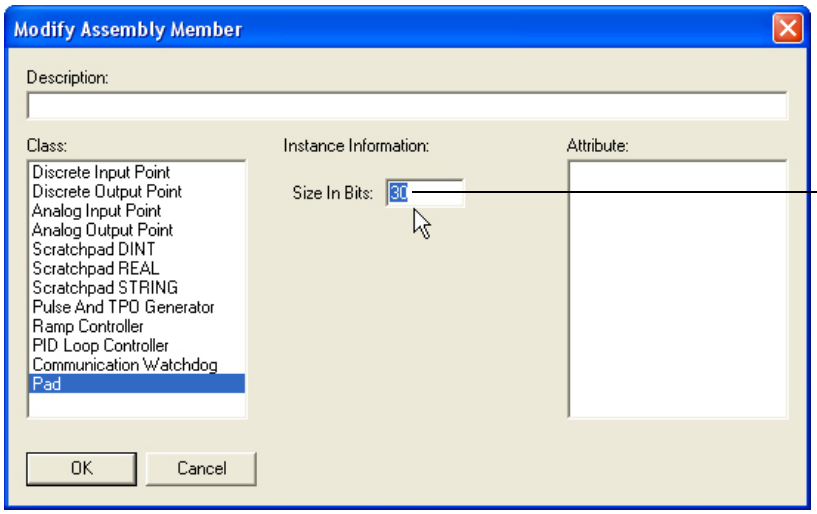
10. Add an instance member that has the following characteristics:

- **Class**: Discrete Input Point
- **Point Name**: Flowmeter
- **Attribute**: Clear Feature Value

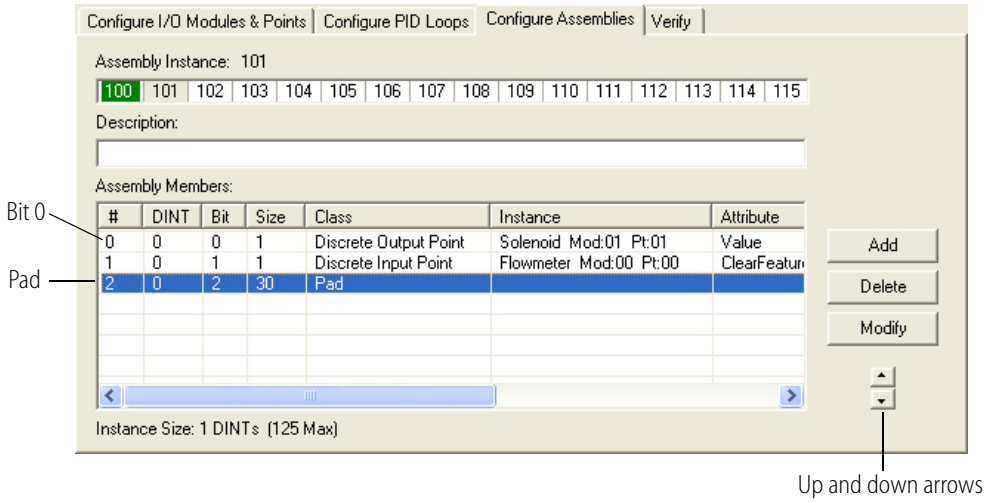


11. Click OK.

12. In the assembly instance, double-click the 31-bit pad, change it to 30 bits, and then click OK.

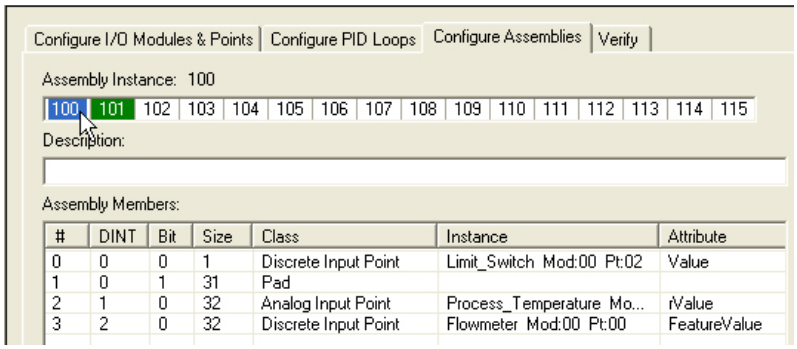


13. Make sure the Solenoid is still in the bit 0 position in output assembly 101. If necessary, use the up and down arrows at the right to move the pad.

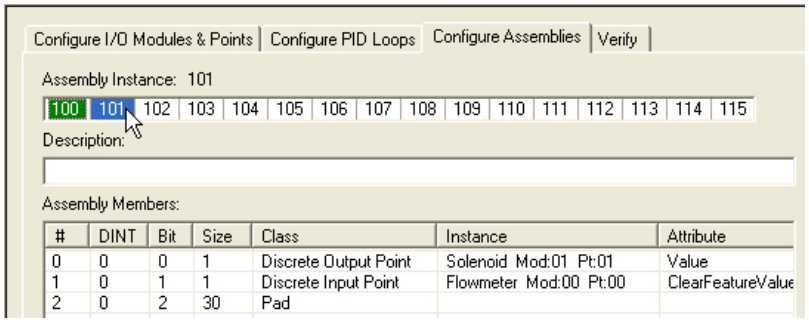


In Lesson 1 you created an input assembly with one 32-bit DINT, and in this lesson you added two more DINTs for a total of three. You created an output assembly instance that has one DINT.

Input Assembly 100:



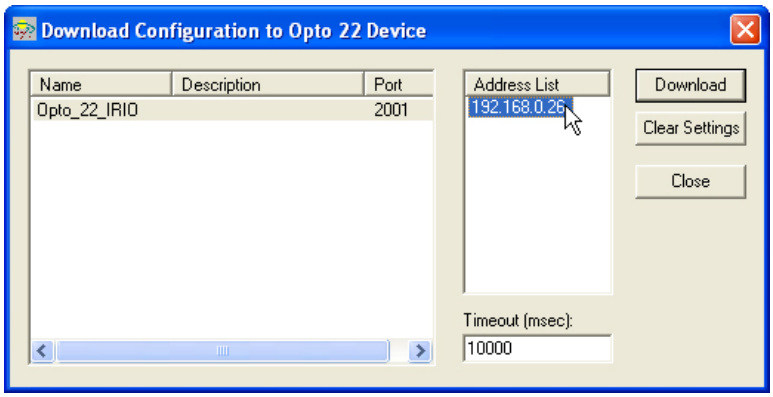
Output Assembly 101:



14. Choose File→Save to save the configuration.

15. Choose Tools→Download Configuration to Opto 22 Device.

16. In the Download Configuration dialog box, select the brain's IP address.



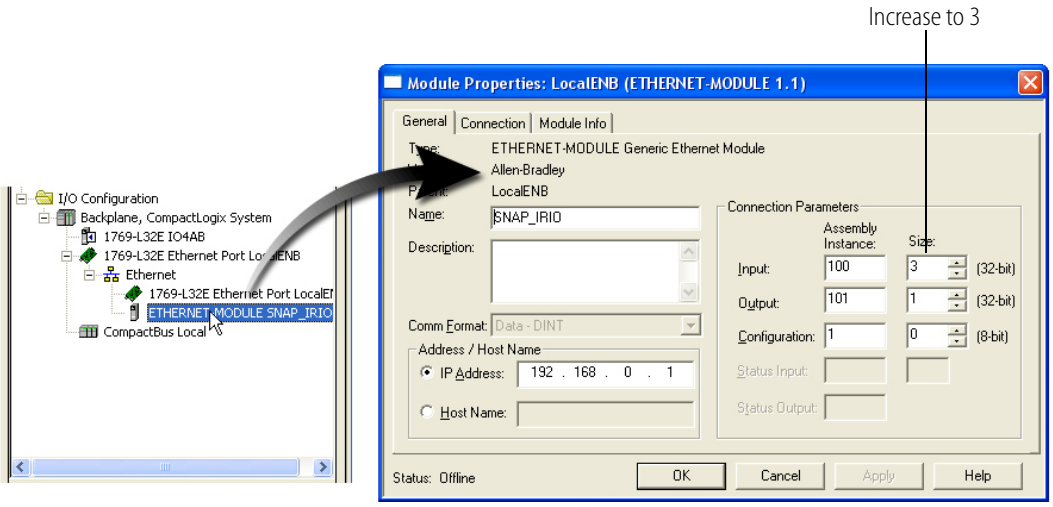
17. Click Download.

18. Save the configuration.

Using a Counter

In this activity you will re-configure RSLogix 5000 to communicate with the new assemblies you created. High-speed counting (up to 20 Khz) is built into certain SNAP digital input modules and the SNAP-PAC-EB1 brain, so there is no need for a special HSC (High-Speed Counting) module. Then you will see a counter working in real time and learn how to reset the counter.

1. In RSLogix 5000, open the project called IO4AB that you created in the lesson 1.
2. (Optional) If you want, you can delete the two rungs of ladder logic from lesson 1. No ladder logic is used in this activity to perform counting.
3. Double-click the Ethernet module to open the Module Properties dialog box.



4. For Input assembly instance 100, increase the size to 3, and then click OK.

   This is necessary because in EtherNet/IP Configurator you added a new DINT. Keep Output assembly instance 101 set to 1 and the Configuration set to 1 and 0.
5. Select Communications→Download to download the RSLogix 5000 program to the controller, and then click Download in the next dialog box that appears.
6. Select Communications→Run Mode, and then click Yes in the next dialog box.
7. Double-click Controller Tags, and then expand SNAP_IRIO:I until you see Data[0], Data[1], and Data[2].

   Since these are 32-bit instances, there is no need to drill down to the bit level.

8. In the Description field for SNAP_IRIO:I.Data[2], enter Flowmeter Counts.

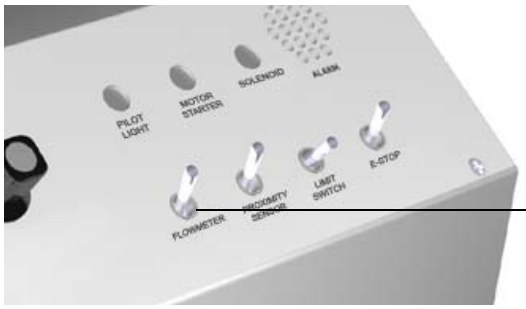
Name	Value	Force Mask	Style	Data Type	Description
Process_Temperature_EU	72.635895		Float	REAL	
SNAP_IRIO:C	{...}	{...}		AB:ETHERNET_...	
SNAP_IRIO:C.Data	{...}	{...}	Hex	SINT[400]	
SNAP_IRIO:I	{...}	{...}		AB:ETHERNET_...	
SNAP_IRIO:I.Data	{...}	{...}	Decimal	DINT[3]	
SNAP_IRIO:I.Data[0]	0		Decimal	DINT	
SNAP_IRIO:I.Data[1]	1116816788		Decimal	DINT	Process Temperature Raw
SNAP_IRIO:I.Data[2]	0		Decimal	DINT	Flowmeter Counts
SNAP_IRIO:O	{...}	{...}		AB:ETHERNET_...	

Data[0], [1], and [2]

Value for Flowmeter Counts

9. Notice that the value for Flowmeter Counts at Data[2] is 0.

10. Now toggle the Flowmeter switch on the Learning Center, and you'll see that the value for Data[2] increases each time you toggle the switch.

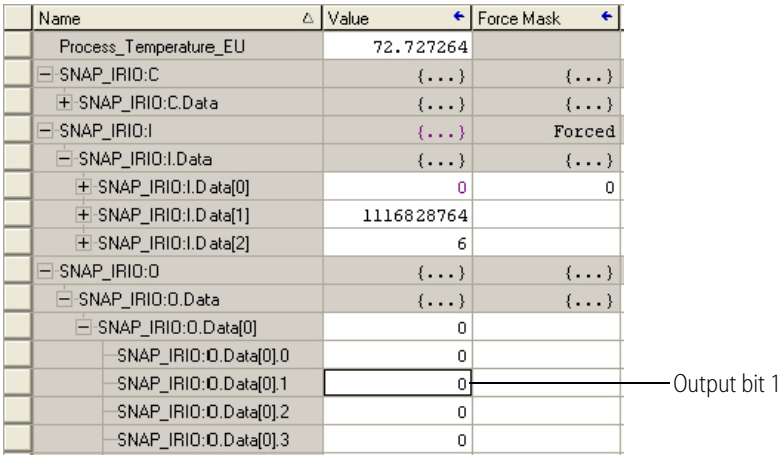


Flowmeter switch

Name	Value
Process_Temperature_EU	72.635895
SNAP_IRIO:C	{...}
SNAP_IRIO:C.Data	{...}
SNAP_IRIO:I	{...}
SNAP_IRIO:I.Data	{...}
SNAP_IRIO:I.Data[0]	0
SNAP_IRIO:I.Data[1]	1116816788
SNAP_IRIO:I.Data[2]	3
SNAP_IRIO:O	{...}

Data[2] (Flowmeter Counts) increases

11. Expand the output data, SNAP_IRIO:O, until you see bit 1 of SNAP_IRIO:O.Data[0].

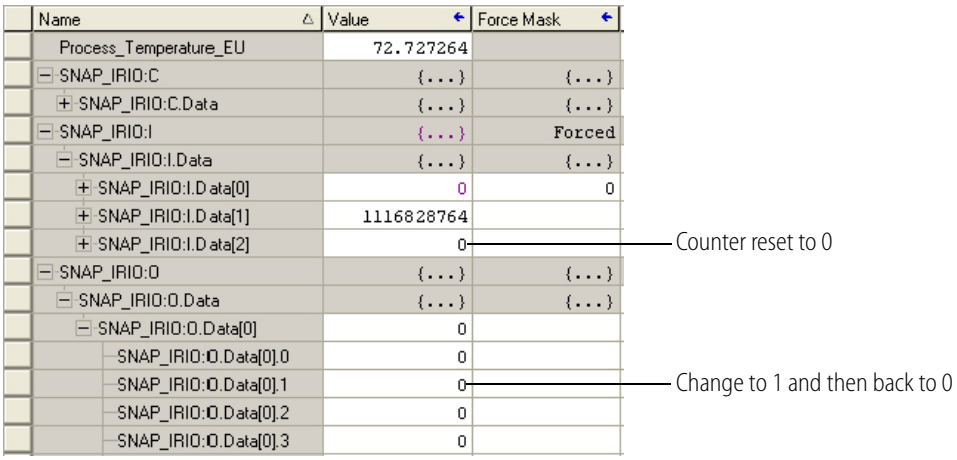


12. In the Description field for SNAP_IRIO:O.1, enter Clear Flowmeter Counts.

13. Select output bit 1, change the value 0 to 1, and then press Enter on your keyboard.

14. Change the value for output bit 1 back to 0 by selecting the value again and entering 0.

Notice that the Flowmeter Counter is reset to 0, which demonstrates another use of the remote I/O's built-in intelligence: I/O attributes accessible from RSLogix 5000 can be used to write to outputs.

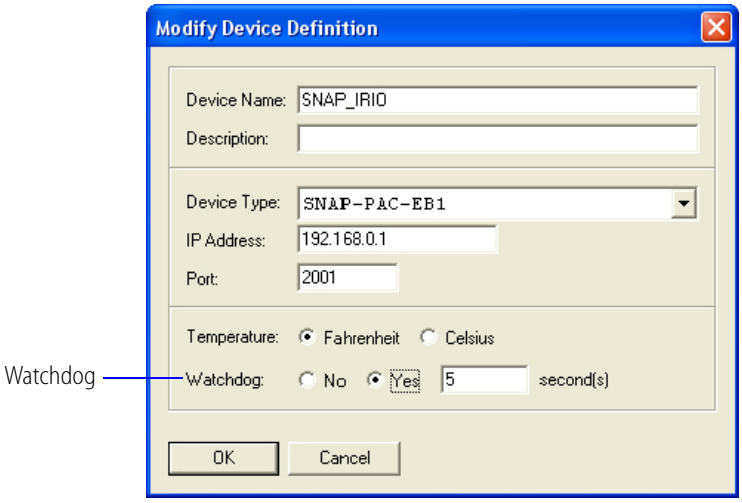


Using a Watchdog

Now let's take a look at using a Watchdog. The watchdog monitors the health of communications between the PLC main rack and the remote I/O. The watchdog goes one step further by allowing you to configure the *fail state* of a discrete output point or the *fail value* for analog output signals.

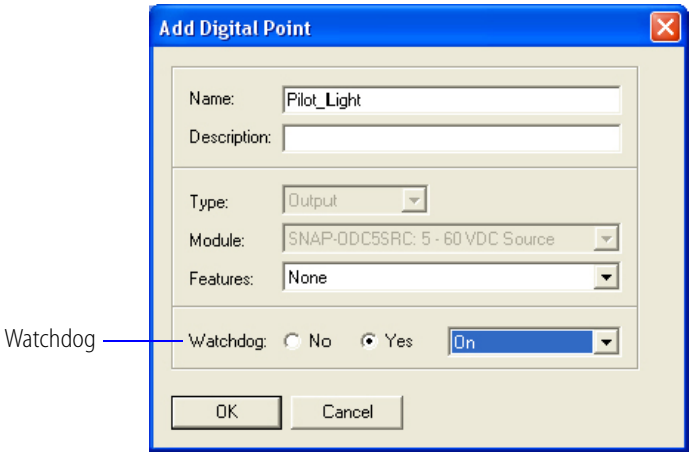
1. In EtherNet/IP Configurator, double-click SNAP_IRIO to open the Modify Device Definition dialog box.

2. In the Modify Device Definition dialog box, select Yes for Watchdog and enter a value of 5 seconds.



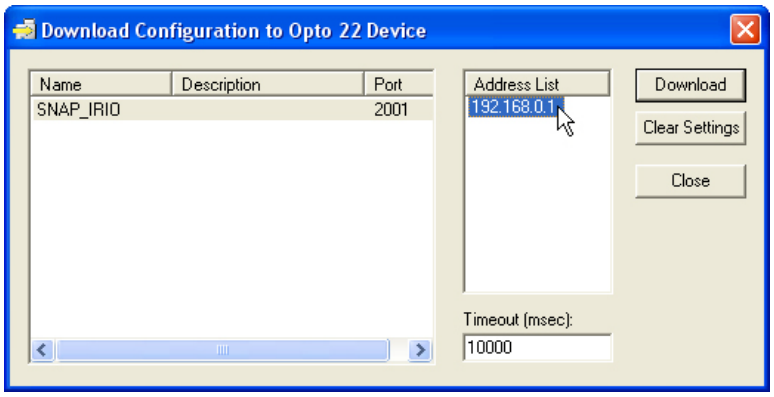
3. Click OK.
4. In the Configure I/O Modules & Points tab, expand module 1, and then double-click point 3 to add a new digital point.

   This new point will demonstrate the fail state to be set if communication to the remote I/O is lost.
5. In the Add Digital Point dialog box, name the new point Pilot Light.
6. Select Yes for Watchdog and set the value to On.



7. Click OK.
8. Choose Tools→Download Configuration to Opto 22 Device.

9. In the Download Configuration dialog box, select the brain's IP address.



10. Click Download.

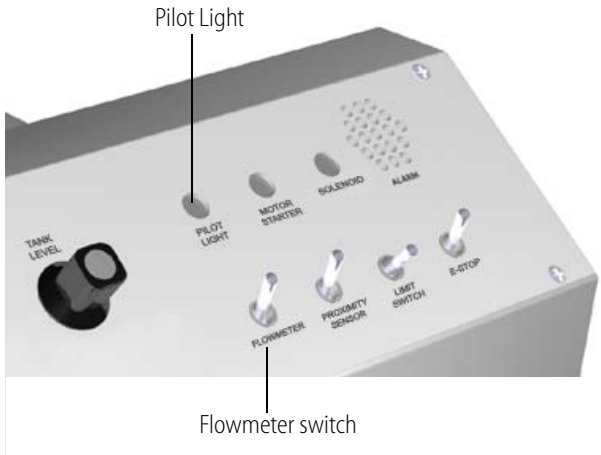
11. When the configuration has been downloaded successfully, click Close.

NOTE: If the Allen-Bradley PLC is still in Run mode, you can skip to step 14.

12. In RSLogix 5000, select Communications→Download, and then click Download in the next dialog box that appears.

13. Select Communications→Run Mode, and then click Yes in the next dialog box.

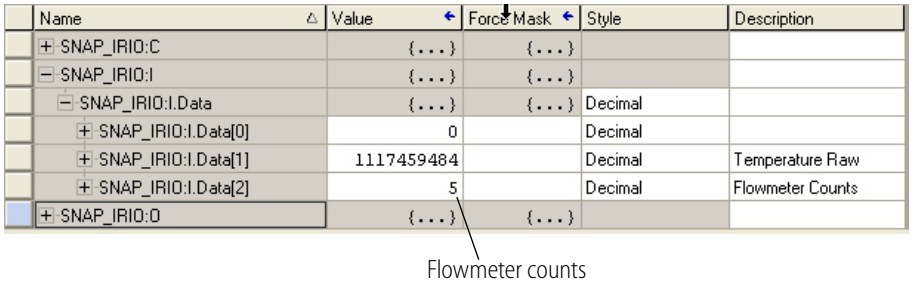
14. Remove the Ethernet cable from the SNAP I/O, wait five seconds, and notice that Pilot Light on the Learning Center lights up.



In this part of lesson 2, you've seen how you can configure and execute a watchdog.

15. While the Ethernet cable is still unplugged, toggle the Flowmeter switch several times.

16. Re-insert the cable, wait for communications to be re-established, and then notice that the flowmeter counts have increased.



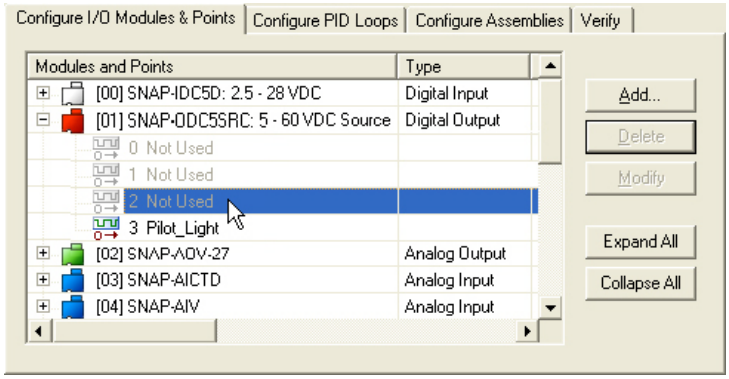
This demonstrates the distributed, independent intelligence of the SNAP remote I/O.

Using the Pulse Generator

In this activity you'll use EtherNet/IP Configurator to add a pulse generator for a direct output, and then download the configuration to the brain.

1. In EtherNet/IP Configurator, open SNAP_IRIO.otg.

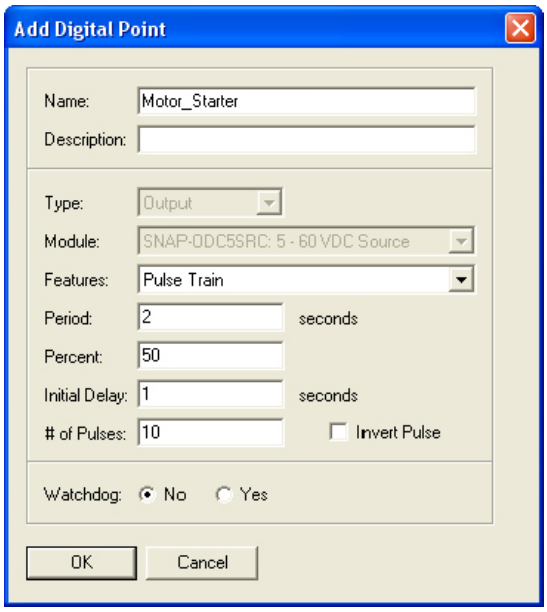
2. In the Configure I/O Modules & Points tab, expand module 1, the digital output module, and then double-click point 2.



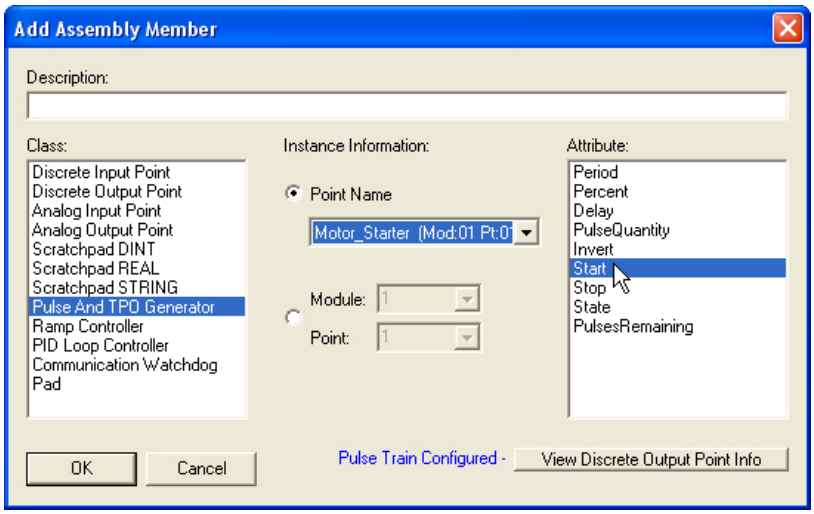
3. In the Add Digital Point dialog box, enter the following:

- **Name**: Motor Starter
- **Features**: Pulse Train
- **Period**: 2
- **Percent**: 50
- **Initial Delay**: 1
- **# of Pulses**: 10

When completed, the Add Digital Point dialog box should look like this:

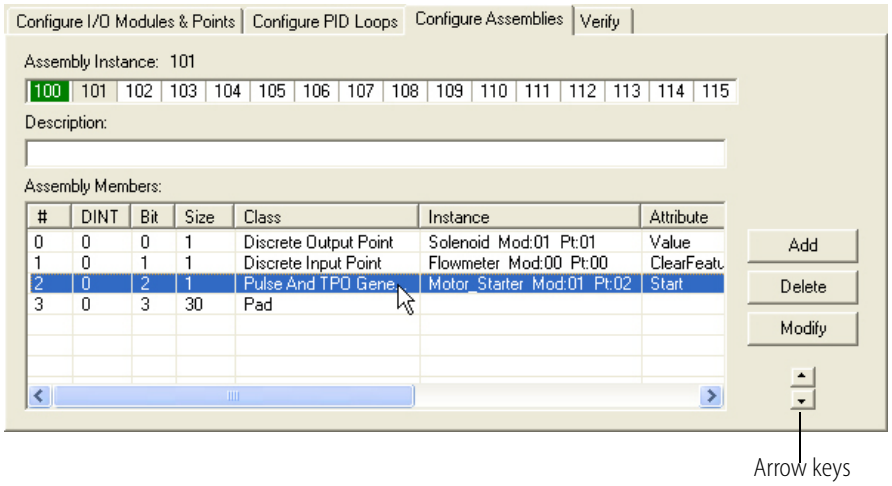


4. Click OK.
5. Click the Configure Assemblies tab, and then click output assembly instance 101.
6. Add an instance member that has the following characteristics:
   - **Class**: Pulse And TPO Generator
   - **Point Name**: Motor Starter
   - **Attribute**: Start



7. Click OK.

8. If necessary, use the up and down arrows to position the assembly member under Flowmeter, ClearFeatureValue.

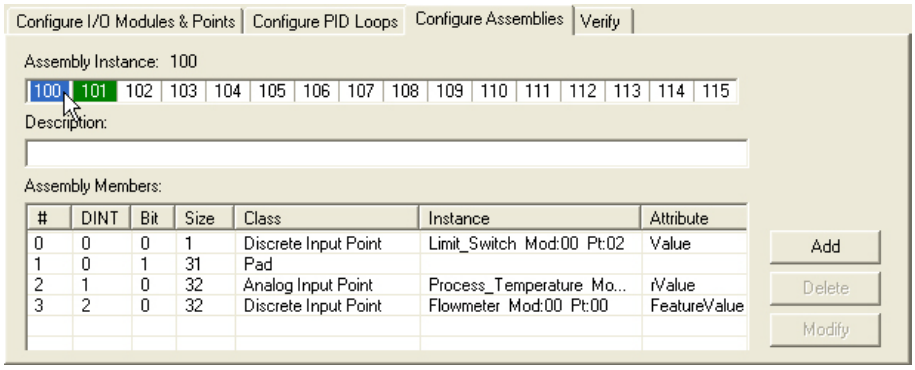


9. Double-click the pad, change the size to 29 in order to form a 32-bit DINT with the three one-bit assembly members.

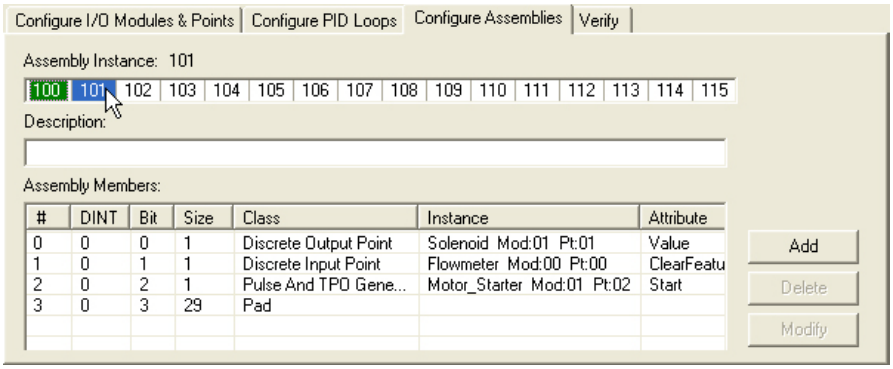
10. Click OK.

Input assembly 100 still has three 32-bit DINTs, and output assembly 101 has one 32-bit DINT as follows:

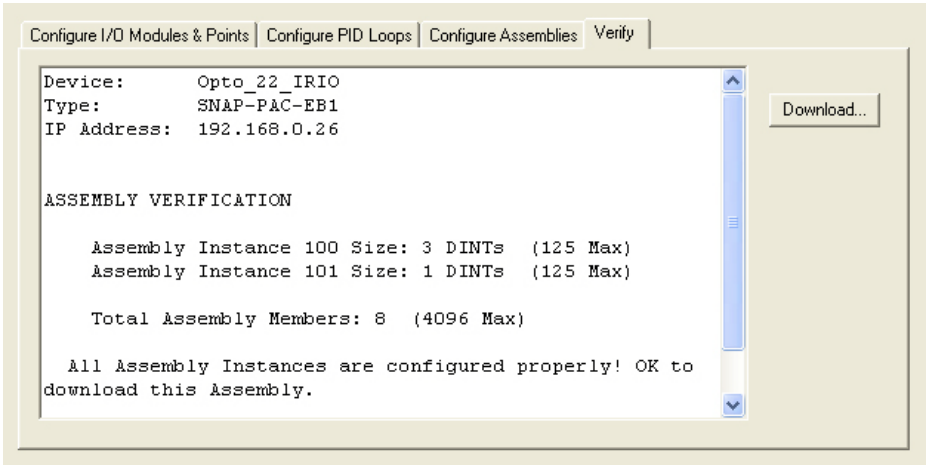
Input Assembly 100:



Output Assembly 101:



11. Click the Verify tab to check the configuration.



12. Click the Download button.

In this activity you added a point called Motor Starter with the Pulse Train feature. Then you added the Motor Starter point to output assembly 101.

Watching the Pulse in RSLogix 5000

In RSLogix 5000 you will watch the pulse you created on the SNAP PAC EB1.

1. Make sure that the IO4AB project that you created in RSLogix 5000 in a previous lesson is open and running.
2. Double-click Controller Tags, and then expand SNAP_IRIO:O.

3. Drill down to the bit level, and in the Description field for bit 2, enter Start Pulse.

Name	Alias For	Base Tag	Data Type	Style	Description
+ SNAP_IRIO:C			AB:ETHERN...		
+ SNAP_IRIO:I			AB:ETHERN...		
− SNAP_IRIO:O			AB:ETHERN...		
− SNAP_IRIO:O.Data			DINT[1]	Decimal	
− SNAP_IRIO:O.Data[0]			DINT	Decimal	
SNAP_IRIO:O.Data[0].0			BOOL	Decimal	
SNAP_IRIO:O.Data[0].1			BOOL	Decimal	
SNAP_IRIO:O.Data[0].2			BOOL	Decimal	Start Pulse
SNAP_IRIO:O.Data[0].3			BOOL	Decimal	

4. Download, and Run.
5. Change the Start Pulse bit to 1 and watch the Motor Starter light on the Learning Center.
6. When you've finished watching, stop the controller, and go offline.

Summary of Lesson 2

In lesson 2 you used EtherNet/IP Configurator to configure the pulse characteristics for a point and then ran it in the I/O unit.

In the first activity of this lesson you continued to configure the assemblies, modules, and points. And in subsequent activities you used the remote I/O unit's intelligence for counting, responding to a watchdog timeout, and pulsing to a direct output.

"Using a Counter" on page 49 demonstrated using a discrete input point as a counter. You configured the discrete input point and ran it in the I/O. You also saw a counter working in real time and learned how to reset the counter.

In the "Using a Watchdog" activity on page 51 you saw how an Opto 22 watchdog allowed you to configure the *fail state* of a discrete output point (or the *fail value* for analog output signals).

In "Using the Pulse Generator" on page 54 you used EtherNet/IP Configurator to configure the pulse characteristics for a point. Then in RSLogix you watched the pulse you created on the SNAP PAC EB1.

Lesson 3: Using Intelligent Analog I/O Functions

In this lesson you will continue to configure the I/O unit and see the following features:

- Scaling—Scaling analog values at the I/O level to match field instrumentation and actual process value
- Engineering Unit Conversion—Setting Engineering Units at the I/O level to be read in RSLogix 5000
- Maximum and Minimum Values—Reading process variable maximum or minimum values in RSLogix 5000
- Output Clamping—Simulate using a process condition to set an output clamp value that is executed in I/O

This lesson includes the following activities:

"Configuring the I/O Unit" on page 59

"Setting Up RSLogix 5000" on page 68

Configuring the I/O Unit

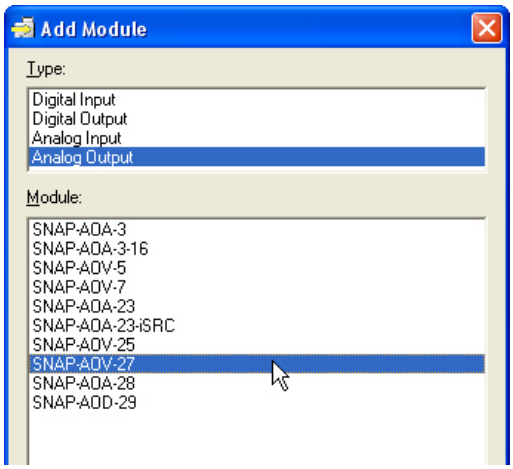
In this activity you will use EtherNet/IP Configurator to configure the two remaining modules so you can experience using analog output from the remote I/O in RSLogix:

Position	Type	Module
02	Analog Output	SNAP-AOV-27
04	Analog Input	SNAP-AIV

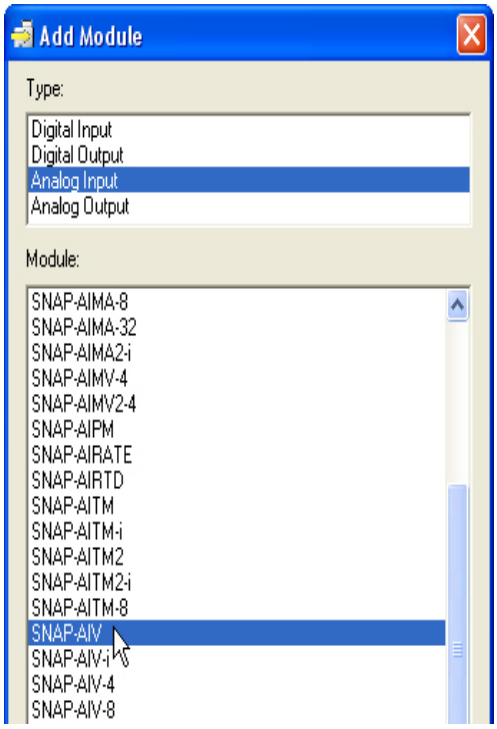
Then you will create additional members for input assembly 100 and output assembly 101.

1. In EtherNet/IP Configurator, open SNAP_IRIO.otg, the configuration you created in a previous lesson.
2. Click the Configure I/O Modules & Points tab.
3. Double-click module 2 to open the Add Module dialog box.

4. Under Type, select Analog Output, and then select the SNAP-AOV-27 module.



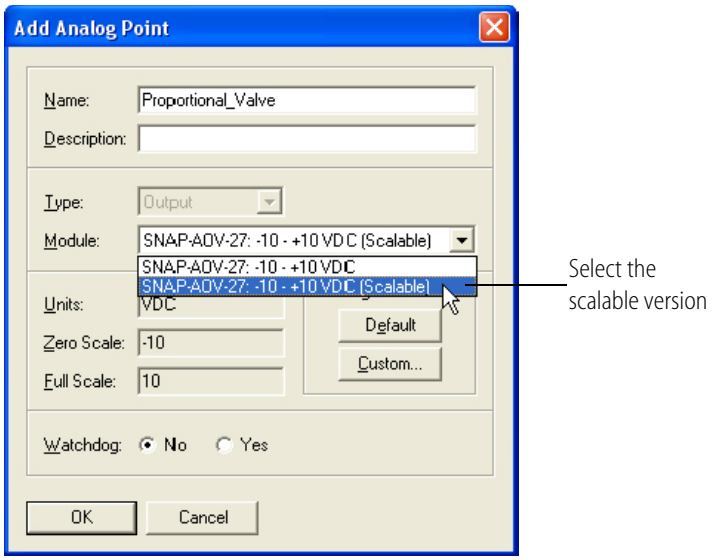
5. Click OK.
6. Double-click module 04 to open the Add Module dialog box.
7. Under Type, select Analog Input. Then select SNAP-AIV.



8. Click OK.

   Now you are ready to add the points.
9. Expand module 2, the SNAP-AOV-27 analog output module.
10. Double-click point 0 to open the Add Analog Point dialog box.

11. Enter the name, Proportional Valve, and then select the scalable version of the module.

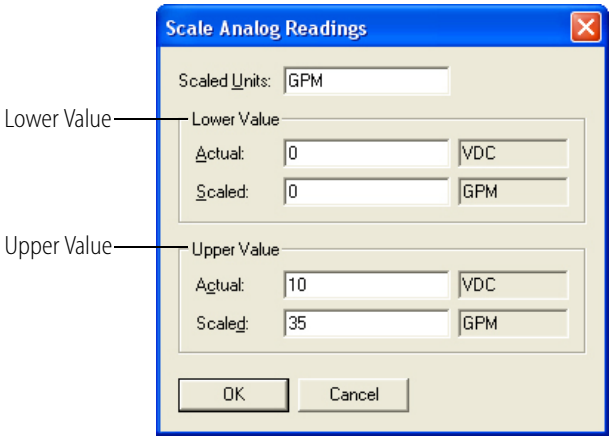


12. Click the Custom button to open the Scale Analog Readings dialog box.

13. In this example, values are

14. In order to change units to scaled units representing gallons per minute, complete the fields as follows:

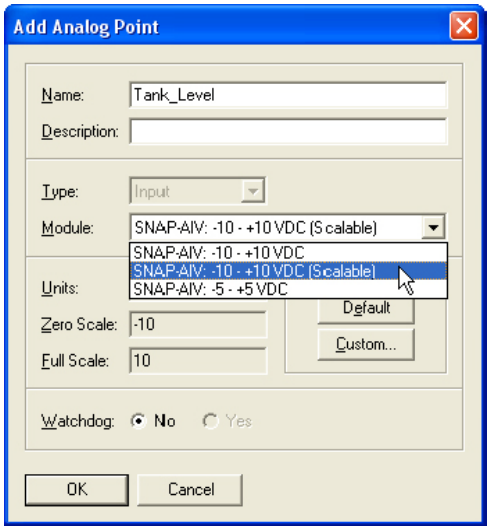
- **Scaled Units**: GPM
- **Lower Value**
  Actual: 0
  Scaled: 0
- **Upper Value**
  Actual: 10
  Scaled: 35



15. Click OK on the Scale Analog Readings dialog box, and then click OK to close the Add Analog Point dialog box.

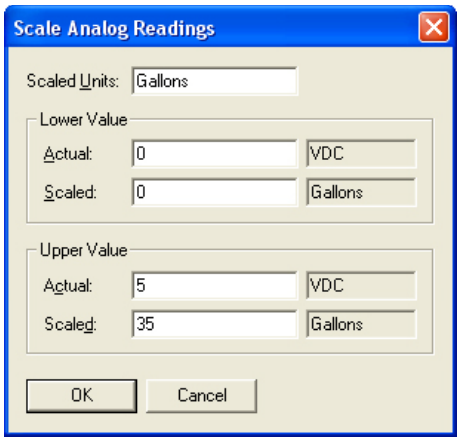
Configuring the Points on the SNAP-AIV Input Module

1. Expand module 04, the SNAP-AIV analog input module.
2. Double-click point 0 to open the Add Analog Point dialog box.
3. Enter the name, Tank Level, and then select the scalable version of the module.



4. Click the Custom button.
5. For this lesson, assume that the fuel tank holds 35 gallons, and then fill in the fields on the Scale Analog Readings dialog box as follows:
   - **Scaled Units**: Gallons
   - **Lower Value**
     Actual: 0
     Scaled: 0
   - **Upper Value**:
     Actual: 5
     Scaled: 35

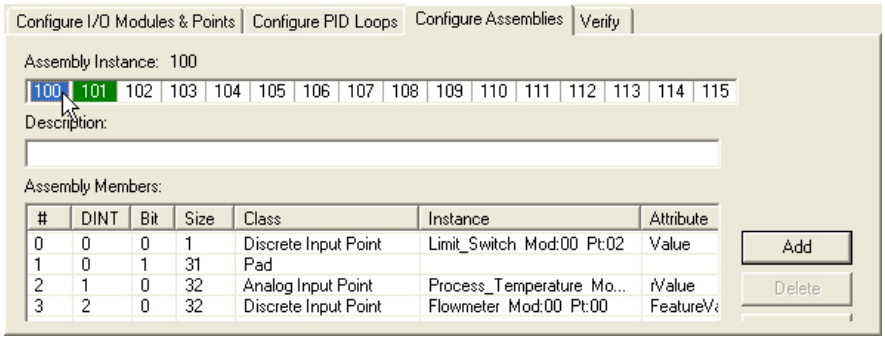
The completed dialog box looks like this.



6. Click OK, and then click OK again.

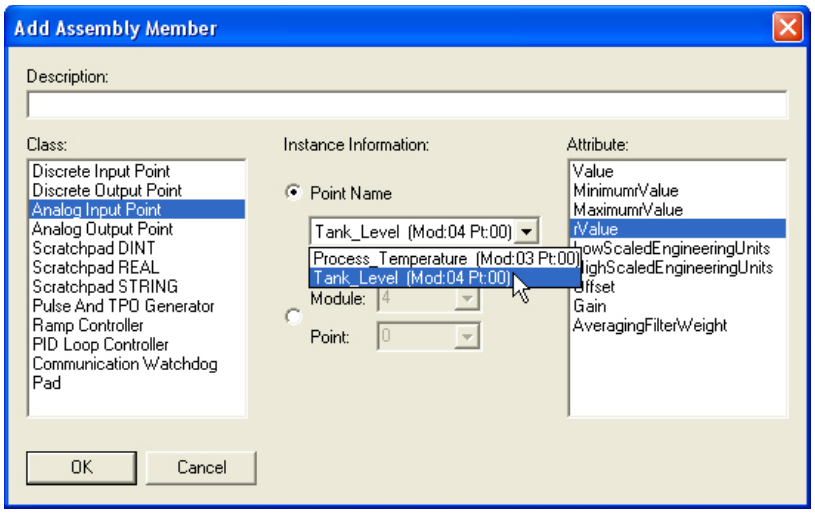
Configuring the Assemblies

1. Click the Configure Assemblies tab, and then click input assembly instance 100.

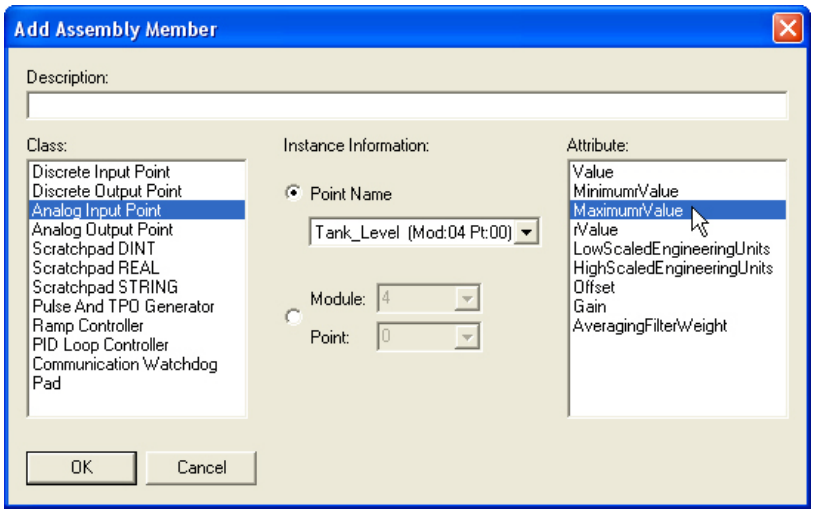


2. In order to create a completely new input assembly, highlight the first assembly member, and then click the Delete button enough times to delete the existing members from the previous lessons.
3. Click the Add button to open the Add Assembly Member dialog box.

4. Select the following characteristics:
   - **Class**: Analog Input Point
   - **Point Name**: Tank Level
   - **Attribute**: rValue

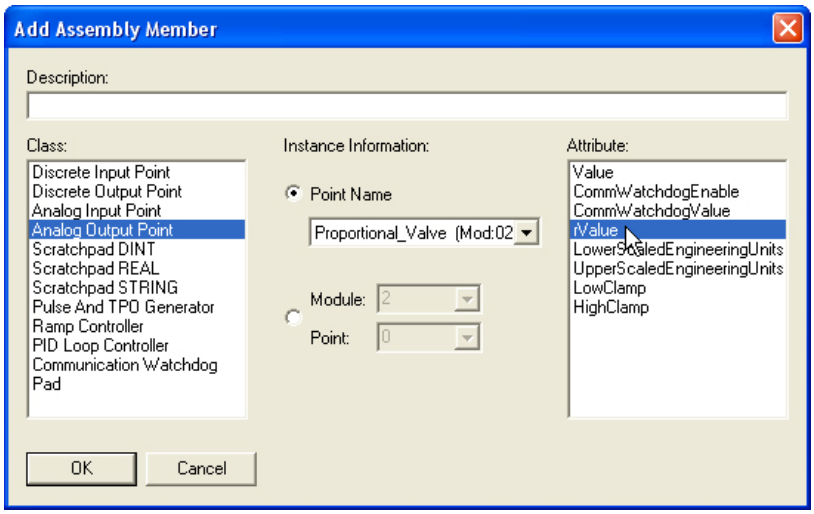


5. Click OK.
6. Click No on the Fill Module dialog box, and then click OK.
7. Click the Add button and add another assembly member with the following characteristics:
   - **Class**: Analog Input Point
   - **Point Name**: Tank Level
   - **Attribute**: Maximum rValue

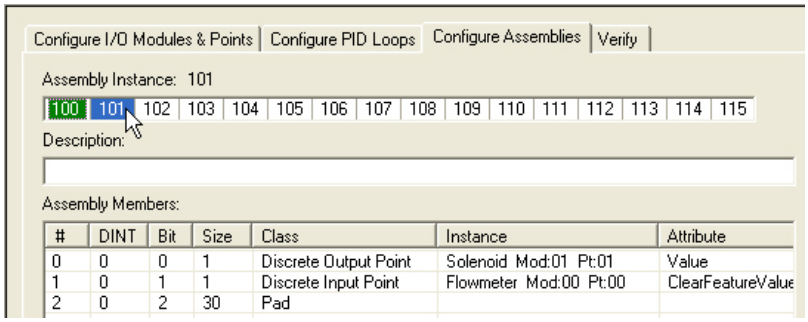


8. Click OK.

9. Click No on the Fill Module dialog box, and then click OK.
10. Add one more member to the input assembly by clicking Add again and selecting the following characteristics:
    - **Class**: Analog Output Point
    - **Point Name**: Proportional Valve
    - **Attribute**: rValue



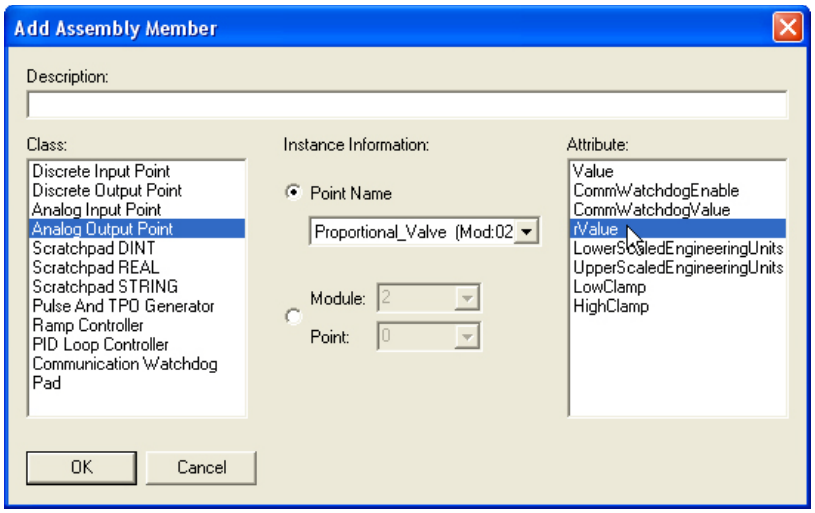
11. Click OK.
12. To configure the output assembly, click assembly instance 101.



13. In order to create a completely new output assembly, delete the existing members using the Delete button.

14. Add an assembly member with the following characteristics:

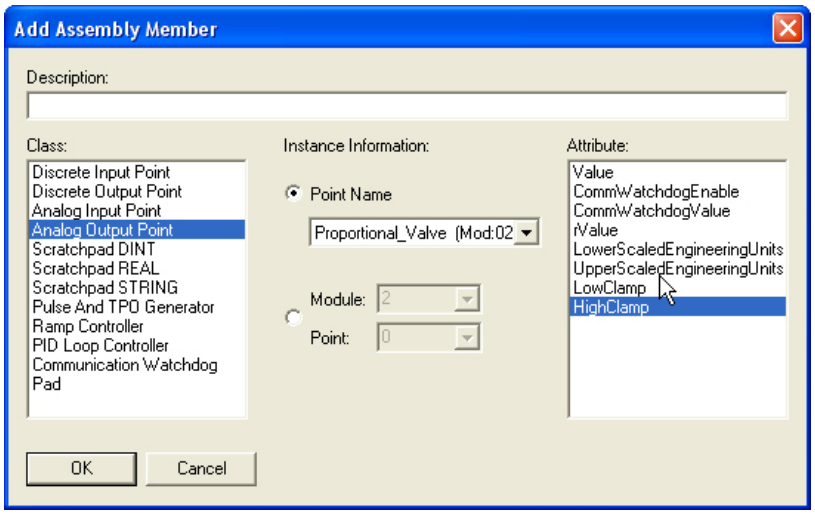
- **Class**: Analog Output Point
- **Point Name**: Proportional Valve
- **Attribute**: rValue



15. Click OK.

16. Add one more member to the output assembly that has the following characteristics:

- **Class**: Analog Output Point
- **Point Name**: Proportional Valve
- **Attribute**: HighClamp

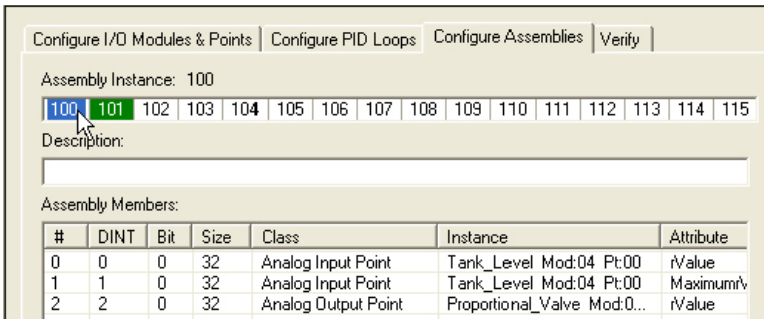


17. Click OK.

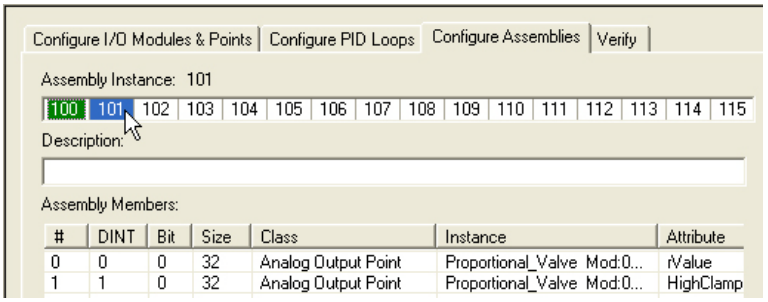
18. On the Fill Module dialog box, select No and then click OK.

In this activity you have created an input assembly instance that has three 32-bit DINTs and an output assembly instance that has two 32-bit DINTs, as follows:

Input Assembly 100:



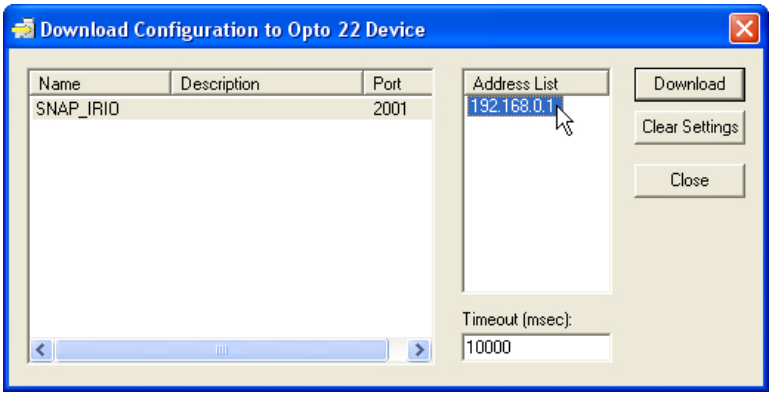
Output Assembly 101:



19. Save the configuration.

20. Choose Tools→Download Configuration to Opto 22 Device.

21. In the Download Configuration dialog box, select the brain's IP address.



22. Click Download.

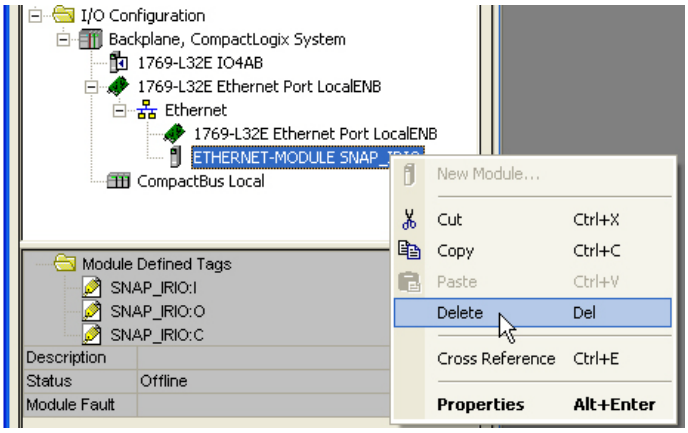
23. When the configuration has been downloaded successfully, click Close.

Now you are ready to set up RSLogix 5000.

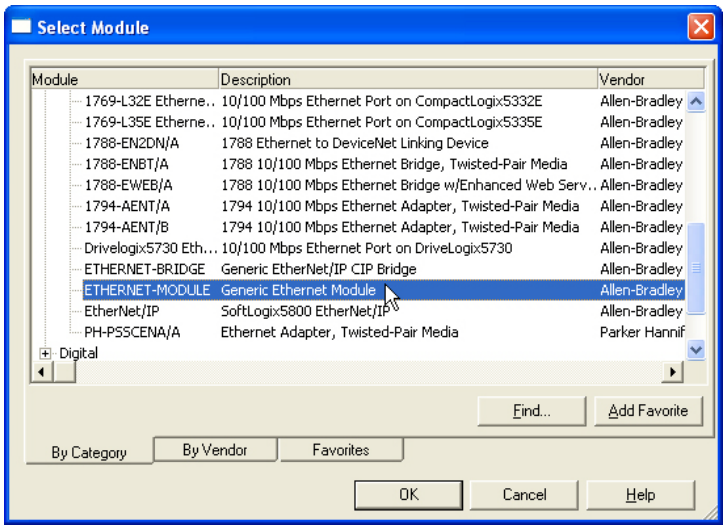
Setting Up RSLogix 5000

1. In RSLogix 5000, open IO4AB, the project from the previous lesson.
2. In the project tree display, expand I/O Configuration, Backplane, 1769-L32E Ethernet Port LocalENB, and Ethernet.
3. Right-click ETHERNET MODULE SNAP_IRIO and select Delete, and then click Yes to confirm.

NOTE: The remote I/O is capable of processing both analog and digital data at the same time. However, the Generic Ethernet Module makes you choose just one data type, which cannot be changed later. In Lesson 1, which dealt with thermocouple temperature, you got around this picking the DINT data type for the Generic Ethernet Module, and then you created a CPS instruction in ladder logic to change the analog tag to a user created variable of REAL data type.



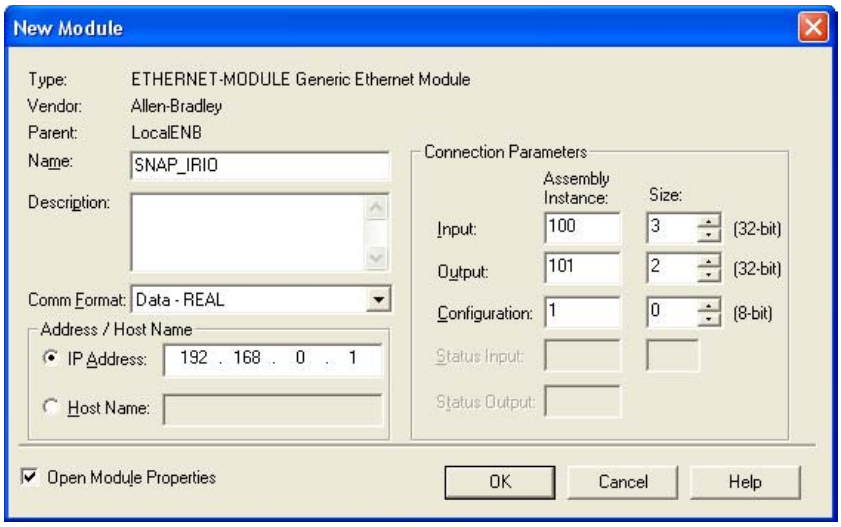
4. Right-click Ethernet and select New Module.
5. Expand Communications in the tree display to open the Select Module dialog box.
6. Scroll down to select Generic Ethernet Module and then click OK to open the New Module dialog box.



7. Enter or select the following information:
   - **Name**: SNAP_IRIO
   - **Comm Format**: Data - REAL.
   - **IP Address**: *IP address of the EB1*
   - **Input Assembly Instance**: 100, Size: 3 (There are three 32-bit input DINTs.)
   - **Output Assembly Instance**: 101, Size: 2 (There are two 32-bit output DINTs.)
   - **Configuration**: 1, 0 (You must enter these values.)

   NOTE: The Input Instance is an RSLogix 5000 READ assembly, and the Output Instance is an RSLogix 5000 WRITE assembly. The Configuration values are not used, but they must be entered.

   The completed dialog box should look like this:



8. Click OK.

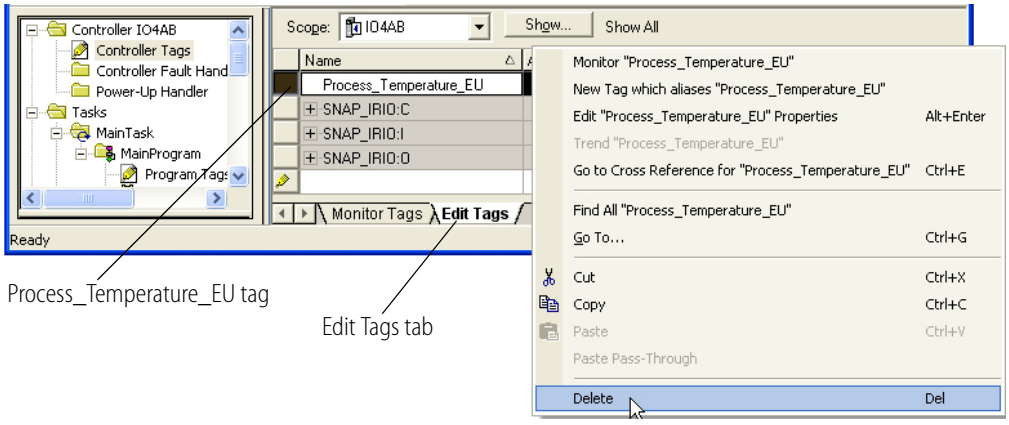
   The Module Properties dialog box opens, showing the Connection tab for you to enter the Requested Packet Interval (RPI). The RPI is basically the scan time of the remote I/O unit.

9. Set the RPI to 200.0 ms, and then click OK.

   The Opto 22 remote I/O has now been configured and added to the RSLogix 5000 software as a generic Ethernet module.

10. Open the Controller Tag, and then click the Edit Tags tab.

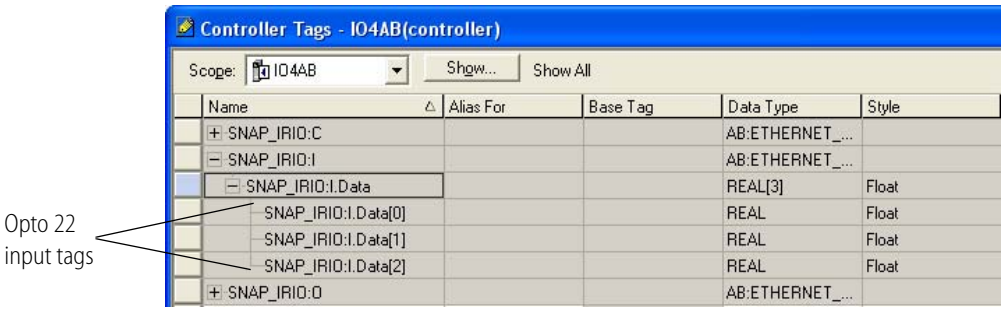
11. Delete the Process_Temperature_EU from lesson 1 tag by right-clicking on it and then selecting Delete.



12. Select Communications→Download to download the RSLogix 5000 program to the controller, and then click Download in the next dialog box that appears.

13. Select Communications→Run Mode, and then click Yes in the next dialog box.

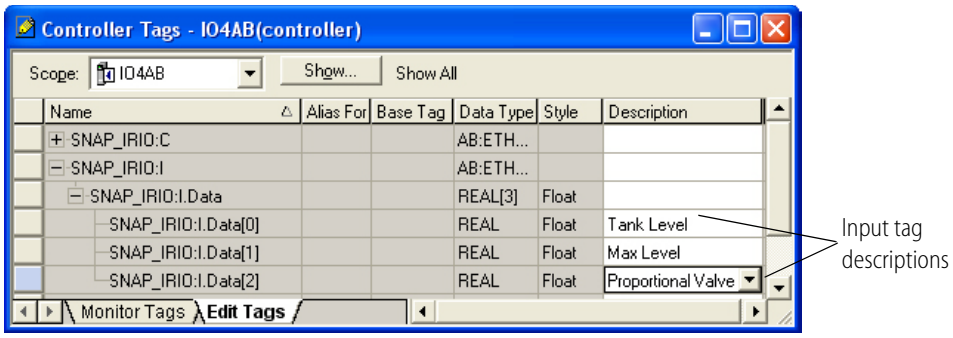
14. In the Controller Tags window, expand SNAP _IRIO:I until you see the Opto 22 input tags.



15. Enter a description for each of the input tags as follows:

Tag	Description
0	Tank Level
1	Max Level
2	Proportional Valve

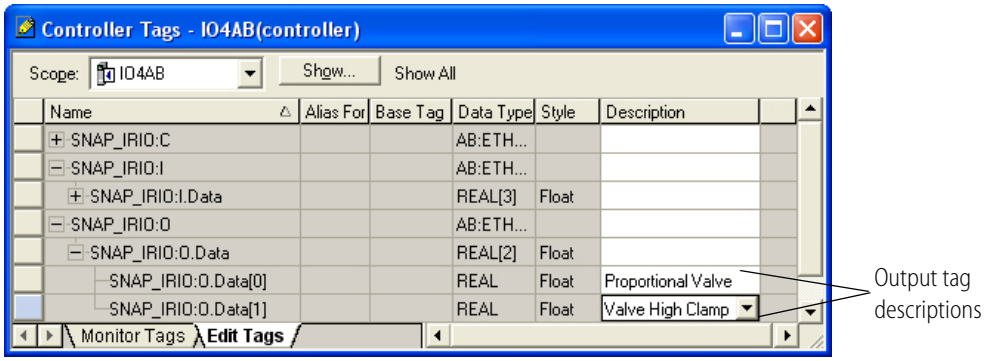
The input tags will now look like this:



16. Expand SNAP _IRIO:O until you see the output tags, and then enter a description for each output tag as follows:

Tag	Description
0	Proportional Valve
1	Valve High Clamp

The output tags will now look like this:

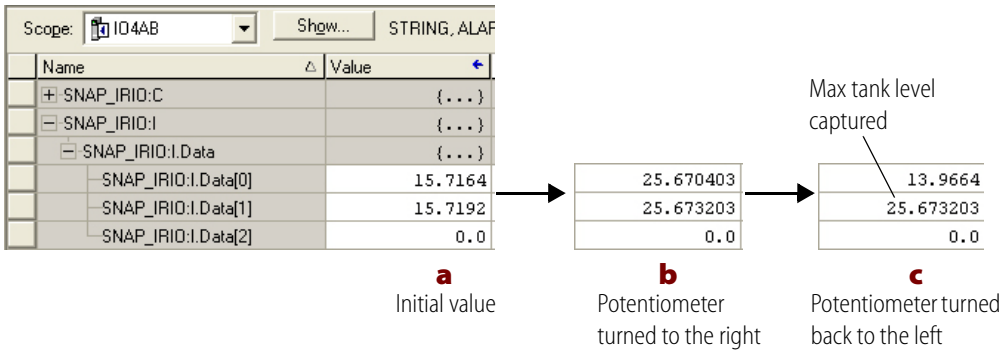


17. Do the following things:

a. Notice the values for input [0] Tank Level and [1] Max Level.

b. Turn the Tank Level potentiometer to the right and notice that the values change.

c. Turn the Tank Level potentiometer back to the left and notice what happens. The value of input [0] Tank Level decreases, but the value of input [1] Max Level has captured the maximum tank level.



You have just read the analog value of the Tank Level and recorded the maximum Tank Level value, all in scaled Engineering Units.

Using Analog Output

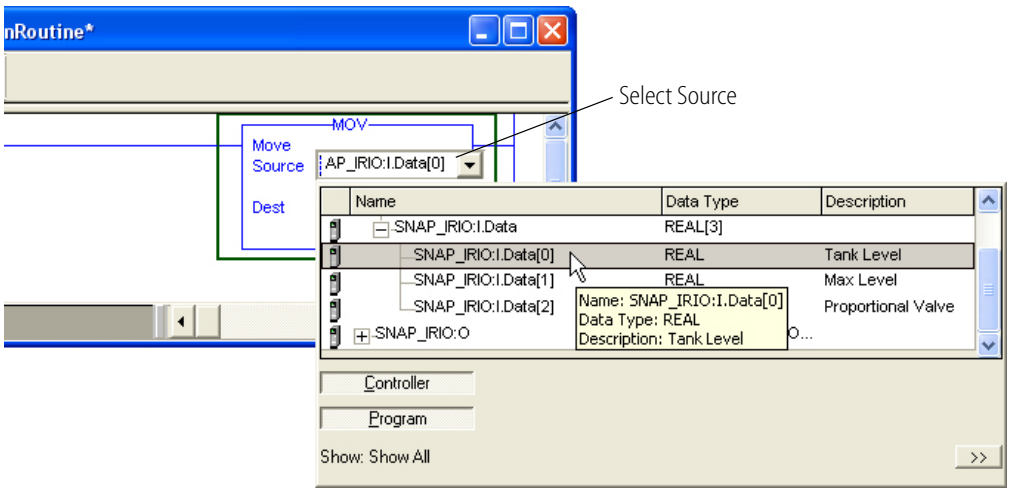
In this activity you will see how the Allen-Bradley PLC communicates to the SNAP analog output. You will also see an example of an intelligent attribute, analog output clamping.

1. Stop the controller by selecting Communications→Go Offline.

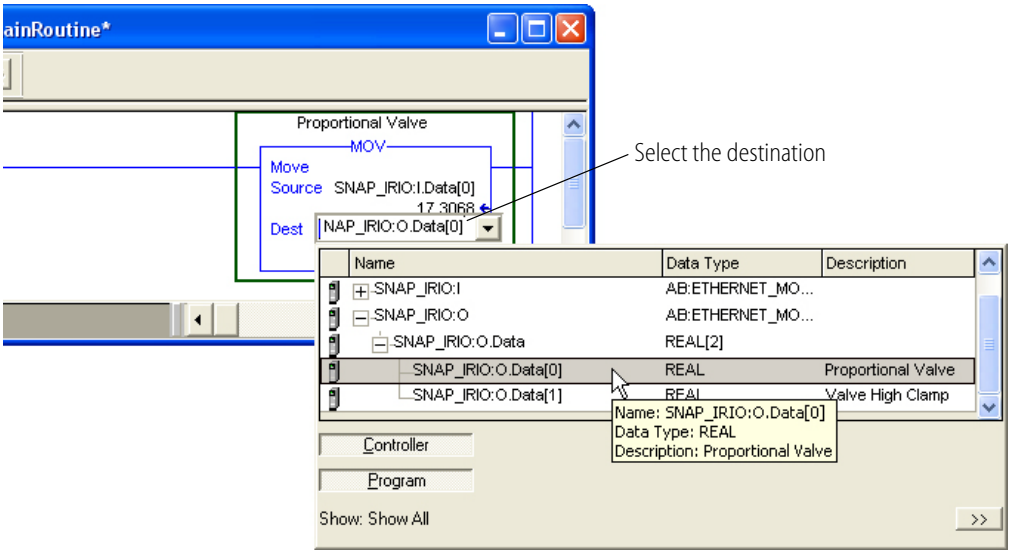
2. Open the MainRoutine and add one rung of ladder logic instruction.

3. Click the Move/Logical tab, and then click the MOV button to add a Move instruction.

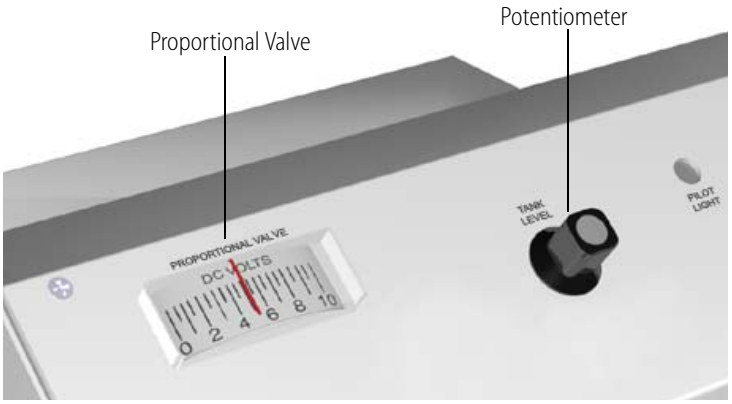
4. Double-click Source, expand SNAP_IRIO:I, and then select SNAP_IRIO:I.Data[0], Tank Level.



5. Double-click Dest, expand SNAP_IRIO:O, and then select SNAP_IRIO:O.Data[0], Proportional Valve.

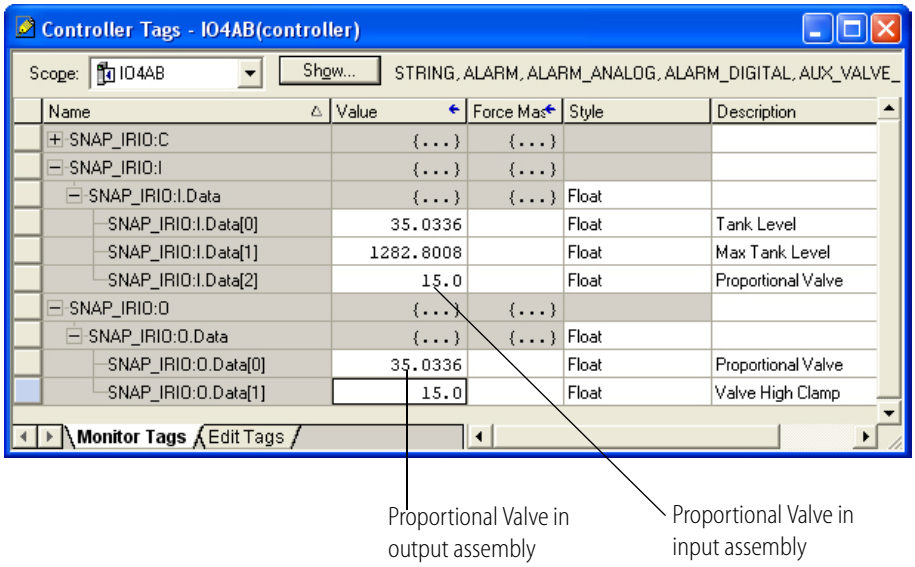


6. Select Communications→Download, and then click Download in the next dialog box that appears.
7. Click Yes in the next dialog, which asks, "Change controller mode back to Remote Run?"
8. Select Communications→Run Mode, and then click Yes in the next dialog box.
9. Open the Controller Tags and expand the input and output tags.
10. Notice on the Learning Center that there is now a value for the Proportional Valve, displayed in scaled Engineering Units.



11. Turn the potentiometer and watch the Proportional Valve value change in RSLogix 5000 as well as in the Proportional Valve display on the Learning Center.
12. Do the following things to see the intelligent I/O feature of an output clamp.
    a. Turn the Tank Level potentiometer on the Learning Center to the left, close to zero.
    b. In RSLogix 5000, go to the Valve High Clamp value and enter a value of 15.
    c. Turn the potentiometer clockwise as far as it will go.

In the output assembly, notice that the Proportional Valve value has gone above 15, yet in the input assembly the Proportional Valve has clamped at 15.



Also note that the Proportional Valve display on the Learning Center has clamped at approximately one half the full scale.

Summary of Lesson 3

In lesson 3 you configured analog input and output points at the I/O level to return values in Engineering Units that were matched to the field instrumentation. In addition you used some of the available intelligent I/O attributes, including Analog Input Maximum Value and Analog Output High Clamp.

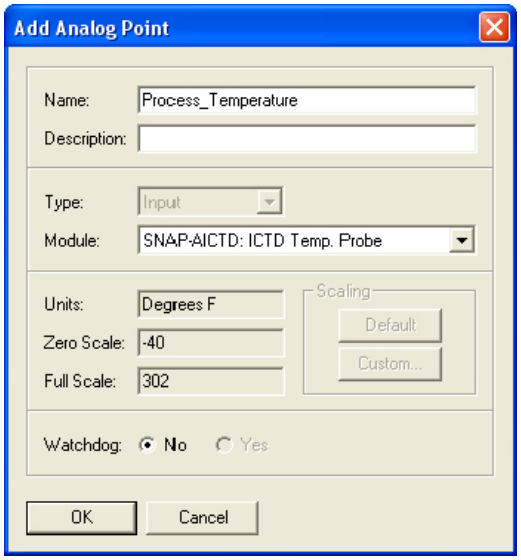
Lesson 4: Using Distributed PID Loop Control

In this lesson you will build on the previous lesson to configure and run a distributed proportional integral derivative (PID) loop in the Opto 22 intelligent remote I/O. This PID loop will write to the PID setpoint sent from the Allen-Bradley controller to demonstrate how you can change a setpoint based on a process condition. You will also use the PID loop tuning tool that's available in the EtherNet I/P Configurator.

Configuring the ICTD Temperature Probe

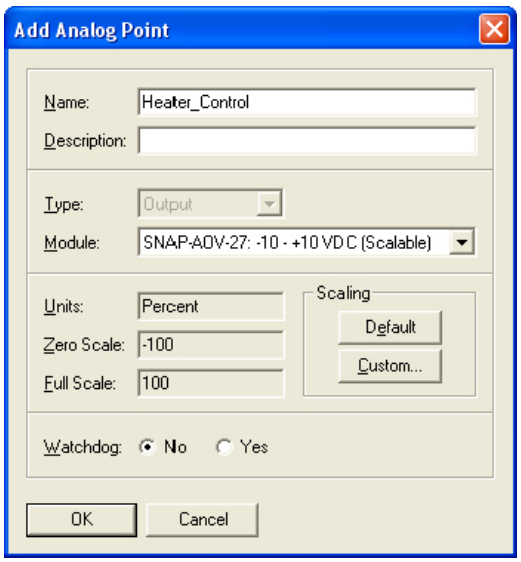
1. In EtherNet/IP Configurator, open SNAP_IRIO.otg, the configuration you created in a previous lesson.
2. Click the Configure I/O Modules & Points tab, and then expand module 3, the SNAP-AICTD analog input module.

3. Double-click point 0 of module 3, the SNAP-AICTD analog input module, and name the new point Process_Temperature.

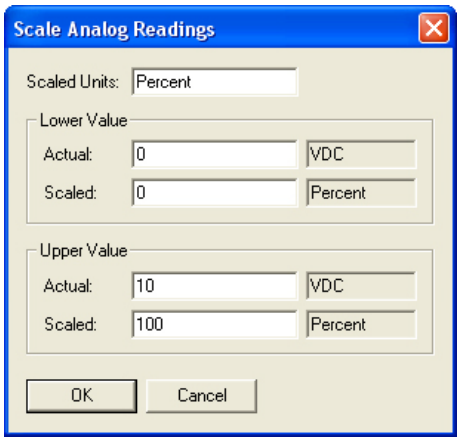


NOTE: The ICTD temperature probe on your Learning Center is actually a PID Simulator, which has—in addition to the ICTD—a resistor that heats up the probe to simulate a real world process. This resister is wired to point 1 of module 2, the SNAP-AOV (analog output module).

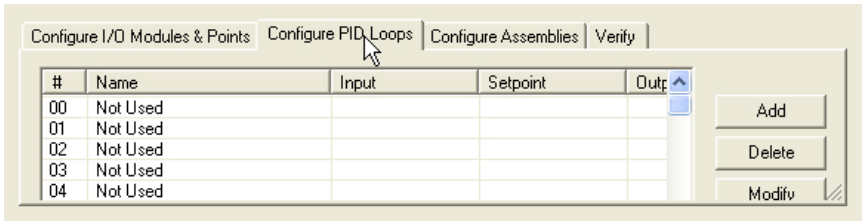
4. Click OK.
5. Expand module 2, the SNAP-AOV analog output module, and add point 1 with the following characteristics:
   - **Name**: Heater_Control
   - **Module**: Scalable



6. Click the Custom button to open the Scale Analog Readings dialog box.
7. Complete the fields as follows:
   - **Scaled Units**: Percent
   - **Lower Value**
     Actual: 0
     Scaled: 0
   - **Upper Value**:
     Actual: 10
     Scaled: 100



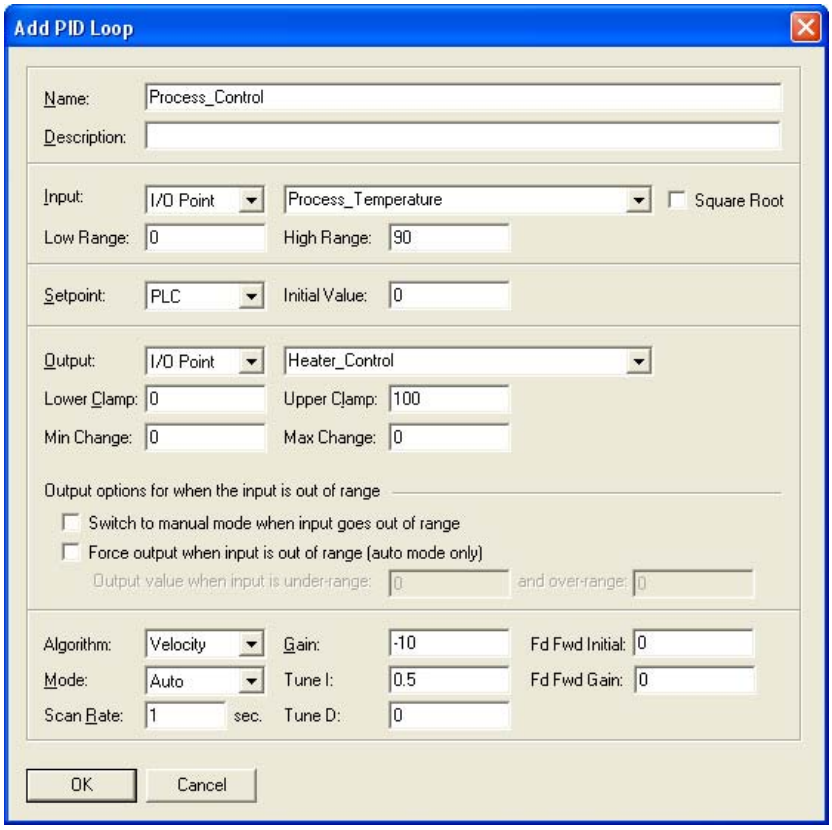
8. Click the Configure PID Loops tab.



9. Select PID #00 and then click the Add button.
10. On the Add PID Loop dialog box, complete the fields as follows:
    - **Name**: Process_Control
    - **Input**: I/O Point, Process_Temperature
    - **Low Range**: 0
    - **High Range**: 90
    - **Setpoint**: PLC
    - **Initial Value**: 0
    - **Output**: I/O Point, Heater_Control
    - **Lower Clamp**: 0

- **Upper Clamp**: 100
- **Algorithm**: Velocity
- **Scan Rate**: 1
- **Gain**: -10
- **Tune I**: 0.4
- **Tune D**: 0

Leave the default settings for all other parameters. The completed dialog box should look like this:



The Scan Rate is the rate at which each individual PID loop is solved. It is not related to the communication between the Allen-Bradley controller and the SNAP intelligent remote I/O (RPI). You might remember that the PID loop execution is independent of the PLC and distributed in the SNAP I/O. Although the max scan rate can be as low as 1 millisecond for an individual PID loop, for this lesson we will leave the scan rate at 1 second.

11. Click OK.

12. Click the Configure Assemblies tab, and then add the following members to input assembly 100:

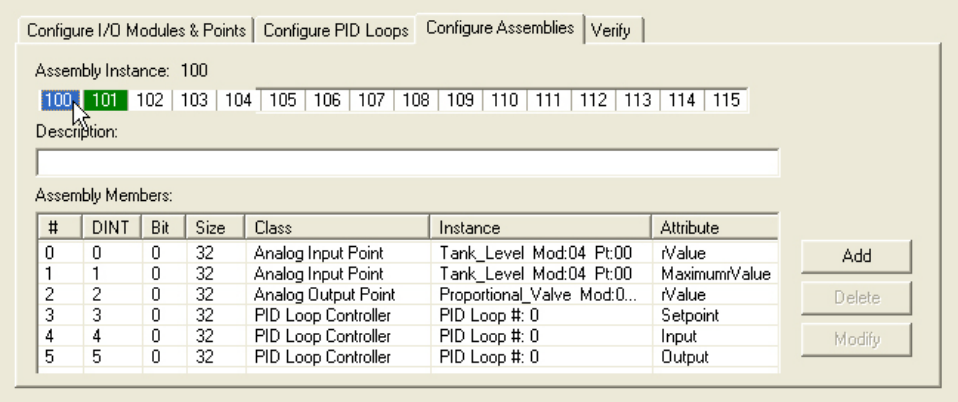
Number	Class	Instance	Attribute
3	PID Loop Controller	PID Loop #: 0	Setpoint
4	PID Loop Controller	PID Loop #: 0	Input
5	PID Loop Controller	PID Loop #: 0	Output

13. Click output assembly 101, and add the following member to the existing configuration:

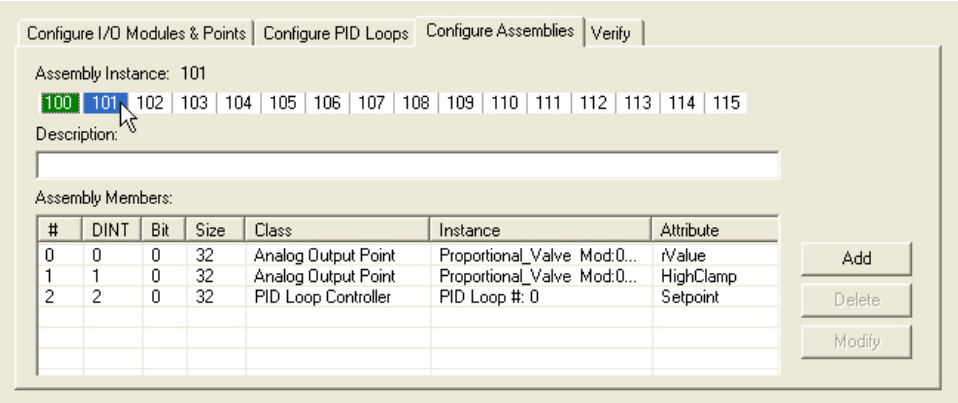
Number	Class	Instance	Attribute
2	PID Loop Controller	PID Loop #: 0	Setpoint

The updated assemblies now look like this:

Input Assembly 100:

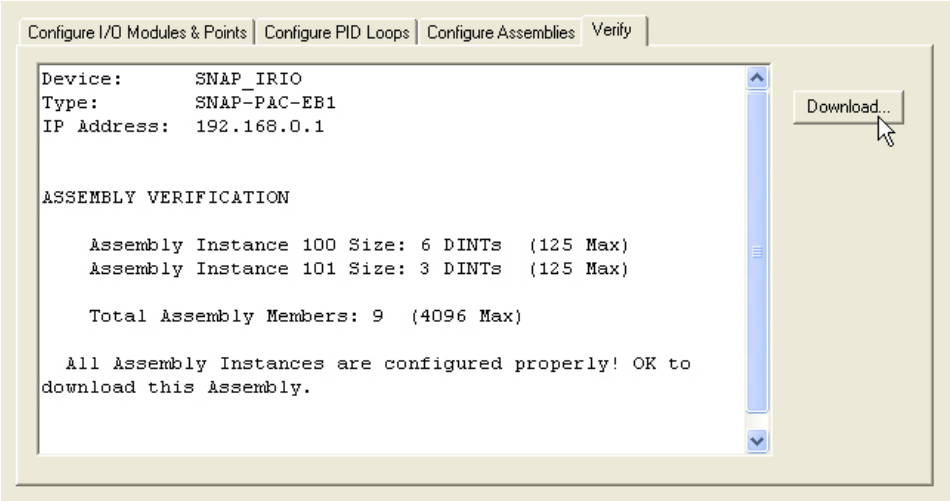


Output Assembly 101:



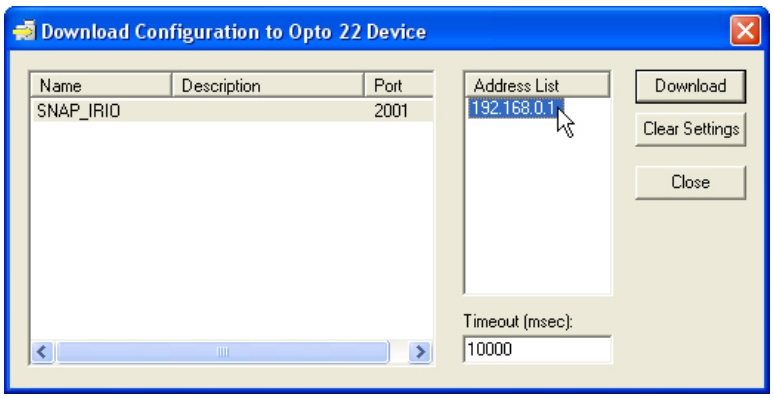
14. Press Ctrl+S to save the configuration.

15. Click the Verify tab.



16. Click the Download button.

17. In the Download Configuration dialog box, select the brain's IP address.



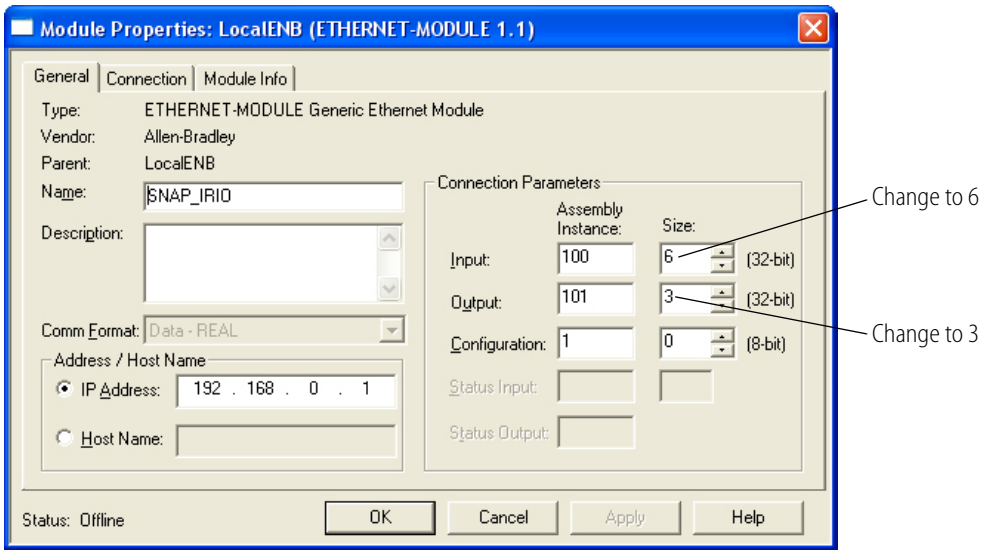
18. Click Download.

19. When the configuration has been downloaded successfully, click Close.

This completes the setup of the Opto 22 remote I/O for lesson 4.

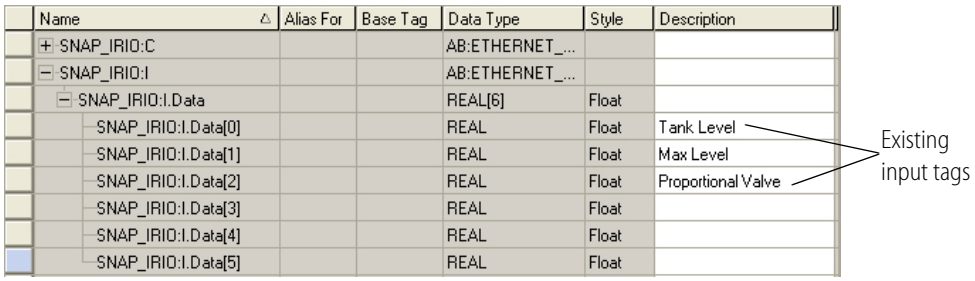
Configuring RSLogix 5000

1. In RSLogix 5000, open IO4AB, the project from the previous lesson.
2. In the project tree display, expand I/O Configuration, Backplane, 1769-L32E Ethernet Port LocalENB, and Ethernet.
3. Double-click ETHERNET MODULE SNAP_IRIO to open the Module Properties dialog box.
4. Change the size for assembly 100 to 6 and the size for 101 to 3.



5. Click OK.
6. In the project tree display, double-click Controller Tags.
7. In the Controller Tags window, expand SNAP_IRIO:I until you see the Opto 22 input tags.
8. Click the Edit Tags tab.

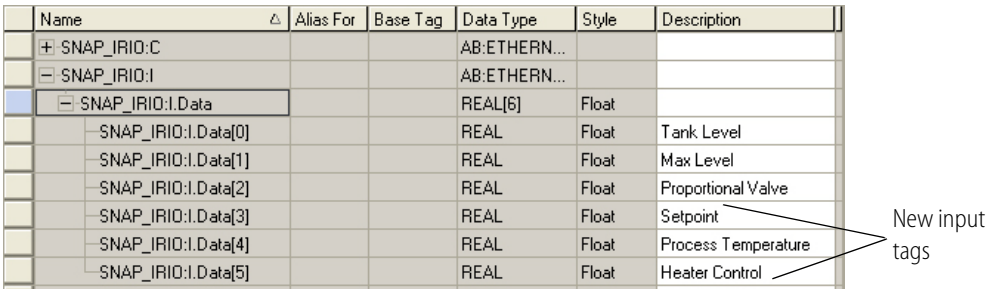
   You should see the existing tags from the previous lesson:



9. Enter descriptions for input tags 3, 4, and 5 as follows:

Tag	Description
3	Setpoint
4	Process Temperature
5	Heater Control

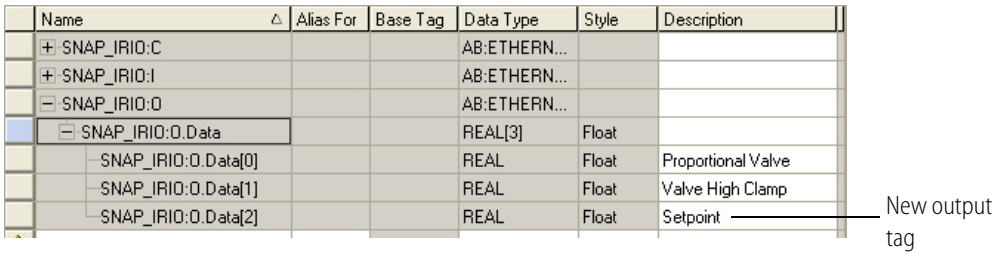
The input tags will now look like this:



10. Expand SNAP _IRIO:O until you see the existing output tags.

11. For the one new output tag, enter Setpoint as the description.

The output tags will now look like this:



12. Select Communications→Download to download the RSLogix 5000 program to the controller.

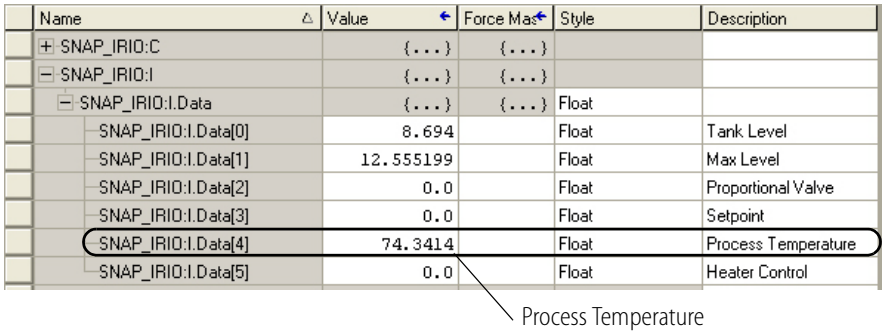
13. Click Download in the next dialog box that appears.

14. Select Communications→Run Mode, and then click Yes in the next dialog box.

Controlling the Setpoint

1. With the Controller Tags window open in RSLogix 5000, click the Monitor Tags tab.

2. Notice that the Process Temperature is displayed in engineering units and it shows the temperature in the room.



3. Hold the probe between your fingers for a only a second or two and notice the temperature rise.

Now you're going to observe how the PID loop reacts when you change the Setpoint based on a process condition.

4. Expand the output tags so that you can see the Setpoint tag.
5. Change the Setpoint tag's value to a few degrees higher than the current Process Temperature, and then press Enter.

   For example, if the Process Temperature is 74, change the Setpoint to 78.

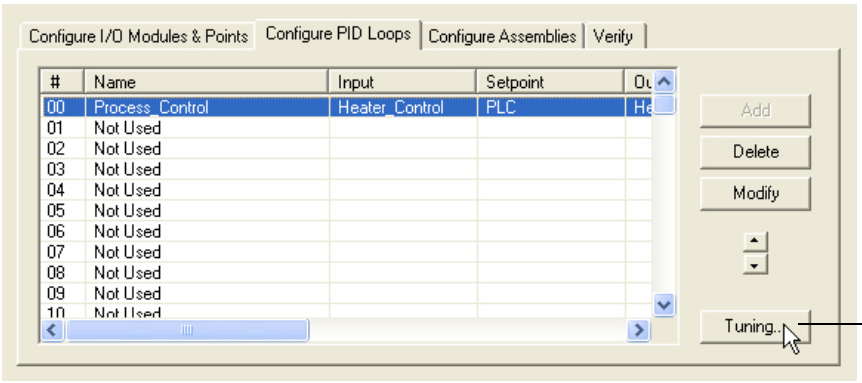
Change the Setpoint to a few degrees higher.

Name	Value	Force Mas	Style	Description
⊞ SNAP_IRIO:C	{...}	{...}		
⊟ SNAP_IRIO:I	{...}	{...}		
⊟ SNAP_IRIO:I.Data	{...}	{...}	Float	
SNAP_IRIO:I.Data[0]	8.694		Float	Tank Level
SNAP_IRIO:I.Data[1]	12.555199		Float	Max Level
SNAP_IRIO:I.Data[2]	0.0		Float	Proportional Valve
SNAP_IRIO:I.Data[3]	78.0		Float	Setpoint
SNAP_IRIO:I.Data[4]	78.087555		Float	Process Temperature
SNAP_IRIO:I.Data[5]	54.46072		Float	Heater Control
⊟ SNAP_IRIO:O	{...}	{...}		
⊟ SNAP_IRIO:O.Data	{...}	{...}	Float	
SNAP_IRIO:O.Data[0]	0.0		Float	Proportional Valve
SNAP_IRIO:O.Data[1]	0.0		Float	Valve High Clamp
SNAP_IRIO:O.Data[2]	78.0		Float	Setpoint

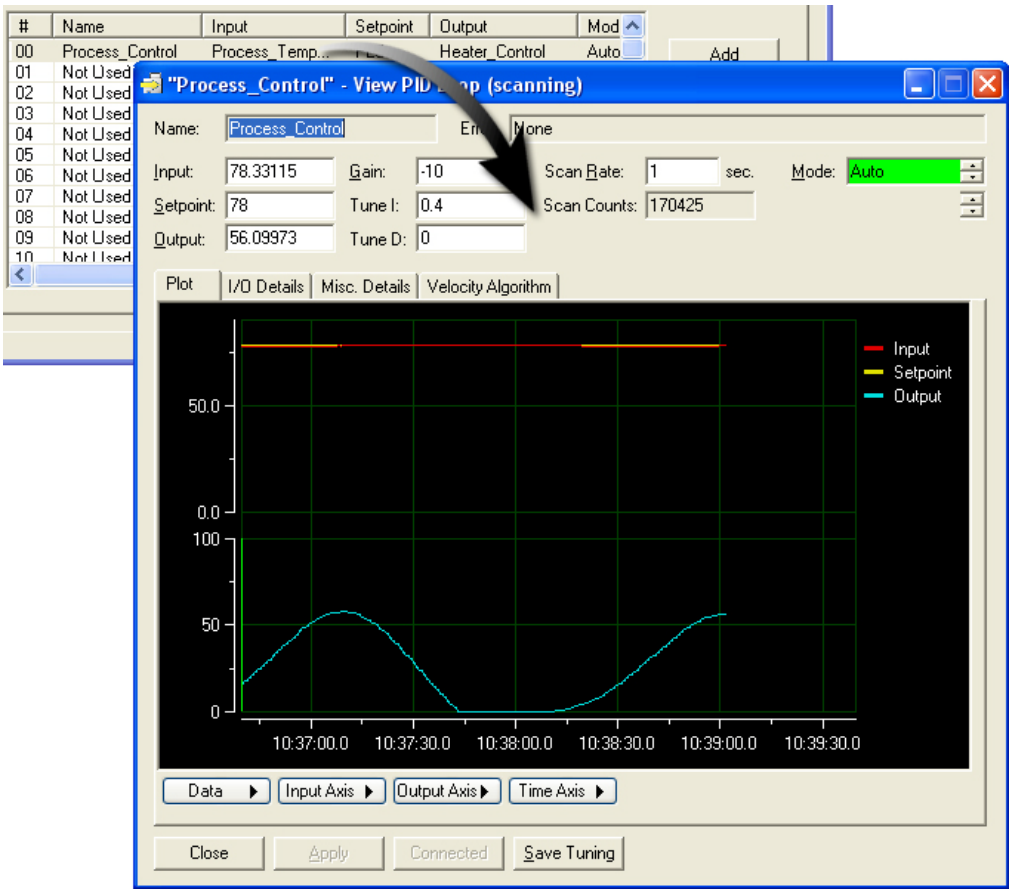
Watch these values react.

6. Watch the Heater Control and Process Temperature react.

   You should see the Heater Control vary as it attempts to change the Process Temperature to match the Setpoint.
7. Now go to EtherNet I/P Configurator and click the Configure PID Loops tab.
8. Select Loop 00, Process_Control.



9. Click the Tuning button.
10. Observe what happens in the View PID Loop dialog box.



In the View PID Loop dialog box, you can tune your PID loop using the Gain, Tune I, and Tune D parameters. To save changes to the I/O brain's RAM, click the Apply button. Or, if you want to save the changes permanently to flash memory and your configuration file, click the Save Tuning button. The Save Tuning button does not interfere with communications to the Allen-Bradley controller. For more information on PID tuning and the features of the PID tuning tool, see form 1770, the *EtherNet/IP for SNAP PAC Protocol Guide.* See also, Opto 22 form 1641, *OptoTutorial: SNAP PAC PID*, which we highly recommend for detailed information on PIDs on Ethernet-based I/O units. Form 1641 is available for download from our website at www.opto22.com.

About PID Loops

PID loops (or simply PIDs) are used to drive an input (a process variable) toward a particular value (the setpoint) and keep the input very close to that value by controlling an output. For example, consider temperature control, where the input is a measurement of ambient temperature, the setpoint is the desired temperature, and the output is a heater. The PID for this system will use a mathematical formula that controls the output to maintain a desired temperature, efficiently adjust to changes in setpoint, and compensate for changes in load, such as the influx of cold air. In this

example, a temperature sensor (analog input), a thermostat (analog input), and a heater control (analog output) are components of one system, controlled by a PID loop.

SNAP PAC I/O units support 96 PID loops. PIDs can control isolated systems or be part of cascaded systems where one loop controls the setpoints or input variables of others.

The PID operates at the I/O unit, independently of the controller. Once configured and downloaded to the brain, a PID operates until the I/O unit loses power. Remember that changes are not written to the I/O unit until the configuration is downloaded to the Opto 22 device. Each PID loop must be individually configured and tuned.

Summary of Lesson 4

In lesson 4 you built on the previous lesson to configure and run a distributed proportional integral derivative (PID) loop in the Opto 22 intelligent remote I/O. The PID loop wrote to the PID setpoint sent from the Allen-Bradley controller to demonstrate how you can change a setpoint based on a process condition. You also used the PID loop tuning tool that's available in the EtherNet I/P Configurator.

What's Next?

Now that you've completed the lessons and are ready to move on to the next level, here's where you can go for more information:

If You Need Information About:	Do This:
EtherNet/IP Configurator, EtherNet/IP messaging, and SNAP I/O hardware	See *"Documents and Online Help" on page 2*
How to configure a system or technical information on Opto 22 products	Contact Opto 22 Pre-sales Engineering Local: (951) 695-3000 Toll-Free (in the U.S.): (800) 321-6786 Fax: (951) 695-3095 E-mail: systemseng@opto22.com
How to find distributors	Go to: http://www.opto22.com/site/co_distributors.aspx
Selecting products from the Opto 22 website	Go to: http://www.opto22.com/site/pr_index.aspx

A: Supported Allen-Bradley Platforms

Opto 22 supports using the ControlLogix® and CompactLogix™ controller platforms, V13-17, with Opto 22 SNAP I/O. Both of these platforms support Implicit Messaging (also known as I/O messaging) and Explicit Messaging.

The following Allen-Bradley platforms also support EtherNet/IP. While some controllers in these platforms only support explicit messaging, Opto 22 may be able to assist you in using them.

- MicroLogix™
- DriveLogix
- SLC-5
- FlexLogix
- PLC-5
- SoftLogix5800

NOTE: Some Allen-Bradley controller platforms have only specific models that support EtherNet/IP or require an adapter module or card.

For a complete and up-to-date list of Allen-Bradley platforms that support EtherNet/IP, and more information on which platforms support Implicit Messaging or Explicit Messaging only, please contact Rockwell Automation.